Risk Scenarios and Macroeconomic Impacts: Insights for Canadian Policy

Kevin Moran
Université Laval
CIRANO

Dalibor Stevanovic
UQAM
CIRANO

Stéphane Surprenant
UQAM

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Abstract

This paper analyzes the macroeconomic implications of risk scenarios for the Canadian economy using a Vector Autoregressive (VAR) model. We focus on three scenarios: an aggressive monetary policy easing, an unexpected rise in oil prices, and a sudden slowdown in U.S. economic activity. By illustrating how these scenarios would cause the economy to deviate from baseline macroeconomic forecasts, we demonstrate the value for policymakers of assessing the potential outcomes of key shocks through this type of analysis. We highlight the varied impacts of these shocks—for example, the sensitivity of industrial production and housing markets to monetary easing, the demand-driven gains from rising oil prices, and the contractionary effects of a U.S. recession. Structural decomposition reveals how specific shocks shape economic outcomes, offering insights into their transmission mechanisms. These findings underscore the importance of incorporating conditional forecasts into policy discussions to better understand the potential risks facing the Canadian economy.

Keywords— Economic forecasts, risk scenarios, VAR, macroeconomic fluctuations, conditional forecasts

JEL Codes— E32, F41, F44

1 Introduction

Forecasts are integral to policy discussions at central banks and government agencies. These discussions typically begin with a baseline (or unconditional) forecast, which represents the most likely outcome based on the information available at the time of prediction and under the assumption that no unforeseen events will occur in the future.[1]

However, the future evolution of the economy may deviate from the central trend identified in the baseline forecast, making it essential to evaluate the associated risks. In this context, public policy has a natural interest in risk scenarios that examine the sensitivity of forecasts to specific eventualities that, while not the most probable, remain plausible. These "what-if" scenarios may include assessing how forecasts change under an alternative policy trajectory, when additional external information is incorporated into the forecast, or when stress testing the banking sector's vulnerability to an economic downturn (McCracken and McGillicuddy, 2019; Antolin-Diaz et al., 2021).[2]

Risk scenarios appear in various reports and budgetary outlooks published by Canadian officials, underscoring how they help policymakers consider a range of possible outcomes and navigate uncertain environments.[3] Furthermore, the importance of risk scenarios was recently emphasized in the Bernanke (2024) report on the Bank of England, which advocates for their expanded role in the institution's forecasting and communication strategies.

This paper argues that risk scenarios for the Canadian economy should be developed and implemented in a coherent, systematic, and transparent manner. This is crucial because the methodologies used to construct these scenarios are often neither standardized

[1]Formal statistical models align the baseline forecast with the model's expected future values of the variables of interest. This approach is motivated by the desirable statistical properties of expectations, particularly when the objective is to minimize the mean squared error of the forecasts.

[2]The terms "risk scenarios," "forecast scenarios," and "conditional forecasts" are used interchangeably in the literature. This paper adopts the first two terms as synonyms. Note that the concept of risk scenario differs from density forecasting or quantile regressions (Adrian et al., 2019; Lenza et al., 2023; Adrian et al., 2025), which focus on assessing forecast uncertainty or predicting rare events but lack the narrative content of risk scenarios.

[3]Examples of policy publications emphasizing risk scenarios include the Bank of Canada Monetary Policy Report, the CMHC's Housing Market Outlook and budgetary statements from the Ontario Finance Minister and the Quebec Finance Minister.

nor clearly communicated, which undermines their effectiveness as narrative tools. Additionally, employing a formal statistical framework emphasizes the connections between shocks, their transmission through the economy and the resulting scenarios. Our overall objective is to foster dialogue on improving the development and use of conditional forecasts, recognizing their pivotal role in creating effective and responsive public policy.

We demonstrate the application of such a formal framework using Vector Autoregressive (VAR) models, a widely used statistical tool for generating forecasts. Two notable academic contributions have explored approaches for modifying forecasts to align them with risk scenarios (Waggoner and Zha, 1999; Baumeister and Kilian, 2014) and several empirical studies have highlighted the utility of these methods in generating scenario-compatible forecasts (Jarociński, 2010; Giannone et al., 2014; Bańbura et al., 2015; McCracken and McGillicuddy, 2019). However, academic research specifically addressing the Canadian economy remains notably scarce, despite this active body of literature.

Our VAR model includes six Canadian macroeconomic aggregates: the Canada-US exchange rate, inflation, housing starts and prices, industrial production and a short-term interest rate reflecting monetary policy. Given the significant influence of energy and the US economy on Canadian economic activity, the VAR also incorporates measures of oil prices and US economic activity. We evaluate three scenarios with potential impacts on the Canadian economy. Domestically, we examine a scenario involving a faster-than-expected loosening of monetary policy. Internationally, we assess two scenarios: an unexpected increase in oil prices and a surprise downturn in US economic activity.

The monetary policy scenario highlights the nuanced aspects of monetary policy transmission across sectors and over time in Canada. Inflation remains surprisingly muted following the aggressive rate cuts featured in the scenario, reflecting the limited influence of monetary policy shocks on short-term price dynamics. In contrast, industrial production rises, albeit with a delay, indicating a more gradual but meaningful response. The housing market reacts more quickly, with sharp increases in prices followed by a gradual uptick in housing starts, underscoring the sector's sensitivity to monetary easing. Interestingly, the Canadian dollar appreciates—possibly due to strengthened capital flows and improved financial market liquidity.

The analysis of the two international scenarios underscores the substantial impact of external factors on the Canadian economy. A sustained increase in oil prices operates as a positive demand shock, stimulating industrial production, housing prices, and the value of the Canadian dollar. In contrast, a U.S. recession exerts severe negative effects, triggering contractions in industrial production and housing markets, along with a sharp depreciation of the currency. The Bank of Canada responds with swift interest rate cuts, which help mitigate some of the downturn's effects but fall short of fully offsetting the broader spillovers. These scenarios highlight Canada's economic vulnerability to global shocks and the need for proactive and adaptive policy measures.

Overall, the scenarios examined in this paper illustrate how policy decisions and global developments can affect the Canadian economy, leading to deviations from baseline forecasts. Conditional forecasts and structural decompositions offer a coherent framework for risk assessment by constructing quantitative narratives of potential future events. These examples demonstrate the value of risk scenarios in enabling policymakers to evaluate the sensitivity of forecasts to plausible, though less likely, outcomes.

The remainder of the paper is organized as follows. Section 2 introduces the notation and methodologies. Section 3 discusses our contribution, defines the VAR model and presents the data used for estimation. Section 4 presents the scenarios and provides a discussion of the results. Section 5 concludes and suggests avenues for future research.

2 Forecast Scenarios: Methodology

This section shows how to construct risk or forecast scenarios, beginning with a simple two-variable example —one variable representing economic activity and the other monetary policy— to build intuition. We then extend the discussion to the general case. Throughout, we highlight the connection between scenarios and implicit assumptions about the underlying shocks.

2.1 A two-variable model

Consider a simple model that links y_t, representing variables associated with economic activity, and x_t, a policy variable serving as a proxy for monetary policy decisions:

$$\begin{bmatrix} y_{t+1} \\ x_{t+1} \end{bmatrix} = \begin{bmatrix} a_1 & a_2 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} y_t \\ x_t \end{bmatrix} + \begin{bmatrix} u^y_{t+1} \\ u^x_{t+1} \end{bmatrix}, \tag{1}$$

where u^y_{t+1} and u^x_{t+1} are reduced-form innovations, i.e., white-noise processes representing the linearly unpredictable components in the evolution of y_{t+1} and x_{t+1}. Model (1), adapted from Walsh (2017), is deliberately simplified to emphasize intuition. By iterating on the first row of (1), we can see how the future values of $y_{t+h}, h = 1, 2, \cdots$ depend on predetermined factors known at time t and future values for the innovations. Reporting only the first three future values, this becomes:

$$\begin{bmatrix} y_{t+1} \\ y_{t+2} \\ y_{t+3} \end{bmatrix} = \underbrace{\begin{bmatrix} a_1 & a_2 \\ a_1^2 & a_1 a_2 \\ a_1^3 & a_1^2 a_2 \end{bmatrix} \begin{bmatrix} y_t \\ x_t \end{bmatrix}}_{\text{predetermined}} + \underbrace{\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ a_1 & a_2 & 1 & 0 & 0 & 0 \\ a_1^2 & a_1 a_2 & a_1 & a_2 & 1 & 0 \end{bmatrix} \begin{bmatrix} u^y_{t+1} \\ u^x_{t+1} \\ u^y_{t+2} \\ u^x_{t+2} \\ u^y_{t+3} \\ u^x_{t+3} \end{bmatrix}}_{\text{future values of innovations}}. \tag{2}$$

The baseline forecast is derived by setting future innovations to zero and considering only the predetermined part of (2). For illustrative purposes, assume $y_t = x_t = 0$, so that the baseline forecasts for future values are also 0. Under that assumption, any future deviation from the baseline must result from unexpected realizations of the innovations:

$$\begin{bmatrix} y_{t+1} \\ y_{t+2} \\ y_{t+3} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ a_1 & a_2 & 1 & 0 & 0 & 0 \\ a_1^2 & a_1 a_2 & a_1 & a_2 & 1 & 0 \end{bmatrix} \begin{bmatrix} u^y_{t+1} \\ u^x_{t+1} \\ u^y_{t+2} \\ u^x_{t+2} \\ u^y_{t+3} \\ u^x_{t+3} \end{bmatrix}. \tag{3}$$

Similar logic applies to the second line of (1) but the model's simple structure implies

$$\begin{bmatrix} x_{t+1} \\ x_{t+2} \\ x_{t+3} \end{bmatrix} = \begin{bmatrix} u^x_{t+1} \\ u^x_{t+2} \\ u^x_{t+3} \end{bmatrix}. \tag{4}$$

Forecast scenarios can now be constructed using (3)-(4) and following Waggoner and Zha (1999). This involves three steps: (1) specifying a particular scenario for the future values of a subset of variables, (2) deriving the innovations consistent with that scenario, and (3) computing how the forecasts for the remaining variables are affected.[4] Consider for example a scenario that imposes future values of the policy variable x_{t+1}, x_{t+2} and x_{t+3} consistent with a monetary policy loosening. Equation (4) would then determine the values of u^x_{t+1}, u^x_{t+2} and u^x_{t+3} required to achieve this loosening, while (3) would be used to assess how the baseline forecast for the non-policy variables changes as a result.[5]

One important shortcoming of the Waggoner and Zha (1999) method is by using reduced-form innovations to generate specific paths for the variables under study, it leaves the origin of these innovations ambiguous. For example, in the monetary loosening sce-

[4]The formulas involved in producing these types of scenarios were initially introduced by Doan et al. (1984). The key contribution of Waggoner and Zha (1999) was to develop a method for conducting proper Bayesian inference about these constrained forecasts. In this paper, we refer to the approach as Waggoner and Zha (1999) for its focus on forecast scenarios, even though we apply frequentist methods.

[5]In this simple example, the scenario imposed on x_{t+1}, x_{t+2} and x_{t+3} uniquely determines u^x_{t+1}, u^x_{t+2} and u^x_{t+3}. This uniqueness does not necessarily hold in the general case discussed below.

nario, the changes to the monetary policy variable could result from a response to unforeseen economic developments or, alternatively, from a deliberate policy decision. To address this issue, Baumeister and Kilian (2014) propose constructing forecast scenarios based on the structural version of the model. This approach involves specifying that fluctuations in the two variables model (1) arise from policy and non-policy shocks ϵ^x_{t+1} and ϵ^y_{t+1}, which are related to the reduced-form innovations by

$$\begin{bmatrix} u^y_{t+1} \\ u^x_{t+1} \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ \phi & 1 \end{bmatrix} \begin{bmatrix} \epsilon^y_{t+1} \\ \epsilon^x_{t+1} \end{bmatrix}, \tag{5}$$

where again the structure is simplified to focus on intuition. Now, (5) shows that innovations to the policy variable (u^x_{t+1}) reflect the reaction of monetary authorities to real developments (ϵ^y_{t+1}) and actual instances of policy shocks (ϵ^x_{t+1}). Entering (5) in (3)-(4) leads to

$$\begin{bmatrix} y_{t+1} \\ y_{t+2} \\ y_{t+3} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ a_1 + a_2\phi & a_2 & 1 & 0 & 0 & 0 \\ a_1^2 + \phi a_1 a_2 & a_1 + a_2\phi & 1 & a_2 & 1 & 0 \end{bmatrix} \begin{bmatrix} \epsilon^y_{t+1} \\ \epsilon^x_{t+1} \\ \epsilon^y_{t+2} \\ \epsilon^x_{t+2} \\ \epsilon^y_{t+3} \\ \epsilon^x_{t+3} \end{bmatrix}, \tag{6}$$

and

$$\begin{bmatrix} x_{t+1} \\ x_{t+2} \\ x_{t+3} \end{bmatrix} = \begin{bmatrix} \phi & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & \phi & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & \phi & 1 \end{bmatrix} \begin{bmatrix} \epsilon^y_{t+1} \\ \epsilon^x_{t+1} \\ \epsilon^y_{t+2} \\ \epsilon^x_{t+2} \\ \epsilon^y_{t+3} \\ \epsilon^x_{t+3} \end{bmatrix}. \tag{7}$$

A forecast scenario using Baumeister and Kilian (2014) then involves specifying sequences of values for the monetary policy shocks ϵ^x_{t+1}, ϵ^x_{t+2} and ϵ^x_{t+3} (such as deliberate instances of monetary loosening) and then, using (6)-(7), computing how the forecasts for both variables are changed.

2.2 The general case

A general formulation begins with the following standard VAR model with p lags and k variables arranged in the $k \times 1$ vector $\mathbf{y_t}$:

$$\mathbf{y_t} = \nu + \sum_{j=1}^{p} \mathbf{A_j y_{t-j}} + \mathbf{u_t}, \tag{8}$$

where the vector of innovations $\mathbf{u_t}$ follows a weak white noise process, i.e., $\mathbb{E}(\mathbf{u_t}) = \mathbf{0}$ and $\mathbb{E}(\mathbf{u_t u_s}') = \mathbf{\Sigma_u}$ for $t = s$ and $\mathbf{0}$ otherwise.[6]

It is convenient to rewrite (8) as a VAR(1) process by stacking $p-1$ lags of $\mathbf{y_t}$ vertically:

$$\mathbf{Y_t} = \mu + \mathbf{A Y_{t-1}} + \mathbf{U_t}, \tag{9}$$

where $\mathbf{Y_t} = (\mathbf{y_t}', \dots, \mathbf{y_{t-p+1}}')'$, $\mu = (\nu', \mathbf{0}', \dots, \mathbf{0}')'$, $\mathbf{U_t} = (\mathbf{u_t}', \mathbf{0}', \dots, \mathbf{0})'$ and

$$\mathbf{A} = \begin{bmatrix} \mathbf{A_1} & \dots & \mathbf{A_{p-1}} & \mathbf{A_p} \\ \mathbf{I_k} & \dots & \mathbf{0_k} & \mathbf{0_k} \\ \vdots & \ddots & \vdots & \vdots \\ \mathbf{0_k} & \dots & \mathbf{I_k} & \mathbf{0_k} \end{bmatrix}.$$

Next, iterate equation (9) forward to obtain an expression for all future values of $\mathbf{Y_t}$:

$$\mathbf{Y_{t+h}} = \left(\sum_{j=0}^{h-1} \mathbf{A}^j \right) \mu + \mathbf{A}^h \mathbf{Y_t} + \sum_{j=0}^{h-1} \mathbf{A}^j \mathbf{U_{t+h-j}},$$

[6] This presentation follows Kilian and Lütkepohl (2017) and part of the argument in Jarociński (2010).

from which an expression for the future values of the original vector $\mathbf{y_t}$ can be obtained with the help of the $K \times Kp$ selection matrix $\mathbf{J} := \left[\mathbf{I_k}, \mathbf{0_{k\times k(p-1)}}\right]$ such that $\mathbf{y_t} = \mathbf{JY_t}$ and $\mathbf{u_t} = \mathbf{JU_t}$:[7]

$$\mathbf{y_{t+h}} = \mathbf{JY_{t+h}} = \mathbf{J}\left(\sum_{j=0}^{h-1}\mathbf{A}^j\right)\mu + \mathbf{JA}^h\mathbf{Y_t} + \sum_{j=0}^{h-1}\mathbf{JA}^j\mathbf{J}'\mathbf{JU_{t+h-j}}$$

$$\implies \mathbf{y_{t+h}} = \mathbf{J}\left(\sum_{j=0}^{h-1}\mathbf{A}^j\right)\mu + \mathbf{JA}^h\mathbf{Y_t} + \sum_{j=0}^{h-1}\mathbf{JA}^j\mathbf{J}'\mathbf{u_{t+h-j}}. \tag{10}$$

As in the simple model, (10) shows that future values of $\mathbf{y_t}$ depend on predetermined factors known at time t and future values of the innovations. The unconditional expectation, $\mathbf{y_{t+h|t}} := \mathbb{E}\left(\mathbf{y_{t+h}}|\left\{\mathbf{y_s}\right\}_{s=1}^{t}\right)$, is calculated by setting all future innovations to their expected values of zero. This simplification leaves only the first two terms of (10), allowing the expression to be rewritten as follows:

$$\mathbf{y_{t+h}} = \mathbf{y_{t+h|t}} + \sum_{j=0}^{h-1}\mathbf{JA}^j\mathbf{J}'\mathbf{u_{t+h-j}}, \tag{11}$$

or

$$\mathbf{y_{t+h}} = \mathbf{y_{t+h|t}} + \sum_{j=0}^{h-1}\mathbf{\Phi}_j\mathbf{u_{t+h-j}}, \tag{12}$$

where $\mathbf{JA}^j\mathbf{J}' := \mathbf{\Phi}_j$ and $\mathbf{y_{t+h|t}}$ defines the baseline scenario. As before (12) illustrates that future values of $\mathbf{y_{t+h}}$ will depart from that baseline only if innovations take on unexpected values.

Equation (12) can also be used to see how forecasts diverge from baseline because of unforeseen structural shocks rather than the statistical innovations $\mathbf{u_t}$. To do so, we make the common assumption that $\mathbf{u_t}$ is a linear combination of underlying structural shocks, so that $\mathbf{u_t} = \mathbf{D}\epsilon_\mathbf{t}$ for a nonsingular matrix with $\mathbf{D}$, $\mathbb{E}(\epsilon_t) = 0$ and $\mathbb{E}\left(\epsilon_\mathbf{t}\epsilon_\mathbf{t}'\right) = \mathbf{I}_K$. In such

[7] Note that $\mathbf{U_t} = \mathbf{J}'\mathbf{JU_t}$.

a case, the last part of (12) is now

$$\mathbf{\Phi}_j \mathbf{u_{t+h-j}} = \mathbf{\Phi}_j \mathbf{D}\mathbf{D}^{-1}\mathbf{u_{t+h-j}} = \mathbf{\Phi}_j \mathbf{D}\epsilon_{\mathbf{t+h-j}} := \mathbf{\Theta_j}\epsilon_{\mathbf{t+h-j}}, \tag{13}$$

where the $\mathbf{\Theta_j}$ matrices underlie the impulse response functions commonly analyzed with VARs. Combining equations (12) and (13) can help us understand how future outcomes $(\mathbf{y_{t+1}}, \ldots, \mathbf{y_{t+h}})$ may come to differ from the forecasts $(\mathbf{y_{t+1|t}}, \ldots, \mathbf{y_{t+h|t}})$ through the effects of future sequences of structural shocks $(\epsilon_{\mathbf{t+1}}, \ldots, \epsilon_{\mathbf{t+h}})$. In particular, we can isolate the effect of each individual shock through the following decomposition

$$\mathbf{y_{t+h}} - \mathbf{y_{t+h|t}} = \sum_{j=0}^{h-1} \mathbf{\Theta_j}\epsilon_{\mathbf{t+h-j}} = \sum_{k=1}^{K} \underbrace{\sum_{j=0}^{h-1} \mathbf{\Theta_{j,\cdot,k}}\epsilon_{k,t+h-j}}_{\text{Contribution of shock } k} . \tag{14}$$

2.3 Constructing risk scenarios

It is transparent from (12) and (14) that constructing forecast scenarios always amounts to choosing sequences of future shocks. The two expressions also suggest that building these scenarios can either be done directly, by formulating scenarios in terms of structural shocks (Baumeister and Kilian, 2014), or indirectly, by formulating scenarios in terms of realized outcomes (Waggoner and Zha, 1999). In either case, the scenario relates to a notion of risk by exploring how future events may push realized values away from the baseline forecast. In this way, forecast scenarios aim to tell us why and by how much a point forecast could turn out to be wrong.

To apply the method proposed by Waggoner and Zha (1999), subtract the forecasts $\mathbf{y_{t+h|t}}$ from both sides of equation (12) and stack the resulting equations at horizons $h = 1, \ldots, H$ vertically to obtain

$$\begin{bmatrix} \mathbf{y_{t+1}} - \mathbf{y_{t+1|t}} \\ \mathbf{y_{t+2}} - \mathbf{y_{t+2|t}} \\ \vdots \\ \mathbf{y_{t+H}} - \mathbf{y_{t+H|t}} \end{bmatrix} = \begin{bmatrix} \mathbf{\Phi_0} & \mathbf{0_K} & \dots & \mathbf{0_K} \\ \mathbf{\Phi_1} & \mathbf{\Phi_0} & \dots & \mathbf{0_K} \\ \vdots & \vdots & \ddots & \vdots \\ \mathbf{\Phi_{H-1}} & \mathbf{\Phi_{H-2}} & \dots & \mathbf{\Phi_0} \end{bmatrix} \begin{bmatrix} \mathbf{u_{t+1}} \\ \mathbf{u_{t+2}} \\ \vdots \\ \mathbf{u_{t+H}} \end{bmatrix},$$

or, more concisely,

$$\underset{KH\times 1}{\mathbf{r}} = \underset{KH\times KH}{\mathbf{R}} \; \underset{KH\times 1}{\mathbf{u}}. \tag{15}$$

Note that each row in equation (15) corresponds to a deviation from baseline for a specific variable at a specific horizon. For concreteness, suppose that we are working at a monthly frequency with two variables ($K = 2$), that we are producing forecasts for up to one year ahead ($H = 12$) and that we want to analyze a scenario imposing values for the second variable's next six values ($y^{scenario}_{2,t+1}, \dots, y^{scenario}_{2,t+6}$). This would single out rows 2, 4, 6, 8, 10 and 12 out of the 24 rows contained in (15) and this restricted form would then be written $\mathbf{r}_\kappa = \mathbf{R}_{\kappa,.}\mathbf{u}_\kappa$, where the imposed restrictions on $y^{scenario}_{2,t+1}, \dots, y^{scenario}_{2,t+6}$ have been used to construct $\mathbf{r}_\kappa$.

The astute reader will have noticed that $\mathbf{R}_{\kappa,.}$ is not a square matrix and many sequences of innovations can therefore obey the restriction. Doan et al. (1984) proposed to privilege the minimal variance solution

$$\mathbf{u}^{scenario} = \underset{\mathbf{u}\in\mathbb{R}}{\operatorname{argmin}} \left\{\mathbf{u}'\mathbf{u} | \mathbf{R}_{\kappa,.}\mathbf{u}_\kappa = \mathbf{r}_\kappa\right\} = \mathbf{R}_{\kappa,.}{}' \left(\mathbf{R}_{\kappa,.}\mathbf{R}_{\kappa,.}{}'\right)^{-1} \mathbf{r}_\kappa$$

where $\mathbf{u}^{scenario}$ corresponds to the 'smallest' perturbation that ensures the restrictions are met. As pointed out by Jarociński (2010) and Antolin-Diaz et al. (2021), this implicitly selects sequences of structural shocks since $\epsilon_{\mathbf{t+h}} = \mathbf{D}^{-1}\mathbf{u_{t+h}}$. We exploit this observation along with the decomposition presented in equation (14) to visualize the dynamic contribution of each of the structural shocks implied by our reduced-form scenarios.

In contrast, the approach proposed by Baumeister and Kilian (2014) involves formulating scenarios directly in terms of sequences of future structural shocks. Although one could implement this approach using equation (12) and the relationship between structural shocks and the noise vector, we can also proceed iteratively from equation (8) by simply simulating future values as

$$\mathbf{y_{t+h|t}}^{scenario} = \nu + \sum_{j=1}^{p} \mathbf{A_j} \mathbf{y_{t+h-j|t}}^{scenario} + \mathbf{D}\epsilon_{\mathbf{t+h-j|t}}{}^{scenario}$$

where $\mathbf{y_{t|t}}^{scenario}, \ldots, \mathbf{y_{t-p+1|t}}^{scenario}$ correspond to the last p observed values (i.e., $\mathbf{y_t}, \ldots, \mathbf{y_{t-p+1}}$). Note that if all future shocks are set to zero, the simulation described above recovers the unconditional expectations $\mathbf{y_{t+h|t}}^{scenario} = \mathbf{y_{t+h|t}}$ because $\mathbb{E}\left(\mathbf{D}\epsilon_{\mathbf{t+h-j|t}} \middle| \{\mathbf{y_s}\}_{s=1}^{t}\right) = \mathbf{0}$. More generally, if we stack the sequence of future structural shock vectors like the sequence of noise vectors as in equation (15) and select a subset of rows κ for which we impose nonzero values, we can see that this simulation recovers the following expectation

$$\mathbf{y_{t+h|t}}^{scenario} = \mathbb{E}\left(\mathbf{y_{t+h}} \middle| \{\mathbf{y_s}\}_{s=1}^{t}, \epsilon_{\kappa}{}^{scenario}\right)$$

since the expected value of the non-restricted structural shocks is zero.

2.4 Variance Decomposition

When the structural shocks influencing the evolution of a VAR model can be identified, it is useful to assess their relative importance for each variable through a forecast error variance decomposition. This decomposition quantifies, for each identified shock, variable and forecast horizon, the contribution of the shock to the variability of the variable.

This decomposition is conducted as follows. Using the notation of Kilian and Lütkepohl (2017), the forecast error in the vector of variables $\mathbf{y}$ at horizon h can be expressed in terms of structural shocks as $\mathbf{y}_{t+h} - \mathbb{E}(\mathbf{y}_{t+h}) = \sum_{j=0}^{h-1} \mathbf{\Theta}_j \epsilon_{t+h-j}$ and hence the following for the mean squared forecast error:

$$MSPE(h) = \mathbb{E}\left(\left(\mathbf{y}_{t+h} - \mathbb{E}(\mathbf{y}_{t+h})\right)\left(\mathbf{y}_{t+h} - \mathbb{E}(\mathbf{y}_{t+h})\right)'\right) = \sum_{j=0}^{h-1} \mathbf{\Theta}_j \mathbf{\Theta}_j'.$$

Since the response of variable k to shock l at horizon h is given by $\theta_{k,j,h}$, the (k, l) element of $\mathbf{\Theta}_h$, the contribution of shock l to the variance of the forecast error of variable k at horizon h is given by

$$MSPE_{k,l}(h) = \theta^2_{k,l,0} + \cdots + \theta^2_{k,l,h-1}.$$

The total variance (representing the aggregate variability of variable k sums over the contributions of all shocks:, that is, $MSPE_k(h) = \sum_{l=1}^{K} MSPE_{k,l}(h)$. Finally, the relative decomposition is obtained by normalizing these contributions by the total variance, dividing both sides by $MSPE_k(h)$.

3 Model Specification and Data

The VAR model in our analysis includes eight variables and is estimated using monthly data spanning January 1992 to June 2024. The starting date aligns with Champagne and Sekkel (2018), who note that the adoption of inflation targeting in 1991 altered the effects of monetary policy shocks on the Canadian economy. Our benchmark estimation uses $p = 2$ lags, as suggested by the Akaike criterion.

Our model incorporates variables selected based on the scenarios under consideration and the identified shocks. The first two variables are the real price of oil (op_t) and the US industrial production (ip_t^{US}) index, both sourced from the FRED-MD database (McCracken and Ng, 2016).[8] The remaining variables are Canadian macroeconomic indicators drawn from the database developed by Fortin-Gagnon et al. (2022): the price level as measured by the consumer price index (p_t^{CAN}), the industrial production index (ip_t^{CAN}), housing starts (hs_t^{CAN}) and the housing price index (hp_t^{CAN}), the Bank Rate

[8] The price of oil is measured using the WTI benchmark deflated by the US CPI, a widely used metric in the literature on oil prices (Baumeister and Kilian, 2016).

(R_t^{CAN}) and the Canada-US exchange rate ($usdcad_t$).[9] All variables enter our VAR in log levels (except for the Bank Rate which is in levels): this approach has become common practice as a means of guarding against the need to take a stance on the system's cointegration properties. As shown by Sims et al. (1990), OLS parameter estimates remain consistent when the model is estimated in levels even in the presence of unit roots.

The Baumeister and Kilian (2014) approach requires the identification of structural shocks, which we achieve using recursive short-run restrictions. This methodology is consistent with established practices in several studies employing VAR models to examine the Canadian economy (Kim and Roubini, 2000; Bhuiyan and Lucas, 2007; Li et al., 2010; Boivin et al., 2010; Moran et al., 2022). In these studies, global or U.S. variables are typically prioritized at the beginning of the vector $\mathbf{y}_t$, followed by Canadian-specific variables. Variables that are particularly sensitive to external events—such as financial asset prices in Li et al. (2010) or the exchange rate, as in our study and Kim and Roubini (2000)—are positioned last. Specifically, we adopt the following ordering:

$$\mathbf{y}_t = \begin{bmatrix} op_t & ip_t^{US} & p_t^{CAN} & ip_t^{CAN} & hs_t^{CAN} & hp_t^{CAN} & R_t^{CAN} & usdcad_t. \end{bmatrix} \tag{16}$$

Applying the Cholesky decomposition to the residuals' covariance matrix identifies the oil price shock with the corresponding reduced-form residual. Our oil price shocks still reflect a composite of contemporaneous factors since ordering real oil prices first implies only that this shock can influence real oil prices within the month. The Bank Rate, measuring the stance of monetary policy, is ordered next to last which reflects the assumption that the Bank of Canada can react to a wide range of macroeconomic events within the month. This positioning implies that the monetary policy shocks we identify are equivalent to those that we would obtain if we imposed a block recursive structure as in Christiano et al. (1999). Finally, we order the exchange rate last, so that it responds to all shocks

[9] We consider housing variables to be relevant because fluctuations in real estate markets are often considered as the defining characteristic of a business cycle (Leamer, 2007, 2015). In addition, the structure of the mortgage market in Canada implies that monetary policy has strong and rapid impacts on housing markets (Nsafoah and Dery, 2024). The exchange rate is expressed in Canadian per US dollar so that a decline represents an appreciation of the Canadian currency.

within the month. This is consistent with the idea that the exchange rate, like other variables determined in financial markets, is forward-looking and highly responsive to the macroeconomic context.

Table 1 in the Appendix presents the variance decomposition exercise applied to our estimated VAR. As outlined in Section 2.4, this exercise quantifies the contribution of each shock identified through the recursive strategy to the variability of the variables under consideration. The first highlight of Table 1 is the importance of shocks to the world price of oil (first panel) in explaining the variability of several Canadian macroaggregates, including prices, housing starts, industrial production, and the exchange rate. Consequently, we can expect that a conditional forecast (or scenario) involving oil prices will produce substantial deviations between the baseline forecast and the scenario forecast.

The second panel of Table 1 shows that shocks to U.S. economic activity play a smaller role in Canadian macroeconomic fluctuations. However, Canadian industrial production is an exception, exhibiting high sensitivity to U.S. economic variability. Finally, the third panel reveals that monetary policy shocks have a modest impact on most variables but do account for a notable share of volatility in housing prices.[10]

4 Forecast Scenarios

This section analyzes domestic and international scenarios that may affect the outlook for the Canadian economy. Domestically, our scenario assumes the Bank of Canada adopts a more aggressive interest rate reduction strategy than the one inherent to the baseline forecast, which itself reflects a loosening cycle prompted by the normalization of inflation rates and slower economic growth toward the end of our sample period in June 2024. On the international front, we consider two scenarios: one simulating the effects of a sharp increase in the real world oil price and another assessing the impact of an economic slowdown in the United States.

[10] The finding that monetary policy shocks contribute modestly to overall variability is consistent with standard results in the VAR literature. This does not imply that systematic monetary policy—referring to the regular responses of monetary authorities to macroeconomic conditions—is unimportant.

4.1 Monetary Policy

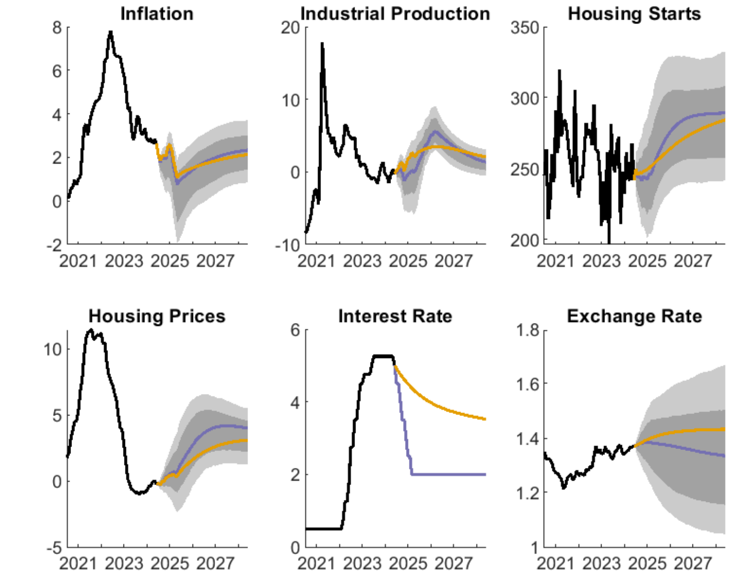
Our monetary policy scenario assumes that the Bank of Canada's ongoing loosening cycle unfolds more aggressively than anticipated in the baseline forecast. Specifically, we hypothesize that the Bank of Canada reduces interest rates by 50 basis points at every 2025 announcement date until a floor of 2% is reached.[11] That 2% rate is then maintained for the remainder of the forecast period.

Figure 1 illustrates how implementing this scenario using the Waggoner and Zha (1999) method alters the projected path for the interest rate and the forecasts for the other Canadian variables. First, the inflation forecast shows only minor adjustments, consistent with the variance decomposition results (Table 1 in the Appendix), which indicate that monetary policy shocks contribute modestly to inflation variability, particularly at shorter horizons (possibly reflecting anchored inflation expectations). Next, industrial production initially declines by approximately 0.5% below the baseline but recovers by the second year, eventually surpassing the baseline by 1.2%. This pattern reflects the delayed effects of lower borrowing costs and improved liquidity on economic activity, as well as the possibility that an unexpectedly strong monetary easing increases perceived uncertainty about future conditions. Elevated uncertainty can lead firms and households to postpone investment and spending decisions, thereby dampening short-term activity despite the accommodative stance (Bloom, 2009; Jurado et al., 2015).

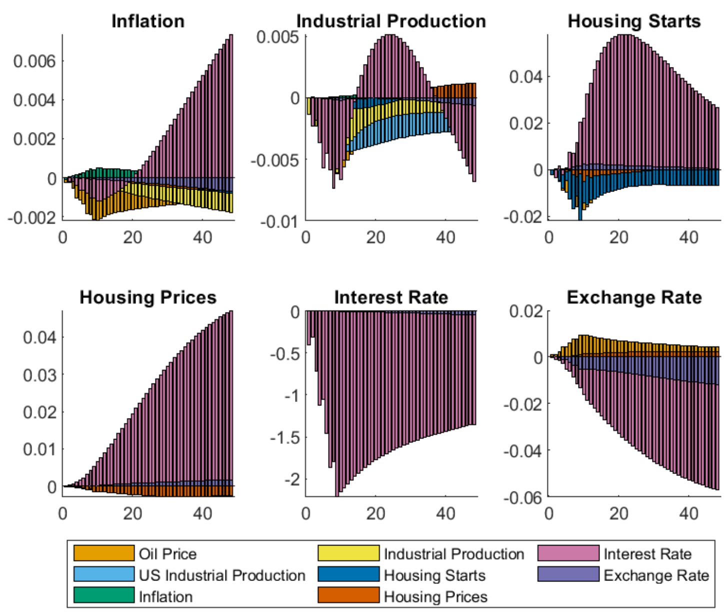
Housing prices, on the other hand, respond rapidly, increasing by nearly 3.5% within the first year relative to the baseline, while housing starts rise by 2.8% after a brief lag. This dynamic aligns with the view that housing demand reacts faster than housing supply to monetary policy shocks, as buyers capitalize on lower mortgage rates before developers adjust construction activity.

Finally, the response of the exchange rate warrants a discussion. It initially shows limited reaction but eventually decreases, which corresponds to an appreciation of the

[11] Interest rate decisions are scheduled in the following eight months of 2025: January, March, April, June, July, September, October and December.



(a) Forecasts



(b) Decomposition of Forecasts According to Structural Shocks

Figure 1: Monetary Policy Loosening Scenario with Waggoner and Zha (1999)

Note: Panel (a): Benchmark forecasts are in yellow and those under the scenario in purple. Shaded areas correspond to 68% and 90% moving block bootstrap confidence intervals. The real oil price, interest rate and exchange rate are reported in levels and other variables are shown in year-over-year growth rates. Panel (b): Decomposition of the forecasts according to implied structural shocks from equation (14)

Canadian dollar (in contrast with the baseline forecast where a depreciation of the dollar materializes). This response may appear counterintuitive at first as standard open economy models typically imply that an unexpected interest rate cut is associated with a depreciation of the domestic currency. However, our scenario differs from such a one-off decrease in interest rates because it includes a full path of persistent interest rate reductions over a two-year horizon. The exchange rate response therefore reflects both the direct effects of lower rates and broader general equilibrium dynamics; in this context, the gradual appreciation of the dollar is consistent with an economic recovery as well as capital inflows spurred by improved liquidity and rising asset prices—especially in the housing market. More generally, the empirical literature has documented several instances where exchange rate responses depart from simple theoretical predictions, including delayed overshooting and reverse exchange rate reactions (e.g., Rusnák et al., 2013; Kim et al., 2017; Ha et al., 2025). Given these nuances and the wide confidence intervals for the exchange rate forecasts, we do not view this result as a fundamental concern for our analysis.

Recall that the Waggoner and Zha (1999) method selects sequences of the innovation vector $\mathbf{u}$ to generate the path prescribed by the scenario (here an aggressive monetary loosening) and then computes how these values for $\mathbf{u}$ modifies forecasts for other variables. To identify which type of shocks the method used to produce these forecast changes, part (b) of Figure 1 uses (14) to decompose, for each variable, the gap between the baseline and scenario forecasts according to the structural shocks responsible for that gap.

This decomposition confirms that this scenario is predominantly driven by monetary policy shocks. This dominance is evident not only in the decomposition of the interest rate but also in the responses of housing starts, inflation, housing prices, and the exchange rate, where the deviations between the baseline and scenario forecasts are almost entirely attributable to monetary policy shocks. However, certain nuances—such as a temporary price puzzle observed in the inflation response—suggest that other factors may moderate the overall effect of monetary policy changes. These findings align with the empirical literature on the transmission of monetary policy in Canada, such as Fortin-Gagnon et al.

(2022), which highlights its differential impacts across economic sectors.

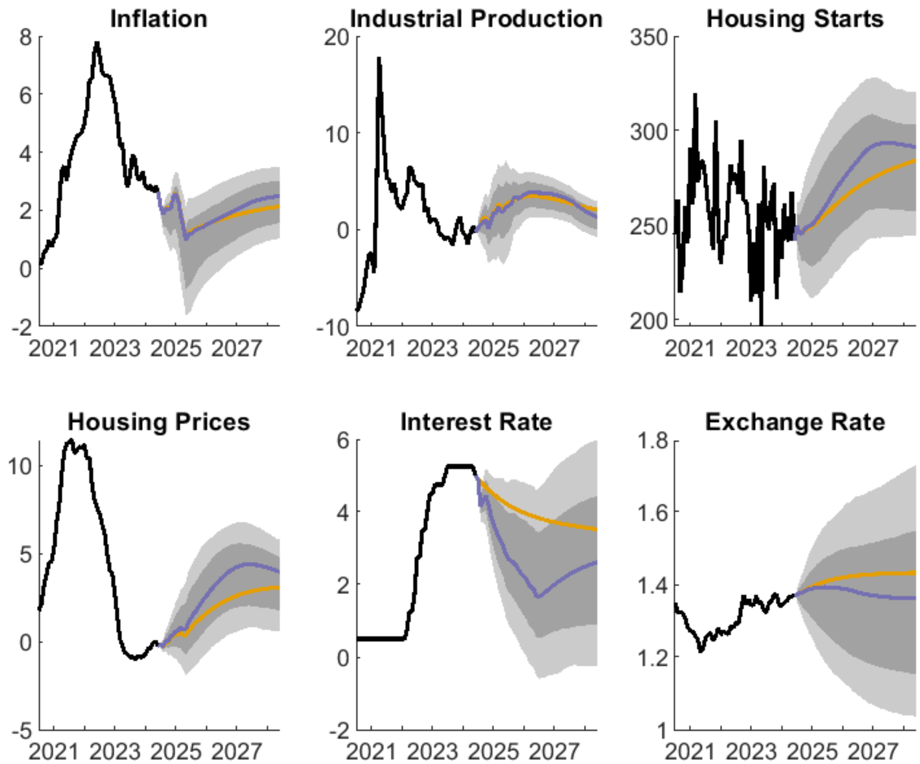


Figure 2: Monetary Policy Loosening Scenario with Baumeister and Kilian (2014)

Note: Benchmark forecasts are in yellow and those under the scenario in purple. Shaded areas correspond to 68% and 90% moving block bootstrap confidence intervals. The real oil price, interest rate and exchange rate are reported in levels and other variables are shown in year-over-year growth rates.

Figure 2 presents the results of an equivalent scenario implemented using the method of Baumeister and Kilian (2014). This approach involves specifying that the aggressive monetary policy loosening is generated by large negative monetary policy shocks over the 24-month period from February 2020 to February 2024.[12] This scenario results in sharp declines in the interest rate, with both inflation and industrial production eventually

[12]In this scenario, the only shocks activated during the entire 48-month out-of-sample period are monetary policy shocks in the first 24 months, while the final 24 months correspond to an unconditional forecast. The observed 'tightening' pattern simply reflects the model's tendency to revert interest rate forecasts toward their historical mean, which is higher than the conditional path imposed over the first two years.

exceeding their respective baseline forecasts. The housing market responds in a manner similar to the previous scenario.

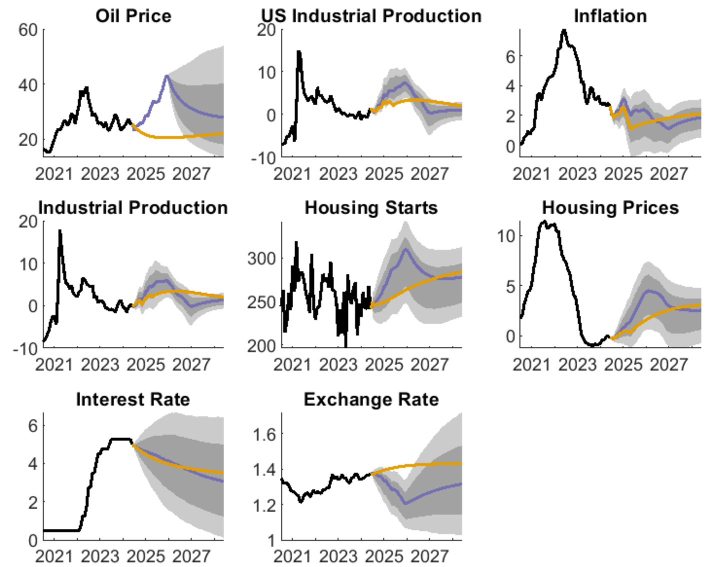
As the interest rate stabilizes towards the end of the 24-month period, housing prices begin to decline, and housing starts stabilize, possibly reflecting a supply-side adjustment as housing supply catches up with demand. These results are broadly consistent with the reduced-form monetary policy scenario depicted in Figure 1. The similarity can be explained by the variance decomposition in Table 1, which highlights how monetary policy shocks are the main drivers of variations in interest rates. Scenarios that constrain the observed path of the interest rate are therefore largely shaped by monetary policy shocks, leading to similar outcomes in reduced-form and structural scenario analyses.[13]

4.2 Oil Price Scenario

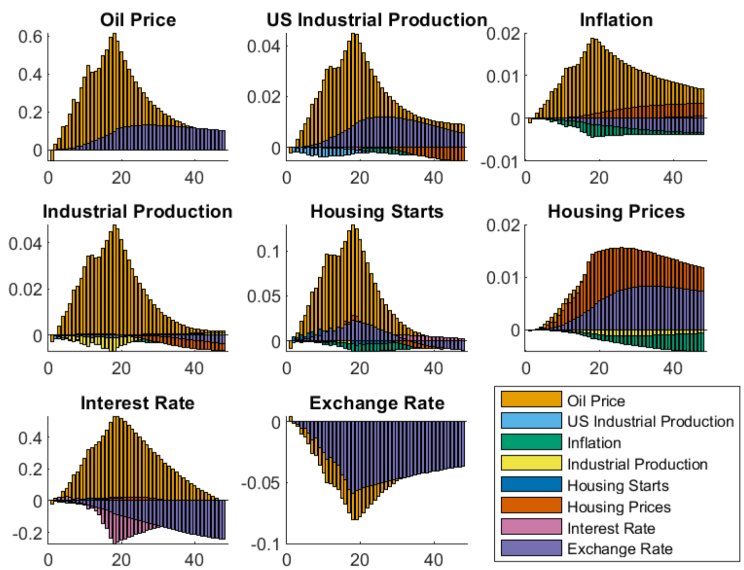
Our first international scenario examines the impact of a sharp, unexpected increase in the real world price of oil. We interpret this increase as driven by the demand for oil, consistent with Kilian (2009)'s result that the global demand for commodities is responsible for most oil price fluctuations. Specifically, we model an 18-month rise in oil prices starting at the end of our sample period in June 2024, generated by applying 75% of the growth rates observed between January 2007 and June 2008—an important recent period characterized by sustained and rapid oil price escalation. The remainder of the forecasting horizon then uses unconditional forecasts.

The results are presented in Figure 3. As before, the first panel compares the baseline versus scenario forecasts whereas the bottom panel examines how the Waggoner and Zha (1999) method created the scenarios. The figure shows that the sharp increases in the real oil price leads to higher industrial production relative to baseline for both Canada (+2.7%) and the US (+1.9%) while inflation rises by 0.8 percentage points above baseline, indicating a strong positive demand stimulus. The housing market also responds significantly, with housing prices increasing by 4.3% and housing starts by 3.6% over the forecast period.

[13] Recall that a scenario computed using the Baumeister and Kilian (2014) method, which works with structural shocks instead of innovations, implies that Figure 2 does not need a bottom panel.



(a) Forecasts



(b) Decomposition of Forecasts According to Structural Shocks

Figure 3: Rapid Oil Price Increase Scenario with Waggoner and Zha (1999)

Note: Panel (a): Benchmark forecasts are in yellow and those under the scenario in purple. Shaded areas correspond to 68% and 90% moving block bootstrap confidence intervals. The real oil price, interest rate and exchange rate are reported in levels and other variables are shown in year-over-year growth rates. Panel (b): Decomposition of the forecasts according to implied structural shocks from equation (14).

Additionally, the exchange rate decreases by 2.2%, an appreciation reflecting improved terms of trade and heightened demand for Canadian exports. Contrary to the monetary policy loosening scenario, the confidence intervals around the exchange rate are much more informative.

The structural decompositions in the bottom panel of the figure indicate that oil price shocks explain 30% of the variance in industrial production and 12% in housing starts. These movements are accompanied by inflation exceeding benchmark forecasts, suggesting that the scenario can be interpreted as a positive demand stimulus boosting aggregate revenues in Canada. Responses in the housing market align with this interpretation, with both housing starts and prices increasing more rapidly than they otherwise would.[14]

Building on these findings, Figure 4 refines the analysis by isolating the effects of oil price shocks using the Baumeister and Kilian (2014) methodology. To construct this scenario, we extracted the implied structural real oil price shock from the previous scenario and set all other shocks to zero. The results confirm our previous conclusions, showing that real oil price shocks act as positive demand shocks for the Canadian economy. Industrial production rises, housing prices increase sharply before stabilizing, and housing starts adjust more gradually as supply catches up to demand.

4.3 US Activity Scenario

The second international scenario examines the impact of a significant slowdown in the United States in the months following the end of our sample. To simulate this, we model a milder version of the Great Recession and its aftermath by setting the growth rate of U.S. industrial production to half the observed growth rates over the 48-month period beginning in December 2007. This period encompasses the Great Recession and its subsequent slow recovery, thereby capturing a recessionary event followed by gradual improvement.

The results, compared to the benchmark forecasts, are presented in Figure 5. Given

[14] The increase in aggregate revenue stemming from this oil price shock thus leads to more pronounced impacts on the housing market than the monetary shocks studied in the first scenario, which had the more limited effect of decreasing borrowing cost.

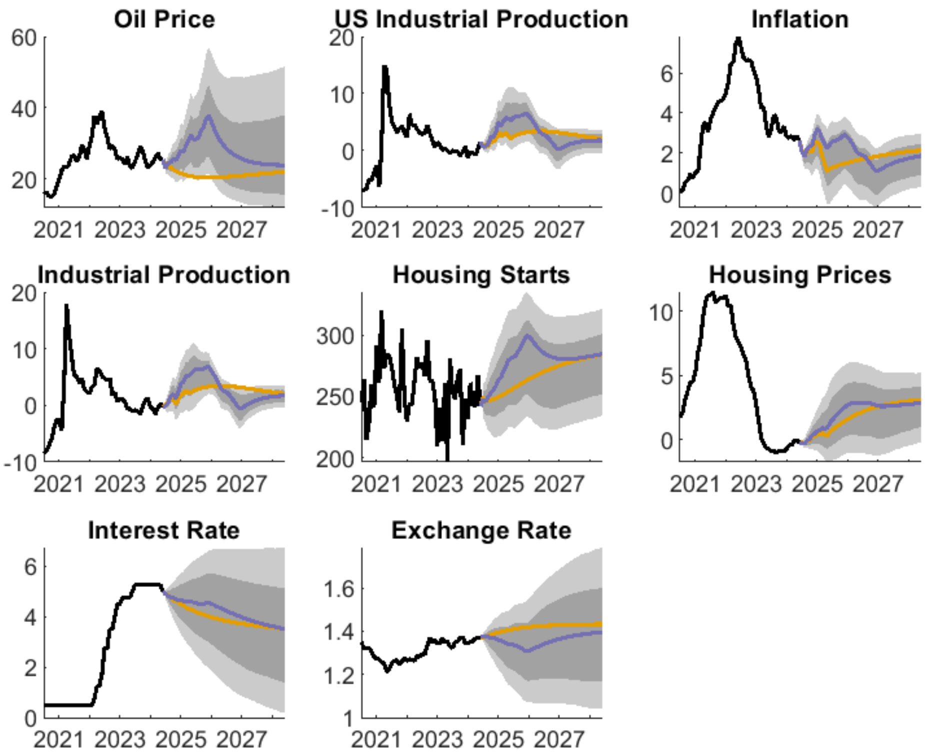


Figure 4: Rapid Oil Price Increase Scenario with Baumeister and Kilian (2014)

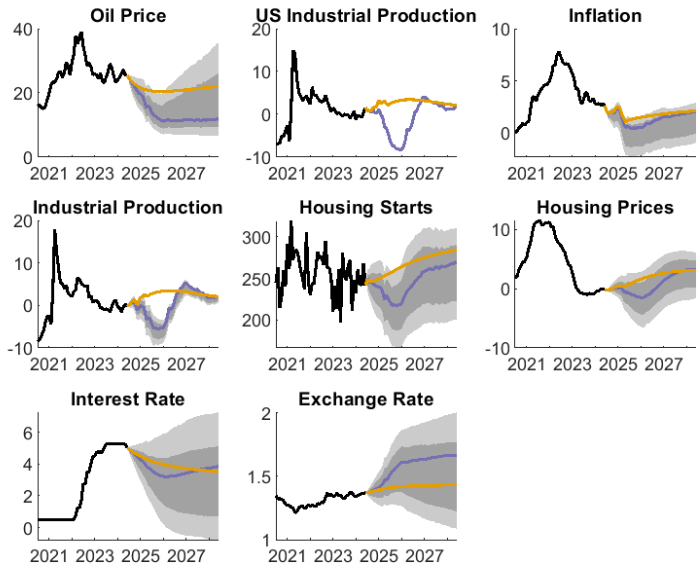
Note: Benchmark forecasts are in yellow and those under the scenario in purple. Shaded areas correspond to 68% and 90% moving block bootstrap confidence intervals. The real oil price, interest rate and exchange rate are reported in levels and other variables are shown in year-over-year growth rates.

the strong trade and financial linkages between the two countries, it is expected that such a downturn in the U.S. economy would generate significant headwinds for Canada. Indeed, the figure shows that Canadian industrial production declines sharply, falling by 3.4% below the baseline at its trough. Housing starts and prices also experience significant contractions, decreasing by 4.2% and 3.5%, respectively. Inflation turns negative, with deflationary pressures pushing price levels 0.6 percentage points below the baseline. The Bank of Canada responds by aggressively cutting interest rates, with reductions exceeding the baseline by 75 basis points within the first year. Finally, the exchange rate increases by 2.8%: this depreciation of the Canadian dollar possibly reflects weaker export revenues and increased global risk aversion. Structural decompositions at the bottom of the figure indicate that the most of the observed variability in industrial production is attributable to negative US industrial production shocks.

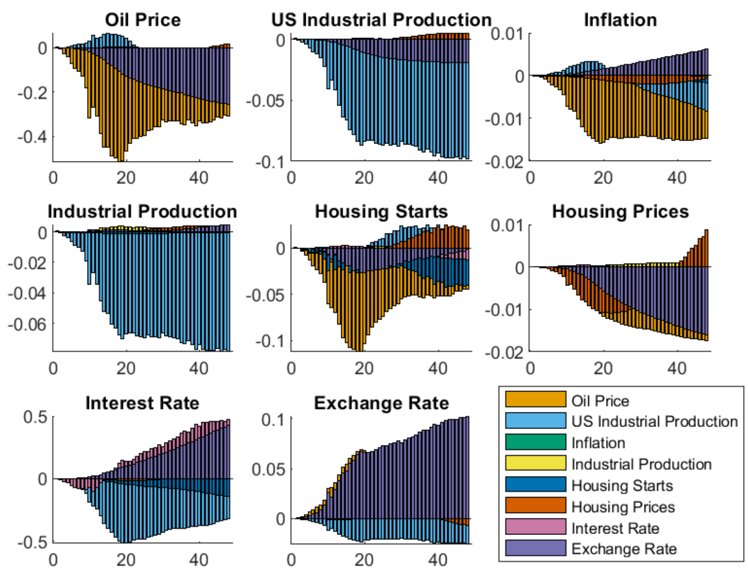
These developments align with the characterization of the U.S. recession scenario as a series of negative demand shocks. However, the decomposition in panel (b) of the figure reveals that much of the observed impact on inflation, housing starts and oil prices stems from negative oil price shocks. These shocks, as shown earlier, act as aggregate demand shocks for Canada. Interestingly, while oil price shocks drive declines in both housing starts and prices; the impact on housing starts appears more pronounced, as observed in the oil price scenario.

Figure 6 isolates the effects of the U.S. shock by constructing a Baumeister and Kilian (2014) scenario that utilizes only the U.S. shocks implied by the reduced-form Waggoner and Zha (1999) scenario presented in Figure 5. All other shocks are set to zero. The results reveal that the effects on oil prices and the housing market are considerably muted, showing only slight deviations from the benchmark forecasts. However, a notable finding is how closely Canadian industrial production mirrors its U.S. counterpart in both the structural and reduced-form scenarios. This alignment reflects the strong trade and supply chain linkages between the two economies, which facilitate the rapid transmission of U.S. economic downturns to Canada, particularly in sectors heavily reliant on cross-border trade. These results underscore the Canadian economy's vulnerability to external shocks and the importance of adaptive monetary policy in mitigating their adverse effects.

These results align well qualitatively with those of other studies analyzing how adverse shocks in the United States negatively impact various sectors of the Canadian economy, notably from Miyamoto and Nguyen (2017) (adverse technological shocks in the United States), Bedock and Stevanovic (2017) (credit shocks), Moran et al. (2022) (uncertainty shocks) or Moran et al. (2023) (shocks to American confidence).



(a) Forecasts



(b) Decomposition of Forecasts According to Structural Shocks

Figure 5: US Economy Slowdown Scenario with Waggoner and Zha (1999)

Note: Panel (a): Benchmark forecasts are in yellow and those under the scenario in purple. Shaded areas correspond to 68% and 90% moving block bootstrap confidence intervals. The real oil price, interest rate and exchange rate are reported in levels and other variables are shown in year-over-year growth rates. Panel (b): Decomposition of the forecasts according to implied structural shocks from equation (14).

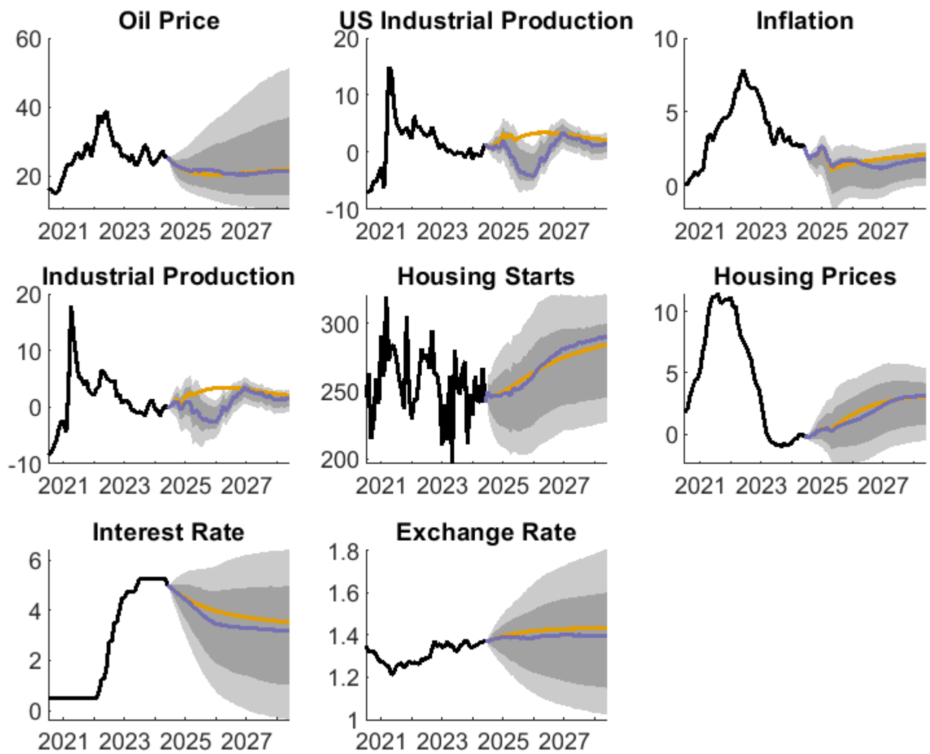


Figure 6: US Economy Slowdown Scenario with Baumeister and Kilian (2014)

Note: Benchmark forecasts are in yellow and those under the scenario in purple. Shaded areas correspond to 68% and 90% moving block bootstrap confidence intervals. The real oil price, interest rate and exchange rate are reported in levels and other variables are shown in year-over-year growth rates.

5 Conclusion

This paper demonstrates the value of conditional forecasting in understanding the potential risks facing the Canadian economy. By simulating scenarios for monetary policy, oil prices, and U.S. activity, we uncover distinct pathways through which these shocks influence macroeconomic variables. The analysis highlights the importance of external factors such as global oil prices and U.S. economic conditions in driving Canadian economic fluctuations. Rising oil prices generate positive demand shocks that bolster industrial production, housing markets, and the exchange rate, while a U.S. slowdown leads to cascading negative effects, exacerbated by falling oil prices and close trade linkages between the two countries.

The structural decomposition of shocks provides further insight, revealing how oil price dynamics amplify both positive and negative demand effects, and how they disproportionately influence housing activity. These results underscore the interconnected nature of macroeconomic variables in a small open economy and the need for adaptive and proactive policy measures to mitigate the risks posed by external shocks. Future research could explore additional scenarios, incorporate sectoral details, or examine how these risks evolve under changing economic conditions. Such extensions would enhance our ability to forecast and manage the uncertainties that shape Canada's economic outlook.

References

Adrian, T., Boyarchenko, N., and Giannone, D. (2019). Vulnerable Growth. *The American Economic Review*, 109(4):1263–1289.

Adrian, T., Giannone, D., Luciani, M., and Mike, W. (2025). Scenario Synthesis and Macroeconomic Risk. Technical report, arXiv.2505.05193.

Antolin-Diaz, J., Petrella, I., and Rubio-Ramírez, J. F. (2021). Structural scenario analysis with SVARs. *Journal of Monetary Economics*, 117:798–815.

Baumeister, C. and Kilian, L. (2014). Real-Time Analysis of Oil Price Risks Using Forecast Scenarios. *IMF Economic Review*, 62(1):119–145.

Baumeister, C. and Kilian, L. (2016). Forty Years of Oil Price Fluctuations: Why the Price of Oil May Still Surprise Us. *Journal of Economic Perspectives*, 30(1):139–160.

Bańbura, M., Giannone, D., and Lenza, M. (2015). Conditional forecasts and scenario analysis with vector autoregressions for large cross-sections. *International Journal of Forecasting*, 31(3):739–756.

Bedock, N. and Stevanovic, D. (2017). An Empirical Study of Credit Shock Transmission in a Small Open Economy. *Canadian Journal of Economics*, 50(3):541–570.

Bernanke, B. S. (2024). Forecasting for monetary policy making and communication at the Bank of England: A review. Report to the Bank of England, April.

Bhuiyan, R. and Lucas, R. F. (2007). Real and nominal effects of monetary policy shocks. *Canadian Journal of Economics*, 40(2):679–702.

Bloom, N. (2009). The impact of uncertainty shocks. *Econometrica*, 77(3):623–685.

Boivin, J., Giannoni, M. P., and Stevanovic, D. (2010). Monetary Transmission in a Small Open Economy: More Data, Fewer Puzzles. March.

Champagne, J. and Sekkel, R. (2018). Changes in monetary regimes and the identification of monetary policy shocks: Narrative evidence from Canada. *Journal of Monetary Economics*, 99:72–87.

Christiano, L. J., Eichenbaum, M., and Evans, C. L. (1999). Monetary policy shocks: What have we learned and to what end? volume 1 of *Handbook of Macroeconomics*, pages 65–148. Elsevier.

Doan, T., Litterman, R., and Sims, C. (1984). Forecasting and conditional projection using realistic prior distributions. *Econometric Reviews*, 3(1):1–100.

Fortin-Gagnon, O., Leroux, M., Stevanovic, D., and Surprenant, S. (2022). A large Canadian database for macroeconomic analysis. *Canadian Journal of Economics*, 55(4):1799–1833.

Giannone, D., Lenza, M., D., M., and Onorante, L. (2014). Short-term inflation projections: a Bayesian vector autoregressive approach. *International Journal of Forecasting*, 30:635–644.

Ha, J., Kim, D., Kose, M. A., and Prasad, E. S. (2025). Resolving Puzzles of Monetary Policy Transmission in Emerging Markets. *Journal of Economic Dynamics and Control*, 173:104658.

Jarociński, M. (2010). Conditional forecasts and uncertainty about forecast revisions in vector autoregressions. *Economics Letters*, 108:257–259.

Jurado, K., Ludvigson, S. C., and Ng, S. (2015). Measuring uncertainty. *American Economic Review*, 105(3):1177–1216.

Kilian, L. (2009). Not All Oil Price Shocks Are Alike: Disentangling Demand and Supply Shocks in the Crude Oil Market. *American Economic Review*, 99(3):1053–1069.

Kilian, L. and Lütkepohl, H. (2017). *Structural vector autoregressive analysis*. Cambridge University Press.

Kim, S. and Roubini, N. (2000). Exchange rate anomalies in the industrial countries : A solution with a structural VAR approach. *Journal of Monetary Economics*, 45:561–586.

Kim, S.-H., Moon, S., and Velasco, C. (2017). Delayed Overshooting: Is It an 80s Puzzle? *Journal of Political Economy*, 125(5):1570–1598.

Leamer, E. E. (2007). Housing is the business cycle. Technical Report 13428, NBER Working Paper.

Leamer, E. E. (2015). Housing Really Is the Business Cycle: What Survives the Lessons of 2008–09? *Journal of Money, Credit and Banking*, 47(1):43–51.

Lenza, M., Moutachaker, I., and Paredes, J. (2023). Density forecasts of inflation: a quantile regression forest approach. European Central Bank Working Paper Series - No. 2830.

Li, Y. D., Iscan, T. B., and Xu, K. (2010). The impact of monetary policy shocks on stock prices: Evidence from Canada and the United States. *Journal of International Money and Finance*, 29:876–896.

McCracken, M. W. and McGillicuddy, J. T. (2019). An empirical investigation of direct and iterated multistep conditional forecasts. *Journal of Applied Econometrics*, 34:181–204.

McCracken, M. W. and Ng, S. (2016). FRED-MD: A monthly database for macroeconomic research. *Journal of Business & Economic Statistics*, 34(4):574–589.

Miyamoto, W. and Nguyen, T. L. (2017). Understanding the cross-country effects of U.S. technology shocks. *Journal of International Economics*, 106:143–1644.

Moran, K., Stevanovic, D., and Touré, A. K. (2022). Macroeconomic uncertainty and the COVID-19 pandemic: Measure and impacts on the Canadian economy. *Canadian Journal of Economics*, 55:379–405.

Moran, K., Stevanovic, D., and Touré, A. K. (2023). Confiance et activité économique : analyse d'impact sur l'économie canadienne. CIRANO Report 2023RP-10.

Nsafoah, D. and Dery, C. (2024). Effect of conventional and unconventional monetary policy shocks on housing prices in Canada. *Journal of Housing Economics*, 64(4):1051–1377.

Rusnák, M., Havranek, T., and Horváth, R. (2013). How to solve the price puzzle? a meta-analysis. *Journal of Money, Credit and Banking*, 45(1):37–70.

Sims, C. A., Stock, J. H., and Watson, M. W. (1990). Inference in linear time series models with some unit roots. *Econometrica*, 58:113–144.

Waggoner, D. F. and Zha, T. (1999). Conditional Forecasts in Dynamic Multivariate Models. *The Review of Economics and Statistics*, 81(4):639–651.

Walsh, C. E. (2017). *Monetary Theory and Policy*. MIT Press.

A Additional Results

The Appendix contain a variety of additional results mentioned in the paper. Below, Table 1 presents the variance decomposition for the benchmark VAR model we used to produce the scenarios in the paper.

Table 1: Variance Decomposition

Horizon	CPI	Housing Starts	Housing Prices	Production	Bank Rate	Exchange Rate
Panel A: Shock to oil prices						
3 months	32.4	8.6	4.1	29	2.4	20.2
	[24.8, 40.1]	[2, 15.5]	[1.3, 7.5]	[1.1, 57.3]	[0.1, 13.7]	[11.6, 30.4]
12 months	29.6	12.2	4.9	30.7	2.8	18.4
	[16.8, 37.1]	[3.5, 21.4]	[0.8, 14.3]	[1.7, 58.5]	[0.2, 20.8]	[6.7, 32.9]
24 months	22.1	11.6	3.7	26	2.5	14.4
	[9.9, 32.3]	[3.5, 20.6]	[0.6, 16.5]	[1.9, 51.3]	[0.4, 22.7]	[4.9, 32.2]
48 months	12.8	11.1	2.6	19.6	2	10.6
	[4.8, 24.9]	[3.5, 20.2]	[0.5, 17.7]	[2, 45.3]	[0.5, 22.5]	[4.2, 30.8]
Panel B: Shock to US economic activity						
3 months	1.6	0.8	0.2	30	1.5	1.7
	[0.1, 6.2]	[0.4, 4.2]	[0, 4]	[16.1, 35.3]	[0.2, 6.8]	[0.3, 5.9]
12 months	1.1	0.5	0.7	36	1.7	1
	[0.3, 6.6]	[0.5, 6.9]	[0.1, 7.5]	[19.4, 47.4]	[0.3, 10.4]	[0.2, 9.3]
24 months	1.1	0.7	0.6	40.6	1.5	0.8
	[0.6, 13.2]	[0.6, 7.6]	[0.1, 10]	[19.6, 51.3]	[0.3, 11.8]	[0.3, 13.2]
48 months	1.9	0.8	0.3	36.2	1.2	0.6
	[0.6, 19.7]	[0.7, 7.9]	[0.1, 13.6]	[18.1, 50]	[0.5, 13.1]	[0.4, 16.7]
Panel C: Shock to Canadian monetary policy						
3 months	0.1	0	0.8	1.3	94.5	0.2
	[0, 0.9]	[0, 0.9]	[0, 3]	[0.1, 3.9]	[80.7, 95.4]	[0, 2.2]
12 months	0.2	1.5	4.8	1.1	90.8	2
	[0, 3.1]	[0.3, 12.6]	[0.4, 18]	[0.3, 5.3]	[64.4, 91.7]	[0.1, 7.2]
24 months	0.2	4.5	13	1.5	87.3	4.9
	[0.1, 9.5]	[0.6, 21.2]	[1.3, 37.4]	[0.5, 11.1]	[54, 89.5]	[0.2, 16.1]
48 months	2.7	5.4	28.1	1.9	81.5	9.9
	[0.5, 27.6]	[0.8, 22.2]	[3.1, 51.6]	[1, 13.2]	[46, 86.6]	[0.4, 26.5]

Note: The decomposition is performed for the transformed variables in the benchmark model. The 95% confidence intervals obtained with 2000 replications of a moving block residual bootstrap are shown in the square brackets.

Using the reduced-form residuals from our benchmark model $\hat{\mathbf{u}}_t$ and the structural impact matrix we identify using short-run recursive restrictions $\hat{\mathbf{D}}$, we can recover an estimate of the series of realized structural as $\hat{\epsilon}_t = \hat{\mathbf{D}}^{-1}\hat{\mathbf{u}}_t$. Figure 7 displays the identified monetary policy shock. Cumulated values reveal sequences of shocks that were particularly positive and negative. This is how we selected a sequence of shocks for the Baumeister and Kilian (2014) monetary policy scenario shown in Figure 2.

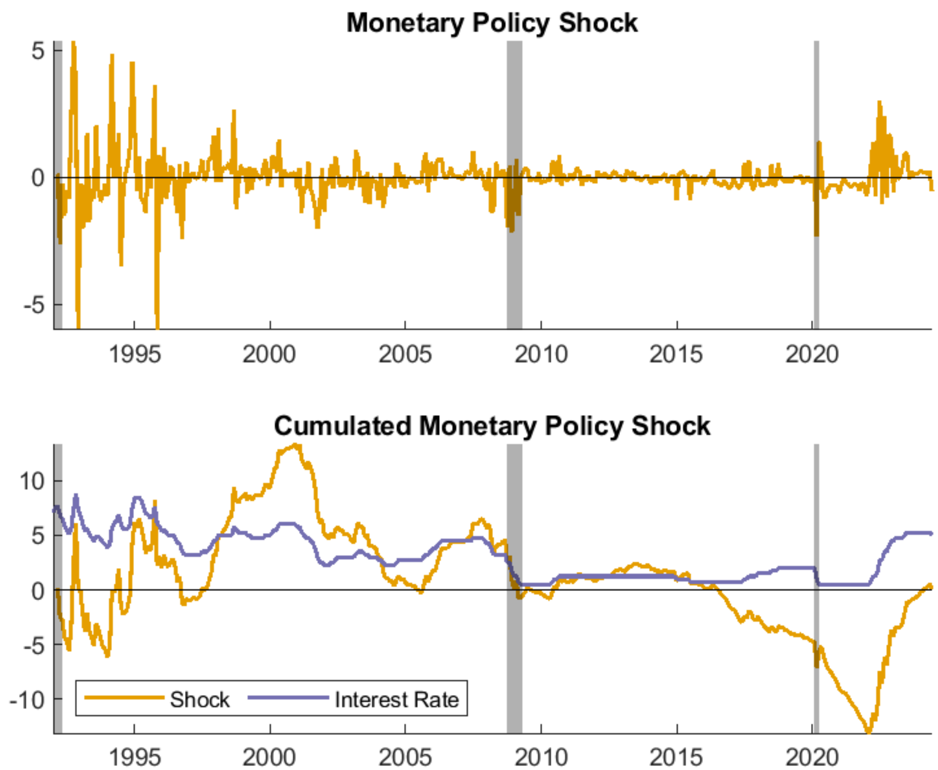
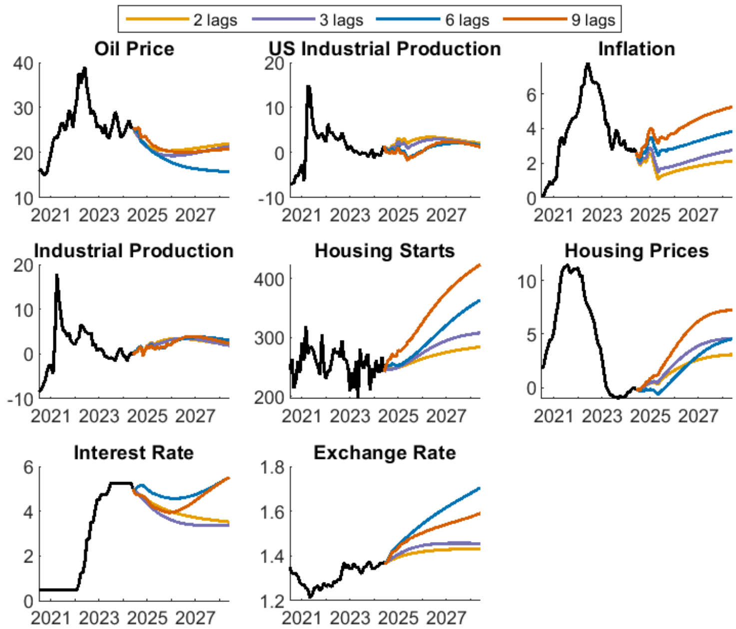


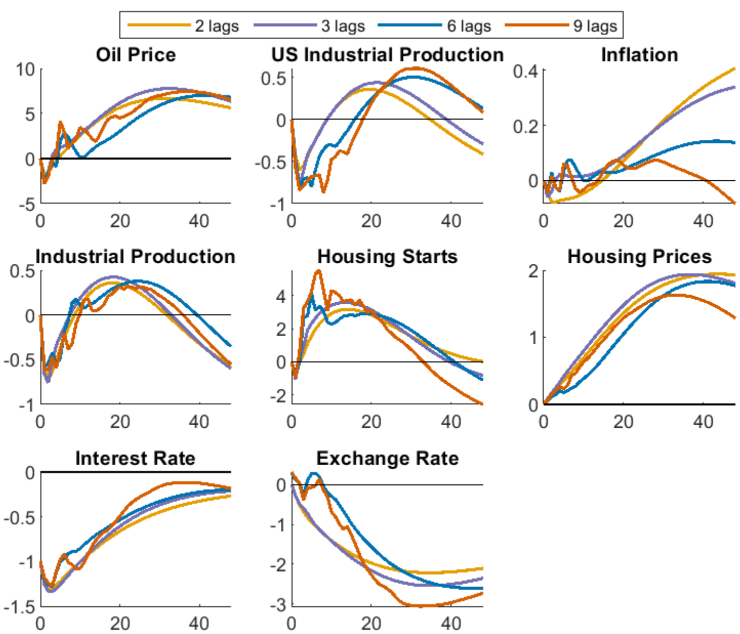
Figure 7: Identified Monetary Policy Shocks

Note: The shock sequence is obtained using block-recursive short-run restrictions in the benchmark VAR model. The shaded areas are CD Howe recession dates.

Next, since the prevalence of longer lag structure in the structural VAR literature, we explore the sensitivity of our results to using different lag lengths. Given our limited sample, the number of variables involved and the fact that even AIC chooses only 2 lags, we explored the sensitivity of our results to using 3, 6 or 9 months of lags. The unconditional forecasts and impulses responses to a monetary policy shock are displayed in Figure 8.



Unconditional Forecasts



Responses to a 100 BPS Interest Rate Cut

Figure 8: Forecast Comparison

Note: All models were estimated by OLS in levels with a constant on monthly data between January 1992 and June 2024. The model with two lags corresponds to our benchmark. Monetary policy shocks are identified using block recursive short-run restrictions as in the benchmark model.