

Changes in Monetary Regimes and the Identification of Monetary Policy Shocks: Narrative Evidence from Canada

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Abstract

We use narrative evidence along with a novel database of real-time data and forecasts from the Bank of Canada's staff economic projections from 1974 to 2015 to construct a new measure of monetary policy shocks and estimate the effects of monetary policy in Canada. We show that it is crucial to take into account the break in the conduct of monetary policy caused by the announcement of inflation targeting in 1991 when estimating the effects of monetary policy. For instance, we find that a 100-basis-point increase in our new shock series leads to a 1.0 per cent peak decrease in real GDP and a 0.5 per cent fall in the price level, while not accounting for the break leads to a very persistent decrease in real GDP and a price puzzle. Albeit the change in monetary policy regime, we find that the effects of monetary policy have not changed much before and after IT. Finally, we compare our results with narrative evidence for the U.S. and the U.K. and find slightly stronger effect of monetary policy on output and significantly smaller effects on the price level in Canada.

Keywords: monetary policy, narrative identification, real-time data, real-time forecasts, business cycles.

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1 Introduction

The identification of monetary policy shocks has generated a vast literature in empirical macroeconomics. Much of this literature uses vector autoregressions (VARs), identified with different approaches, and finds that the effects of monetary policy for the U.S. are relatively modest, with peak decline estimates ranging between 0.3 and 1 per cent for output following a 100-basis-point monetary innovation. The estimates for the price level range between a positive response (coined the “price puzzle” by [Eichenbaum \(1992\)](#) and [Sims \(1992\)](#)), to slightly negative, depending on the identification strategy used (e.g., [Leeper et al. \(1996\)](#), [Christiano et al. \(1996, 1999\)](#), [Bernanke and Mihov \(1998\)](#), [Bernanke et al. \(2005\)](#), [Uhlig \(2005\)](#)). However, [Romer and Romer \(2004\)](#), R&R henceforth) find much larger effects of U.S. monetary policy shocks using narrative methods. This strategy uses historical records to construct a series of intended interest rate changes at meetings of the Federal Open Market Committee (FOMC) and then isolate the innovations to these interest rate changes that are orthogonal to the Federal Reserve’s information set. A 100-basis-point innovation from the R&R measure translates into output and price level peak declines larger than 4 per cent. [Coibion \(2012\)](#) reconciles the differences between R&R and the previous VAR studies and suggests that the effects of monetary policy are more likely to be medium sized (i.e., about -2 per cent for output and prices). [Cloyne and Hürtgen \(2016\)](#) extend the narrative approach to the U.K. and find effects of monetary policy that are in line with those of [Coibion \(2012\)](#) for the U.S.¹

Another body of literature in monetary economics has documented important shifts in the conduct of monetary policy in the U.S. and abroad. [Clarida et al. \(2000\)](#) estimate monetary policy rules for the U.S. and find substantial differences before and after Volcker’s appointment, with monetary policy becoming more responsive to expected inflation in the later period. Within a time-varying VAR with stochastic volatility, [Primiceri \(2005\)](#) also shows that the systematic component of monetary policy has responded more aggressively to inflation and unemployment. [Boivin and Giannoni \(2006\)](#) estimate VARs over the pre- and post-1980 periods, and show evidence of a reduced effect of monetary policy shocks in the latter period. Using a small structural model, they show that by responding more

¹For an exhaustive integration of this long literature, see the recent survey by [Ramey \(2016\)](#).

strongly to inflation expectations, monetary policy has been more effective in stabilizing the economy in the post-1980 period. Focusing on small open economies, [Alstadheim et al. \(2013\)](#) show that the central banks of the U.K., Sweden and Canada have shifted away from responding to exchange rate movements around the 1990s, when these countries implemented inflation-targeting (IT) regimes.

Our paper builds on these two strands of literature and provides a new measure of monetary policy shocks for Canada. We use this measure to bring new evidence on the macroeconomic effects of monetary policy in a small open economy and highlight the importance of changes in the conduct of systematic monetary policy. As in R&R, our analysis proceeds in two stages. The first stage identifies the exogenous component of monetary policy. To do this, we use historical documents to construct a series of intended changes in the target policy interest rate along with a novel database of real-time data and forecasts assembled from the Bank of Canada's staff economic projections from 1974 to 2015. These real-time data and forecasts are used to isolate the innovations to the intended policy changes that are orthogonal to the policy-makers' information set. We then proceed to the second stage, where we estimate a monthly monetary VAR that includes our new shocks measure as the relevant policy rate. Following a 100-basis-point monetary policy shock, real monthly gross domestic product (GDP) has a peak decline of 1.0 per cent about 18 to 24 months after the shock, ending close to zero after four years, while the consumer price index (CPI) response is weaker and takes longer to materialize, falling by about 0.5 per cent after four years. We show that it is crucial for these results to depart from R&R in two important ways: (i) by controlling for U.S. interest rates as well as the USD/CAD exchange rate in the policy-makers' information set, and (ii) by accounting for the structural break in the conduct of monetary policy caused by the announcement of IT in 1991. Canada has had a continuing floating exchange rate regime since 1970 and exchange rate movements were an important factor in monetary policy decisions, as documented by [Fortin \(1979\)](#), [Courchene \(1981\)](#), [Lubik and Schorfheide \(2007\)](#) and [Alstadheim et al. \(2013\)](#), among others. Additionally, the announcement of the IT regime in 1991 prompted a sharp shift in the conduct of monetary policy. We show that while the exchange rate and U.S. interest rates were the main determinants of changes in the target policy rate in the 1970s and 1980s,

GDP and inflation forecasts have become the key factors since the introduction of the IT regime. Furthermore, we show that not accounting for this change leads to monetary policy shocks that imply a prize puzzle and show clear signs of endogeneity.

Given the break in the conduct of monetary policy in Canada, we investigate whether the effects of monetary policy have changed after the introduction of IT. We use our new measure of shocks and estimate our baseline VAR separately for both our subsamples (pre-IT and IT periods). We find that although real GDP reacts modestly more and the price level slightly less during the IT period, the responses are qualitatively similar. These results sharply contrast with those of [Barakchian and Crowe \(2013\)](#) who find that since 1988, a contractionary monetary policy shock (from commonly-used VARs and the R&R shocks) raises output and inflation in the U.S.

We then compare the effects of monetary policy in Canada with narrative evidence from the U.S. (R&R shocks updated to 2007) and the U.K. ([Cloyne and Hürtgen \(2016\)](#) shocks). When comparing our results, we also control for a break in the monetary policy reaction function for those countries.² We find that monetary policy shocks in Canada generate output effects that are in line with those of the U.S. and somewhat stronger than in the U.K.; however, the price level response is weaker in Canada than in those countries. This exercise further shows that, on the one hand, accounting for a break in the monetary policy reaction function matters importantly when identifying shocks for the U.S., consistent with [Barakchian and Crowe \(2013\)](#) and [Ramey \(2016\)](#). On the other hand, as argued by [Cloyne and Hürtgen \(2016\)](#), accounting for the introduction of IT in the U.K. is not as important when estimating the effects of monetary policy, in contrast with our evidence from Canada.

We further examine the robustness of our main results to many alternative specifications and provide additional results: for instance, (i) using [Jordà \(2005\)](#)'s local projections method, we test the robustness of our results and also assess the responses of open economy variables such as the USD/CAD exchange rate, imports and exports. Following a 100-basis-point shock from our new measure, we find that the Canadian dollar appreciates (relative to the U.S. dollar) by about 1.0 per cent for a year and then depreciates slowly,

²The conduct of monetary policy in the U.S. and the U.K. has also undergone significant changes. As just mentioned, many papers argue that U.S. monetary policy has become more responsive to future expected inflation since the Volcker disinflation. Similarly, the U.K. also introduced an IT regime in 1993, and granted the Bank of England formal autonomy to pursue these targets in 1997.

ending 2 per cent lower after four years, leading to a peak decline of 4.0 per cent in imports. Following the decline in economic activity, exports decrease by about 3.5 per cent despite the depreciation of the currency; (ii) we estimate a standard VAR *à la* [Christiano et al. \(1996, 1999\)](#) with the target policy rate instead of our shocks series and find a large price puzzle; (iii) we show the robustness of our baseline VAR results with different measures of output and price level; and finally, (iv) we show that our results are robust to many alternative first-stage specifications.

The remainder of the paper is organized as follows. Section 2 provides a brief historical discussion of the Canadian monetary policy framework, details the derivation of the new measure of monetary policy shocks for Canada and provides some analysis. Section 3 presents our baseline results for the effects of monetary policy and compares them with narrative evidence from the U.S. and the U.K. Additional results and robustness exercises are presented in Section 4 and Section 5 concludes.

2 Derivation of a new measure of monetary policy shocks for Canada

In this section, we first provide a short historical discussion of the Canadian monetary policy framework and then describe how we adapt R&R’s identification strategy to these institutional details. Next, we specify our first-stage regression and provide a description of our database construct of real-time data and staff forecasts. Finally, we summarize the first-stage estimation results, present the new measure of monetary policy shocks and provide some analysis.

2.1 Monetary Policy in Canada: Background

The Bank of Canada was established in 1935, in the middle of the Great Depression, in response of a severe deterioration in public confidence in the behavior of markets and the financial system. Since then, it has been operating under the Bank of Canada Act, which is, in essence, similar to the broad mandate given to the U.S. Federal Reserve under

U.S. legislation.³ Although the Bank’s mandate remained broadly unchanged since its beginnings, the monetary policy framework and the targets for inflation control changed significantly. For example, in the early 1970s, the Bank’s efforts to curb inflation in the face of international inflation pressures proved to be insufficient; as a result, in 1975 the Bank followed other central banks and began targeting monetary aggregates (M1). It quickly proved to be an ineffective strategy and was dropped in 1982. The Bank then entered a period (up to 1991) in which there was no clear monetary policy target; there was rather only a desire to reduce inflation and to approach “price stability.” After the 1982–84 disinflation, there was no further reduction in inflation, and without an explicit target for monetary policy, the Bank had difficulty explaining its policy actions. Discussing that turbulent period, [Thiessen \(2000\)](#) states: “Any efforts to keep interest rates low and to support economic activity were often misinterpreted as signs that the Bank was, in fact, pursuing an inflationary policy and would only make matters worse. As a result, the Bank found itself having to follow the U.S. lead on interest rates and resist downward movements in the exchange rate for tactical reasons. Failure to defend the Canadian dollar would produce even larger increases in domestic interest rates and inflict more serious damage on the economy.” Indeed, before the 1990s the Bank seemed to follow U.S. rates closely and respond to changes in the value of the Canadian dollar relative to its U.S. counterpart. For example, [Fortin \(1979\)](#), [Courchene \(1981\)](#), [Kuszczak and Murray \(1986\)](#) and various press releases (e.g., [Bank of Canada \(1992, 1993\)](#)) all point to the Bank reacting to movements in U.S. rates and/or changes in the USD/CAD exchange rate at different points in time.⁴

Given the relatively high rates of inflation throughout the 1980s, the economic boom and the introduction of the goods and services tax by the federal government in 1991, policy-makers were afraid that inflation would again escalate.⁵ It was against this backdrop that

³The preamble to the act notes that the central bank is established “to regulate credit and currency in the best interests of the economic life of the nation, to control and protect the external value of the national monetary unit and to mitigate by its influence fluctuations in the general level of production, trade, prices and employment, so far as may be possible within the scope of monetary action, and generally to promote the economic and financial welfare of Canada.”

⁴Our results in Section 2.4 below show that the Bank was reacting aggressively to exchange rate movements prior to the early 1990s.

⁵This period was marked by different developments that clouded the economy with uncertainty. For example, after five years of relative stability at around 4 per cent, inflation took off in 1988; the Bank Rate was very high, coupled with the historical high of the Canadian-U.S. 90-day treasury bill spreads; and the USD/CAD exchange rate was very volatile. There was also political uncertainty around the unravelling of

the Bank of Canada and the federal government agreed on targets for inflation reduction in February 1991. The first inflation targets were set at 3 per cent by the end of 1992, 2.5 per cent by mid-1994 and 2 per cent by the end of 1995. Inflation fell more rapidly than expected; by the end of 1992 it had already converged to 2 per cent. This target has become the official operating objective for monetary policy, although inflation is allowed to vary within a range of 1 to 3 per cent.⁶

Although the framework around which the Bank conducted monetary policy evolved substantially over the past four decades, the Bank's main tool to conduct policy has always been an explicit interest rate to influence the overnight market ([Courchene \(1979\)](#), [Fettig \(1994\)](#)).⁷ Since February 1996, the Bank uses the Target for the Overnight Rate to indicate its intention for the overnight market, and this rate is set as the mid-point within a 50 basis points operating band. The Bank Rate is set as the upper limit of this band. Note that the operating band for the overnight rate was introduced in April 1994, nearly two years before the introduction of the target rate. The introduction of the operating band was seen as a first step to provide more transparency to monetary policy ([Lundrigan and Toll \(1998\)](#)).⁸ Prior to the operating band for the overnight rate, the Bank Rate has always been the key interest rate at which the Bank lends to chartered banks.

Finally, since December 2000 the Bank takes monetary policy decisions at fixed announcement dates (FAD), eight times per year. These dates are determined and announced to the public about one year and a half before the first FAD of the year.

the Meech Lake Accord in 1990.

⁶Since the introduction of the inflation-targeting regime, the Bank's policy-makers have relied heavily on staff economic forecasts and other current economic indicators to determine the appropriate stance of monetary policy. We provide evidence in Section 2.4 below.

⁷Even when the Bank emphasized targeting the money supply (during the 1975–82 period), it achieved the targeted growth rate of money by setting short-term interest rates at levels that would bring the monetary conditions consistent with the Bank's views of inflationary pressures, and not through changes in the reserve base, which would have influenced the money supply (e.g., [Fortin \(1979\)](#), [Sparks \(1979\)](#), [Racette and Raynauld \(1994\)](#) and [Longworth \(2003\)](#)).

⁸These rates are published on the Bank of Canada website. See Appendix A.2 for more details on the key interest rates at the Bank of Canada.

2.2 Identification

The intended monetary policy variable (e.g., the target policy rate) is a combination of a systematic component $f(\Omega_t)$, where the function (f) captures the policy-makers’ reaction function to an information set (Ω_t) and an exogenous component (ϵ_t) that reflects unexpected changes in monetary policy. R&R’s strategy to identify ϵ_t —the narrative approach—has two key steps: first, they derive a series of intended changes in the federal funds rate (FFR) around FOMC meetings, and second, they control for the Federal Reserve staff real-time forecasts (Greenbooks) to create a measure of intended FFR changes that is orthogonal to information about past, current and future economic developments.⁹ This approach is appealing because it goes a long way in overcoming many econometric challenges faced when estimating the effects of monetary policy, such as the simultaneous determination of interest rates and macroeconomic variables,¹⁰ the forward-looking behavior and real-time nature of monetary policy decisions.¹¹ However, R&R’s approach implicitly assumes that the monetary policy reaction function does not change throughout the sample they study. This is at odds with some prominent papers such as [Clarida et al. \(2000\)](#), [Primiceri \(2005\)](#) and [Boivin and Giannoni \(2006\)](#), which show a significant change in the systematic component of U.S. monetary policy around the early 1980s, where policy began reacting more aggressively to expected future inflation.

We apply the R&R approach to identify monetary policy shocks (ϵ_t) for Canada.¹² One of the major contributions of R&R was to use the minutes of the FOMC meetings to construct the series of intended changes in the FFR, as the Federal Reserve did not always

⁹R&R’s strategy has become a popular method to derive measures of exogenous shocks. Apart for monetary policy shocks, the narrative approach has also been employed to identify fiscal policy shocks; e.g. [Romer and Romer \(2010\)](#) and [Ramey \(2011\)](#) for the U.S. and [Cloyne \(2013\)](#) for the U.K. For a recent application to government asset purchases, see [Fieldhouse and Mertens \(2017\)](#) and [Fieldhouse et al. \(2017\)](#).

¹⁰Many studies have tackled the simultaneity problem using a timing restriction in VARs (e.g., the “recursive assumption” of [Christiano et al. \(1996, 1999\)](#)); others have used factor-augmented VARs (e.g., [Bernanke et al. \(2005\)](#)) to exploit a larger set of data as a better proxy for the policy-makers’ information set, or used sign restrictions (e.g., [Faust \(1998\)](#), [Uhlig \(2005\)](#)) as a way to identify the shocks ϵ_t .

¹¹Central banks devote a lot of resources monitoring the economy and forecasting in real-time the future path of macroeconomic variables (e.g., see [Romer and Romer \(2000\)](#) and [Croushore and Stark \(2001\)](#) for the Federal Reserve (U.S.); [Duguay and Poloz \(1994\)](#), [Poloz et al. \(1994\)](#) and [Dorich et al. \(2013\)](#) for the Bank of Canada). Moreover, there can be stark differences in using ex-post revised vs. real-time data when estimating monetary policy reaction functions (e.g., [Orphanides \(2001, 2003\)](#) or [Molodtsova et al. \(2008\)](#)).

¹²We use the term “narrative” because we use various historical documents to (i) construct the intended policy target; (ii) construct our database of real-time data and staff forecasts; and (iii) justify our estimation of equation (1) below.

target it explicitly.¹³ As mentioned above, a handy feature of the Canadian monetary policy framework is that the Bank of Canada has always used an explicit target interest rate. Specifically, in the first step we construct our policy rate series using the *Target for the Overnight Rate* from February 1996 onward, the *operating band for the overnight rate* between April 1994 and February 1996, and the *Bank Rate* between 1973 and April 1994.¹⁴ This framework is very similar to the U.K., where the policy rate (also called the Bank Rate) has always been the relevant policy target.¹⁵

The next step in the derivation of our monetary policy shock series is to purge the intended policy rate from the systematic component $f(\Omega_t)$ of monetary policy. The specific regression equation we estimate is:

$$\begin{aligned} \Delta i_m = & \alpha + \beta_1 i_{t-d14} + \sum_{h=1}^3 \rho_h u_{t-h} + \sum_{j=-1}^2 \gamma_j \hat{y}_{m,j}^f + \sum_{j=-1}^2 \delta_j \pi_{m,j}^f \\ & + \sum_{j=-1}^2 \theta_j (\hat{y}_{m,j}^f - \hat{y}_{m-1,j}^f) + \sum_{j=-1}^2 \phi_j (\pi_{m,j}^f - \pi_{m-1,j}^f) \\ & + \beta_2 FFR_{t-d14} + \beta_3 ER_{t-d14} + \beta_4 \Delta FFR_{m-m-1} \beta_5 \Delta ER_{m-m-1} + \epsilon_m, \end{aligned} \quad (1)$$

where the dependent variable (Δi_m), the change in the intended policy rate, is measured at a meeting-by-meeting frequency, as indicated by the subscript m . The subscript j denotes the quarter of the real-time data or forecast relative to the meeting date, while subscripts $t-h$ and $t-d14$ refer to information from the previous months and two weeks relative to the meeting date, respectively (and not to information from a previous meeting). Specifically, we regress the change in the policy target rate (Δi_m) between two meetings on the one- and two-quarter-ahead forecasts of real output growth ($\hat{y}_{m,j}^f$) and inflation ($\pi_{m,j}^f$), as well as the nowcast and the real-time one-quarter lag.¹⁶ We also include the revisions to the forecasts relative to the previous round of forecasts (e.g., $\hat{y}_{m,j}^f - \hat{y}_{m-1,j}^f$), since both the level

¹³The Volcker's disinflation 1979–82 period is an example of when the Federal Reserve was not explicitly targeting the FFR.

¹⁴See Appendix A.2 for more details on the construction of our intended policy rate series.

¹⁵Also note that the Bank Rate, the operating band for the overnight rate, or the Target for the Overnight Rate are not market rates but policy rates announced by the Bank of Canada. It is similar to the target for the FFR for the U.S., and to the U.K. Bank Rate used by [Cloyne and Hürtgen \(2016\)](#).

¹⁶Note that we test the robustness of our results to adding a second lag ($t-2$) of real-time GDP growth and inflation (see Section 4.4) and to adding a third quarter ($t+3$) of forecasts (see Appendix D.7). We find that our results are unaffected by these alternative first-stage specifications.

and change in the forecasts can be important determinants of the Bank’s behavior. To control for economic developments between meetings, we include the intended policy rate two weeks before the meeting and the (real-time) rates of unemployment for the previous three months.¹⁷

The third line of equation (1) departs importantly from R&R as we also control for the levels and changes of the U.S. FFR (FFR_{t-d14}) and the logarithm of the USD/CAD nominal exchange rate (ER_{t-d14}) two weeks before the meeting.¹⁸ Canada is a small open economy with close ties to the U.S., and these variables are included to capture any tendency for the Bank to react to interest rate movements in the U.S. as well as the changes in the value of the Canadian dollar relative to its U.S. counterpart. As mentioned above, the Bank reacted to movements in U.S. rates and/or changes in the USD/CAD exchange rate at different points in time, especially before the introduction of the IT regime.¹⁹

We make another important departure from R&R and break the estimation of equation (1) into two sub-samples of meetings: the first sub-sample includes all those meetings preceding the inflation targets (i.e., 1974-1991) and the second sub-sample regroups all meetings afterward (1992 on).²⁰ The reason for doing this is three-fold: first, there is strong evidence suggesting a change in the Bank’s reaction function. For example, [Rowe and Yetman \(2002\)](#) argue that there was a major change in the Bank’s objectives near the time formal inflation targets were announced. As explained in the previous subsection, the Bank followed U.S. interest rates and exchange rates developments very closely before the IT period, while since the beginning of IT, the Bank has been using economic forecasts and other current economic indicators more thoroughly to assess the necessary stance of

¹⁷As mentioned by R&R, using forecasts to identify monetary policy shocks has a further advantage since they summarize a wider range of macroeconomic information as well as the anticipated movements in the economy. This approach thus allows us to identify shocks without including a large set of variables as in the FAVAR approach, for example.

¹⁸In Section 4 below, we show that our results are robust to using a seven-day lag instead of 14 days.

¹⁹Note that we control for the level and change of the U.S. FFR and the USD/CAD prior to a meeting m and not for the forecasts. The reason is two-fold: first, the narrative records point to the Bank *reacting* to changes in U.S. FFR and the USD/CAD nominal exchange rate, especially during the 1980s, and not responding to anticipated future movements in those rates. Second, we do not have a consistent set of forecasts for these variables.

²⁰Because IT was announced in 1991 but the first inflation target was set for 1992, we decide to break the first-stage estimation between 1991 and 1992; consequently, our first sub-sample covers 1974-1991 and our second covers 1992 to 2015. Note that breaking the estimation right after the announcement (between February and March 1991) does not alter our results.

monetary policy (e.g., [Montador \(1995\)](#), [Duguay and Poloz \(1994\)](#), [Macklem \(2002\)](#), [Dorich et al. \(2013\)](#) and various *Monetary Policy Reports* (MPRs)).²¹ Second, we will show in Section 2.4 that our regression estimates of equation (1) strongly support this change in the reaction function, as the response of the intended policy rate (Δi_m) to changes in the USD/CAD exchange rate and U.S. FFR and to real GDP growth and inflation forecasts changes drastically in the first vs. the second sub-sample. Third, as we will show in Section 3, the effects of monetary policy are markedly different when one does not break the first-stage estimation to account for the IT period.²²

Lastly, we take the estimated residuals from equation (1) for each sub-sample and splice them together to create our new meeting-by-meeting series of monetary policy innovations. This new series, which can be interpreted as exogenous changes that are not taken in response to information about current and future economic developments, will then be converted into a monthly basis and used in the second stage (Section 3) to quantify the effects of monetary policy on macroeconomic variables.

2.3 Data construction

When constructing our dataset for the first-stage regression (equation 1), we need to match the variables forming the Bank’s information set (Ω_t) with the intended policy rate variable. As noted above, our intended policy rate is constructed using the Bank Rate from 1973 up to March 1994, the operating band for the overnight rate between April 1994 and February 1996, and the Target for the Overnight Rate afterward. We use the changes in this series as the left-hand side variable in equation (1).

To build the information set (Ω_t), we first use a novel database of real-time data and forecasts for real GDP and inflation constructed from the Bank of Canada’s staff economic projections. Bank of Canada staff produce four exhaustive projections each year, following the release of the quarterly national income and expenditure accounts, which are generally

²¹For example, [Courchene \(1981\)](#) has a whole chapter titled “1980: Riding the U.S. roller coaster,” arguing that Canada was simply a side passenger in the U.S. monetary policy roller coaster of the early 1980s. Also, [Howitt \(1986\)](#) states that the Bank’s policy after 1979 consisted of resisting any long-term depreciation of the Canadian dollar and short-term fluctuations in that rate caused by temporary changes in U.S. interest rates.

²²For sake of comparison and completeness, in Section 4.2 we use the same specification as in R&R to identify the shocks and compare their implications with those from our new measure of shocks.

carried out around the end of March, June, September, and December.²³ These staff projections contain quarterly forecasts as well as historical (real-time) data of numerous macroeconomic aggregates. They are a material part of the analysis presented to the Governing Council every quarter in the weeks leading up to the publication of the Bank’s Monetary Policy Report.²⁴ The quarterly staff projections are analogous to the Greenbook forecasts prepared by the Federal Reserve Board staff; they are judgmental in the sense that the forecasts are based on different sources of information and economic models. Second, we construct the (real-time) unemployment rate series from digitized Statistics Canada archives (1978-2015) and hard copies of Bank of Canada Reviews for 1973-1977. Third, our series for the USD/CAD exchange rate is taken from Statistics Canada, and the U.S. FFR is taken from the Federal Reserve Board website. Appendix A.1 presents further details on the data series used in the first-stage regression. This is a large dataset that we hope will be useful for future research.²⁵

Note that the relevant inflation index varied over our sample. Up to March 1980 inclusively, we use total CPI inflation, while from April 1980 onward, we use core CPI inflation.²⁶ The output measure forecasted by staff also varied: prior to 1982, staff prepared forecasts for real gross national expenditures, while since 1982, it has been forecasting real GDP growth. The earliest vintage of projection data where we have both output and inflation forecasts is 1974:Q1.

Before matching each monetary policy decision (“meetings,” for short) with the relevant set of real-time data and forecasts, we need to define what exactly we mean by “meeting.” As mentioned above, since December 2000 the Bank announces monetary policy decisions

²³Note that for many years from 2005 on, Bank of Canada staff produced eight projections per year: the four just mentioned, and four updates prepared for the FADs in-between the national accounts data releases. When available, we use these additional forecasts.

²⁴See [Macklem \(2002\)](#) for details about the information and analysis presented by the staff to the Governing Council. We highlight the fact that these are staff estimates and thus may not be the same estimates provided in the MPR, the Bank of Canada publication containing detailed economic analysis and economic outlook and representing the view of the Governing Council, available every quarter since 2001.

²⁵For example, [Champagne et al. \(2017\)](#) use the same projections dataset to study the real-time properties of the Bank of Canada’s staff output gap estimates.

²⁶Since May 2001, core CPI inflation in Canada has been known as CPIX, which excludes the eight most volatile components of the CPI and adjusts the remaining components for the effects of changes in indirect taxes. Before May 2001, core inflation was defined as CPI excluding food, energy, and the effects of changes in indirect taxes.

eight times per year on predetermined dates (FAD). Consequently, these FAD become our meetings from 2000:12 to 2015:10 (since the latest policy decision in our sample is October 21, 2015). Before 2000:12, the definition of meeting is less trivial as we cannot know with certainty when a meeting happened. Following Cloyne and Hürtgen (2016), we define a meeting as all dates where a change in our intended policy rate occurred; moreover, when a new set of forecasts is released but there is no change in our intended policy rate, we do not treat the forecast release as a decision itself because we cannot be sure these are genuine monetary policy decisions.²⁷

Next, we need to assign the relevant projection data to each meeting since the regression in equation (1) is conducted on a meeting-by-meeting frequency. We are facing the complication that we do not have a new projection for every monetary policy decision because there are more meetings than forecast releases. For all those meetings without a new projection, we assign the latest available set of forecasts.²⁸ Note that since the introduction of the fixed announcement dates in December 2000, this has been less of an issue because a new set of forecasts is prepared for most of the announcement dates such that matching a new projection with a meeting is straightforward.²⁹ Before this, we must be careful when assigning a set of forecasts to a given meeting in order to avoid endogeneity of forecasts to the policy change. Therefore, we use the projection prepared at the end of the quarter preceding the meeting date, ensuring that the forecasts do not include the effects of the subsequent policy change. Table (1) provides examples of the data assignment to meetings. The first column lists the variables of interest (i.e., regressors) from equation (1), while the other columns show the data source and the time period forecasted (or the backdata, when using lagged data) for different meeting dates (shown in the top row).

The second block of columns, corresponding to the April 17 and May 22, 1980 meetings,

²⁷In Section 4.4, we test the robustness of the definition by adding meetings with zero policy rate change in two different ways: (i) we add all those dates where we have a new forecast but no change in the intended policy rate and (ii) we add those dates corresponding to two days after an FOMC meeting and where we do not have a meeting already defined in the week. We find that our results remain broadly robust to adding these additional observations.

²⁸Note that in equation (1) we control for developments between a given meeting and the last available projection by including monthly lags of the unemployment rate and the interest rate two weeks before the meeting.

²⁹For those announcement dates without a new projection, we keep assigning the latest projection data available.

Table 1: Assigning forecasts and economic variables to monetary policy decisions

	Meeting dates [current quarter]									
	12/22/1976 [1976:Q4]		...	4/17/1980 [1980:Q2]		5/22/1980 [1980:Q2]		...	7/17/2001 [2001:Q3]	
Variables	Source	Forecast / Data		Source	Forecast / Data	Source	Forecast / Data		Source	Forecast / Data
$\hat{y}_{m,t-1}^f$	Sep-76 proj	1976:Q3	...	March-80 proj	1980:Q1	March-80 proj	1980:Q1	...	June-01 proj	2001:Q2
$\hat{y}_{m,t}^f$	Sep-76 proj	1976:Q4	...	March-80 proj	1980:Q2	March-80 proj	1980:Q2	...	June-01 proj	2001:Q3
$\hat{y}_{m,t+1}^f$	Sep-76 proj	1977:Q1	...	March-80 proj	1980:Q3	March-80 proj	1980:Q3	...	June-01 proj	2001:Q4
$\hat{y}_{m,t+2}^f$	Sep-76 proj	1977:Q2	...	March-80 proj	1980:Q4	March-80 proj	1980:Q4	...	June-01 proj	2002:Q1
$\pi_{m,t-1}^f$	Sep-76 proj	1976:Q3	...	March-80 proj	1980:Q1	March-80 proj	1980:Q1	...	June-01 proj	2001:Q2
...	...	...	...	...	...	...	...	...	...	...
u_{t-1}	Real-time data	Nov-76	...	Real-time data	Mar-80	Real-time data	Apr-80	...	Real-time data	Jun-01
u_{t-2}	Real-time data	Oct-76	...	Real-time data	Feb-80	Real-time data	Mar-80	...	Real-time data	May-01
...	...	...	...	...	...	...	...	...	...	...
ER_{t-d14}	Real-time data	12/8/76	...	Real-time data	4/3/80	Real-time data	5/8/80	...	Real-time data	7/3/01
FFR_{t-d14}	Real-time data	12/9/76	...	Real-time data	4/3/80	Real-time data	5/8/80	...	Real-time data	7/3/01
...	...	...	...	...	...	...	...	...	...	...

Notes: Assignment of forecasts and lagged real-time data to different meeting dates. The upper row corresponds to the exact date of the meeting, with (in brackets) the corresponding year and quarter in which the given meeting is happening. The “Source” column refers to the specific staff projection database from which the real GDP growth and inflation real-time and forecasts data were prepared, while the lagged (real-time) unemployment rate, exchange rate, FFR and the policy rate are taken from Statistics Canada or Bank of Canada archives. The “Forecast/Data” column shows the year and quarter of the forecasts estimates (for real GDP growth and inflation), while it shows the specific date (month or day) for the other lagged real-time variables.

provides a case where we assign the same set of forecasts to two consecutive meetings. Because these two meetings happen in 1980:Q2, we use the projection data from March 1980 to get the values for real GDP growth ($\hat{y}_{m,t+j}^f$) and inflation ($\pi_{m,t+j}^f$). Moreover, we assign the relevant lags of unemployment rates, exchange rates and U.S. FFR available at the time of the meeting from our real-time data set.³⁰

Lastly, we use all changes in our intended policy rate, apart from those meetings occurring within the same four weeks during the March 1980 to May 1994 period (when meetings were occurring at a high frequency).³¹ Overall, our data assignment allows us to have a

³⁰Note that the *change* in the USD/CAD exchange rate and in the U.S. FFR (i.e., ΔER_{m-m-1} , ΔFFR_{m-m-1} in equation (1)) between these two consecutive meetings (May 22 and April 17, 1980) are computed as follows: $(ER_{22May1980,t-d14} - ER_{17Apr1980,t-d14})$ and $(FFR_{22May1980,t-d14} - FFR_{17Apr1980,t-d14})$, respectively.

³¹During those years the Bank Rate was changing more often than in the rest of the sample (see Appendix A for details). We test the robustness of our results in Section 4.4 to dropping changes within two weeks instead of four weeks for the specified period and find that both specifications yield similar results.

sample of meetings matched with projections data from 1974:M4 to 2015:M10, containing a fair number of observations (337 meetings).

2.4 Estimation results

We now use our dataset of changes in the intended policy rate, carefully matched (by meeting) with the staff forecasts and real-time data to estimate the regression equation (1). As mentioned earlier, our preferred strategy critically departs from R&R as we estimate equation (1) for the pre-1992 and 1992-onward periods separately, such that our estimates account for the change in the monetary policy reaction function observed around the introduction of IT. To show the importance of breaking our estimation into two parts, we also estimate equation (1) using the full sample (all 337 meetings). Table (2) reports the results of these estimations.

Examining the full-sample (no-break) estimates (left column) suggests that monetary policy has been conducted in an acyclical fashion over the past 40 years. For example, coefficients on real GDP growth level sum up to 0.27, while they sum to -0.24 for the revision to the forecast. Coefficients on inflation forecast levels and revisions to inflation forecasts are very low, at 0.04 and -0.02, respectively. Thus, a 1 percentage point increase in inflation from one forecast release to the next is associated with a mild increase in the policy rate of 0.02. Finally, a 1 percentage point fall in the unemployment rate translates into a small 0.06 percentage point increase in the policy rate. Monetary policy is also positively related to changes in the U.S. FFR and negatively related to movements in the USD/CAD exchange rate.

This acyclical behavior of monetary policy, along with the responses to U.S. interest rates and exchange rate movements, hide considerable heterogeneity once one breaks the first-stage estimation into two sub-samples. The second and third columns (the “IT-break estimation”) show the regression estimates for the 1974-1991 and the 1992-2015 sub-periods, respectively.³² Three results stand out: first, summing coefficients on real GDP and inflation for the pre-IT period yields procyclical estimates of -0.17 and -0.29 percentage points, respectively, and a countercyclical estimate of -0.18 for the unemployment rate. A very

³²A Chow test of parameter stability with a break date set to January 1992 yields an F-statistic of 2.26 with an associated p-value of 0.0007.

Table 2: Determinants of the change in the policy rate

Variable	Full-sample (no-break) estimation		IT-break estimation			
	1974-2015		Pre-IT		IT period	
	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error
Constant	0.166	(0.29)	1.954	(1.57)	-0.155	(0.30)
Initial Bank Rate	-0.029	(0.03)	0.006	(0.08)	-0.053	(0.04)
U.S. FFR:						
level	0.045	(0.03)	0.046	(0.07)	0.013	(0.03)
change	0.292***	(0.07)	0.249***	(0.08)	0.164*	(0.09)
US/CAD exchange rate:						
level	0.071	(0.27)	-1.186	(1.69)	-0.013	(0.22)
change	-3.730***	(1.35)	-14.139***	(4.00)	-1.222	(1.08)
Forecasted output growth,						
<u>Quarters ahead:</u>						
-1	0.223	(0.14)	0.511**	(0.21)	0.130	(0.09)
0	-0.336	(0.22)	-0.389	(0.27)	-0.156	(0.23)
1	0.341	(0.24)	0.449*	(0.25)	0.300	(0.40)
2	0.039	(0.20)	0.070	(0.30)	0.138	(0.25)
Change in forecasted output growth,						
<u>Quarters ahead:</u>						
-1	-0.033	(0.12)	-0.260	(0.16)	-0.046	(0.10)
0	0.225	(0.19)	-0.059	(0.25)	0.363*	(0.20)
1	-0.143	(0.20)	0.076	(0.22)	-0.498*	(0.29)
2	-0.285	(0.24)	-0.572*	(0.34)	0.062	(0.18)
Forecasted inflation,						
<u>Quarters ahead:</u>						
-1	0.019	(0.13)	0.074	(0.21)	-0.008	(0.20)
0	-0.198	(0.20)	-0.052	(0.25)	-1.073	(0.72)
1	0.380**	(0.17)	0.185	(0.18)	1.790	(1.29)
2	-0.160	(0.13)	-0.353**	(0.15)	-0.419	(1.09)
Change in forecasted inflation:						
<u>Quarters ahead:</u>						
-1	-0.084	(0.18)	-0.146	(0.26)	-0.093	(0.19)
0	-0.012	(0.24)	-0.636	(0.44)	1.123*	(0.59)
1	-0.025	(0.28)	0.207	(0.35)	-1.060	(0.95)
2	0.100	(0.33)	0.430	(0.51)	0.415	(0.82)
Unemployment rate,						
<u>Months:</u>						
-1	-0.333*	(0.17)	-0.390*	(0.23)	-0.240	(0.21)
-2	0.256	(0.22)	0.339	(0.34)	0.093	(0.18)
-3	0.018	(0.15)	-0.128	(0.22)	0.129	(0.12)
Observations	337		146		191	
R-squared	0.388		0.537		0.309	

Notes: Robust standard errors in parentheses; asterisks indicate statistical significance (i.e., (***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.1$). Dependent variable: change in the intended policy rate, constructed as described in the text. “Full-sample estimation” refers to first-stage regression estimated over the full sample (1974:M4–2015:M10). “IT-break estimation” refers to first-stage regression estimated over two sub-samples separately (i.e., Pre-IT: 1974–1991, and IT period: 1992–2015). A Chow test of parameter stability with a date break fixed to January 1992 (IT introduction) yields a F-statistic of 2.26 with an associated p-value of 0.0007.

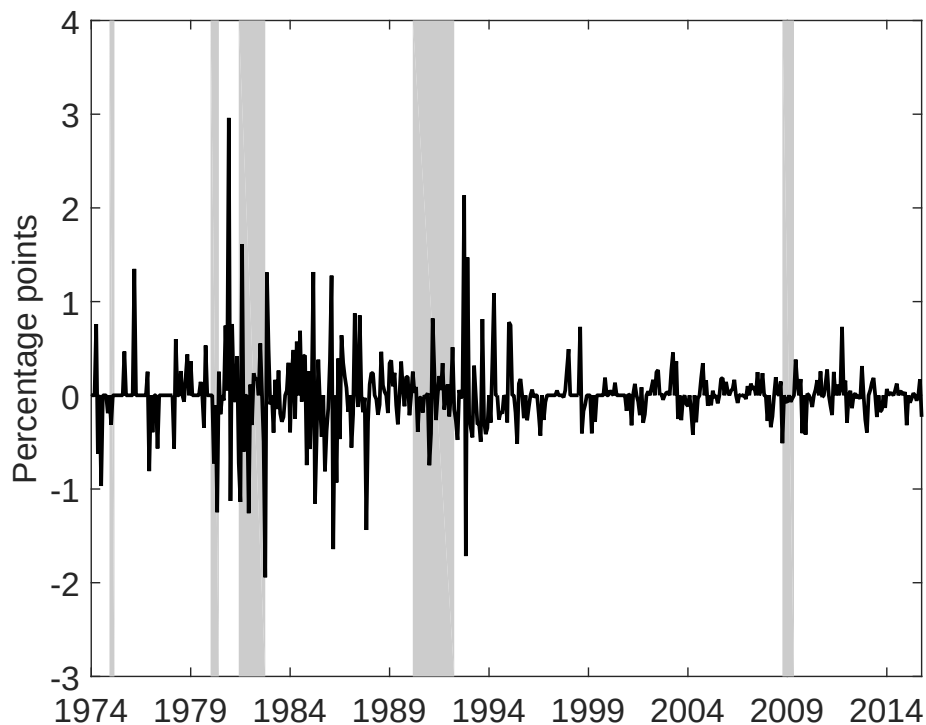
different picture emerges for the second sub-sample: summing the same coefficients yields estimates (in percentage points) of 0.29 for real GDP, 0.68 for inflation and -0.02 for the unemployment rate, implying strong countercyclical monetary policy since 1992. Second, the pre-IT behavior of monetary policy can be explained by the response with respect to the U.S. rates and USD/CAD exchange rate: a 1 per cent increase in the U.S. FFR between two meetings translates into a 0.3 percentage point increase in the policy rate, while a 1 per cent decrease in the value of the exchange rate between two meetings implies a 0.15 percentage point increase in the policy rate. Third, the response of monetary policy toward these two variables changed dramatically since 1992: the response to changes in the FFR decreased by more than a third (0.18) and fell to almost zero with respect to exchange rate movements (0.01 percentage point). Since 1992, Canadian monetary policy has been responding fiercely to economic developments related to inflation and real GDP growth and much less to exchange rate movements.

Overall, our full-sample estimates for the response of the policy rate to real GDP growth and inflation forecasts are close to zero and far from the procyclical first-stage estimates of R&R for the U.S. and [Cloyne and Hürtgen \(2016\)](#) for the U.K., and are not a good representation of the Bank’s behavior for more than half of our sample. Looking at our 1992-2015 estimation results, we see they are more similar than those of the U.S. and U.K., albeit not identical. Finally, the residual component of equation (1) from the “IT-break” estimation (ϵ_m), i.e., the component of policy rate changes that is orthogonal to the policy-makers’ information set, is our new measure of monetary policy shocks.

2.5 Analyzing the new shock series

This residual series corresponds to specific meeting (i.e., policy decision) dates. To use these residuals for economic analysis, they must be converted into a monthly series of monetary policy innovations. To do this, we assign each shock to the month in which the corresponding meeting occurred. If there is no meeting in a given month, we record the shock as zero for that month; if there is more than one meeting within the same month, we sum the shocks. [Figure 1](#) presents our new monthly series of monetary policy shocks, which we denote ϵ_t as above.

Figure 1: New monthly monetary policy shocks series for Canada



Notes: Shaded gray bars represent recessions as determined by the C.D. Howe Institute.

As found by R&R for the U.S. [Cloyne and Hürtgen \(2016\)](#) for the U.K., our new series for Canada is more volatile in the first half of our sample, up to the end of 1992. Note that our series is substantially more volatile in the early 1990s than the U.S. and U.K. series; as mentioned earlier in Section 2.1, this is likely due to the uncertain environment the Canadian economy was facing in those years. The decline in the magnitude of the new measure of shocks coincides nicely with the view that there was a regime change in 1992, when the Bank of Canada began targeting inflation explicitly. Three other developments mentioned earlier also made the policy-making process more transparent during this sub-period: the introduction of the operating band around the overnight rate in 1994, which led to the explicit Target for the Overnight Rate in 1996, as well as the introduction of fixed announcements dates in December 2000.³³

We can use our new measure of monetary policy shocks to measure the stance of monetary policy: i.e., periods with a sequence of positive innovations are ones in which the

³³As noted by [Cloyne and Hürtgen \(2016\)](#), larger shocks in the first part of the sample could also reflect that the level of the Bank Rate was relatively higher than in the second part.

Bank raised the policy rate more than it would normally have given current and expected economic conditions. Appendix Figure B.1 plots the exogenous Bank Rate path (i.e., our new shock series, cumulated) along with the shocks series estimated over the full sample (no break) and the actual path of the Bank Rate. Interestingly, the shocks series imply a very different path for the exogenous policy rate (dotted blue vs. dashed red lines). For instance, after following a pattern similar to our new measure of shocks between 1974 and 1989, the no-break series diverged markedly afterwards: it implies that monetary policy had been very tight for 10 years up to 1999, where it loosened precipitously afterward. Since 2007, this alternative shock measure implies that given current and expected future economic conditions, monetary policy has been—by far—at its loosest stance over the last 40 years.

2.6 Are the new estimated monetary policy shocks predictable?

We follow [Coibion \(2012\)](#) and test whether our new monthly measure monetary policy shocks is unpredictable from movements in ex-post revised data.³⁴ We perform a Granger causality test by regressing our innovations series ϵ_t on a large set of lagged macroeconomic variables (x_{t-i}) including two of the most relevant measures of inflation for Canada (CPI, CPIX), two measures of output (real GDP, industrial production), the unemployment rate, commodity price inflation, the change in the Toronto Stock Exchange Index (TSX) and the change in money supply (M2):³⁵

$$\epsilon_t = c + \sum_{i=1}^I \beta_i x_{t-i} + v_t. \quad (2)$$

Under the null hypothesis that our shock series ϵ_t is not predictable, the β_i are jointly equal to zero. Table 3 reports the F-statistics and p-values for the null hypothesis based on estimation of equation (2) for our new measure of monetary policy innovations (“New measure of shocks,” right panel) along with the alternative shock series discussed above,

³⁴We also look whether our new measure is uncorrelated with other structural shocks, such as the U.S. and U.K. monetary policy shocks of R&R and [Cloyne and Hürtgen \(2016\)](#) (correlations of 0.03 and 0.06, respectively), as well as oil supply shocks (0.00) from [Kilian \(2009\)](#).

³⁵See Appendix A.3 for data details. Note that we have a monthly series for real GDP in Canada, which we will also use below when quantifying the macroeconomic effects of monetary policy shocks.

estimated using the full sample (“no-break,” left panel).

Table 3: Predictability of monetary policy shocks series

Variable	Full sample (no-break) shocks				New measure of shocks			
	I = 3 lags		I = 6 lags		I = 3 lags		I = 6 lags	
	F-stats	P-values	F-stats	P-values	F-stats	P-values	F-stats	P-values
CPI inflation	1.33	0.26	1.14	0.34	0.62	0.60	0.71	0.65
CPIX inflation	0.85	0.47	1.68	0.12	0.29	0.83	1.34	0.24
Change in real GDP	2.76	0.04	2.82	0.01	1.59	0.19	1.75	0.11
Change in ind. prod.	1.52	0.21	0.80	0.57	1.10	0.35	0.55	0.77
Unemployment rate	0.39	0.76	2.05	0.06	0.34	0.80	1.82	0.09
Commodity price inflation	2.96	0.03	1.65	0.13	1.66	0.17	1.09	0.37
Change in nominal USD/CAD	0.58	0.63	0.90	0.50	0.17	0.92	0.63	0.70
Change in TSX	1.89	0.13	0.94	0.46	1.37	0.25	0.54	0.77
Money growth (M2)	0.17	0.91	0.14	0.99	0.34	0.79	0.31	0.93

Notes: The table reports F-statistics and p-values for the null hypothesis that all coefficients (β_i) are equal to zero. The standard errors are corrected for the possible presence of serial correlation and heteroskedasticity using a Newey-West variance-covariance matrix. The “Full sample (no-break) shocks” specification refers to first-stage regression estimated over the full sample (1974-2015). “New measure of shocks” refers to our new series of monetary policy shocks, where the first-stage regression is estimated over two sub-samples separately (i.e., Pre-IT and IT period). Estimation sample from 1974:M1 to 2015:M10. All variables are at monthly average frequency.

Two things stand out: first, the shock series estimated on the full sample (no-break) shows many low p-values, implying some degree of predictability. For example, this alternative shock series is significantly predictable using real GDP growth, commodity price changes and six lags of the unemployment rate; it also has low p-values when equation (2) is estimated with the CPIX and the change in the TSX. Second, a sharp contrast emerges when one looks at our new measure of shocks (columns 5 to 8): for example, the p-values of real GDP are almost 5 times (three lags) and 10 times (six lags) larger using our new measure and substantially larger for the change in commodity prices and the unemployment rate. Overall, most p-values are very large for the new measure; this lack of predictability and stark contrast with the alternative full-sample shock series is another argument in favor of our new measure of monetary policy shocks and suggests that it is a suitable instrument for identifying the macroeconomic effects of monetary policy in Canada.

3 Macroeconomic implications of the new measure of monetary policy shocks

3.1 Baseline results

The next stage of our analysis is to use our new measure of monetary policy shocks to estimate the macroeconomic effects of monetary policy from 1974 to 2015. To do this, we use a parsimonious VAR with the following four variables: the log monthly real GDP (y_t), the log price level (p_t) based on the CPI, the log commodity prices ($pcom_t$) based on the Bank of Canada commodity index (BCPI), converted to Canadian dollars, and our new measure of monetary policy shocks.³⁶ Note that our VAR includes monthly real GDP instead of industrial production; papers in the literature have used industrial production indexes because of their monthly availability and high correlation with real GDP.³⁷ As industrial production is also available on a monthly basis in Canada, we use it below when we compare our results with other countries. Data definitions can be found in Appendix A.3.

Specifically, the VAR we estimate is given by:

$$X_t = B(L)X_{t-1} + \varepsilon_t, \quad (3)$$

where $B(L)$ is a lag polynomial with P lags. The vector of observables X_t is defined as: $[y_t, p_t, pcom_t, cum.shock_t]'$. Since VARs usually include the levels of macroeconomic variables as well as the level of interest rates, we cumulate our new monetary policy shock series ($cum.shock_t = \sum_{i=1}^t \epsilon_i$) and order it last in the VAR, and employ [Christiano et al. \(1996\)](#)'s recursive identification strategy, i.e., assuming that monetary policy responds to, but does not affect the non-policy variables contemporaneously.³⁸ Our sample has a monthly fre-

³⁶In Section 4.3, we consider two other measures of the price level: CPIX, which removes the eight most volatile components of CPI, and CPIxMIC, which excludes mortgage interest costs from the CPI. Moreover, in Appendix D, we test the robustness of our results to larger VAR specifications, such as (D.1) adding the unemployment rate and the Bank Rate; (D.2) explicitly including the USD/CAD nominal exchange rate in the VAR; and (D.3) adding exports and imports to our baseline VAR specification.

³⁷Appendix D.6 compares our baseline results with those from a VAR with IP as the measure of output.

³⁸On the one hand, because we estimate a monthly VAR, this assumption is less restrictive than with quarterly VARs. On the other hand, if we have correctly captured the information set that the policy-makers use to form their decisions in our first-stage estimation, our shock series should be contemporaneously exogenous and thus the recursive assumption should not be essential for our results. We relax

quency t , starting in 1974:M4 and ending in 2015:M10. We use $P=24$ lags in the VAR estimation and include a constant and a time trend.³⁹

Figure 2 presents the impulse responses of real GDP, the (CPI) price level, and the Bank Rate to a 100-basis-point monetary policy shock using our new measure (black solid line with circles), together with 68 and 95 per cent bootstrapped confidence intervals using 2000 replications. Following this contractionary innovation to the policy rate, real GDP has a peak decline of 1 per cent between months 18 and 24; the shock effects then fade as GDP ends close to zero after four years. The GDP response is highly significant (95 per cent) between months 5 and 28. The price level (CPI) is less responsive to the contractionary shock: it stays roughly flat for the first 24 months, where it starts falling and ends about 0.5 per cent lower after four years. The response is only significant over the last 15 months. The last panel of Figure 2 shows that the increase in the Bank Rate is short-lived:⁴⁰ the Bank Rate increases on impact, starts falling in month four and turns negative after 12 months, closing to zero after three years.⁴¹

Figure 2 further shows the importance of accounting for the break due to the introduction of IT in Canada; the red dashed lines represent the impulse responses from the estimation of the same VAR as in equation (3), but where we substitute our new measure of shocks for the shock series estimated without any break in the first-stage regression (“no-break” shocks). Two things stand out: first, the response of real GDP is smaller for

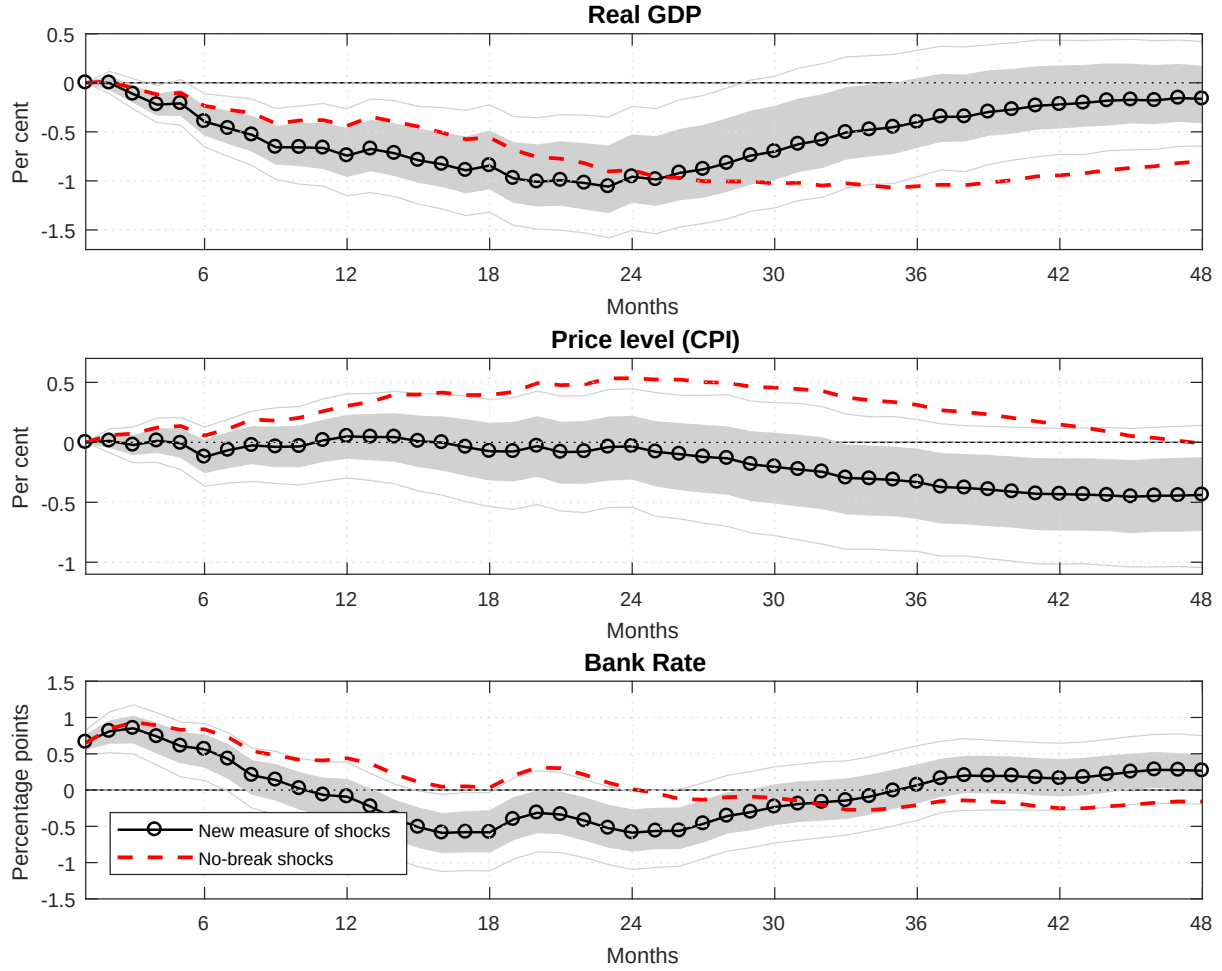
this assumption in Appendix D.5 and show that our results remain robust. Moreover, following [Stock and Watson \(2012\)](#) and [Mertens and Ravn \(2013\)](#), recent papers have used externally-identified shocks as instruments for the structural residuals in monetary VARs. [Gertler and Karadi \(2015\)](#), for example, use jumps in future prices around FOMC announcements to construct a series of monetary policy surprises that they employ as external instruments in different VARs. Unlike [Gertler and Karadi’s \(2015\)](#) monetary policy surprises, our new measure of shocks is constructed directly from the Bank Rate through a first-stage regression. Hence, as pointed out by [Cloyne and Hürtgen \(2016\)](#), our new series is a direct measure of the structural shock and consequently, we believe that our shocks are better used directly instead of as a proxy.

³⁹Appendix D.5 also shows that our results are robust to different lag structures and to removing the constant and the trend in the VAR.

⁴⁰For this third panel, we add the Bank Rate ordered last in the VAR.

⁴¹While the wider literature on the effects of monetary policy tends to employ VARs, R&R use single regressions. [Coibion \(2012\)](#) finds that an important part of R&R’s large effects of monetary policy is due to the contractionary impetus implied by the single regression approach and to the non-reserve borrowing period (1979–82); when R&R shock series is used in a VAR instead, the effects become smaller and more robust to individual shocks episodes. For sake of completeness, in Section 4.1 we present single regression results and show that they broadly are in line with our VAR results. In Appendix F, we perform a sensitivity exercise as in [Coibion \(2012\)](#) and find that our results are robust to any three-year period in our sample.

Figure 2: Macroeconomic effects of monetary policy shocks



Notes: Impulse responses to a 100-basis-point contractionary monetary policy shock along with the corresponding 68 and 95 per cent confidence bands. “New measure of shocks” refers to our new measure of monetary policy shocks (black line with circles) while “No-break shocks” refers to the shock series estimated over the full 1974–2015 sample (dashed red line) in the first-stage regression. The VAR includes log real GDP, log CPI, log BCPI and the measure of monetary policy shocks. For the Bank Rate response, the VAR includes the same set of variables, adding the Bank Rate (ordered last). $P=24$. Sample: 1974:M4 to 2015:M10.

the full-sample shocks during the first two years but keeps declining persistently afterward while the response to our new shocks measure is stronger but more temporary, as it retreats during the last 24 months. Consequently, there is a substantial difference (0.8 percentage points) between the real GDP responses after four years. Second, the response of the price level (CPI) is also quite different using the no-break shock series. While our new shock series implies a flat response of the CPI for 24 months before falling, the response following

the no-break shocks exhibits a price puzzle: it is positive throughout with a peak above 0.5 per cent after two years. This alternative response of CPI lies largely outside the 68 per cent confidence bands of our main estimates, and outside the 95 per cent upper band for more than two years.

Overall, these results show how accounting for the break in the monetary policy reaction function matters for our estimates of the effects of monetary policy. When one does not consider the IT break, the real GDP response experiences a slow but persistent decline following the monetary policy shock, and a price puzzle emerges.

3.2 Have the effects of monetary policy changed after IT?

As we document in Section 2, the conduct of monetary policy in Canada has undergone important changes with the introduction of IT in 1991. After years of relatively high and volatile inflation rates, the introduction of IT brought inflation down more rapidly than anticipated, and by the end of 1992 it had already converged to the 2 per cent target set for 1995. Not only the level of inflation has been lower since then, but its stability and predictability have also improved (e.g., see [Longworth \(2002\)](#)).⁴²

An important question is to what extent has the effects of monetary policy changed after the introduction of IT. A number of papers have recently documented changes in the effectiveness of monetary policy in the U.S. after the Volcker disinflation. Notably, [Boivin et al. \(2010\)](#) have shown that U.S. monetary policy shocks, as identified by recursive VARs, Factor-augmented VARs and a DSGE model, have had more muted effects on real GDP and inflation after the Volcker disinflation. They suggest that an improved conduct of monetary policy and better anchored inflation expectations are potential drivers of these changes. Moreover, [Barakchian and Crowe \(2013\)](#) documents (for the U.S.) that since 1988, many of the commonly-used VAR identification strategies, as well as the R&R shocks, produce impulse response functions that not only result in a price puzzle, but are also at odds with the traditional view that positive monetary policy shocks lead to a fall in economic

⁴²Additionally, [Mendes et al. \(2010\)](#) show that inflation persistence has decreased substantially after the introduction of the IT regime. Likewise, GDP growth has been noticeably more stable since the end of the 1991-92 recession and the introduction of IT.

activity.⁴³

To examine whether the effects of monetary policy have changed after the introduction of IT in Canada, we estimate our baseline VAR separately for both our sub-samples, before (1974-1991) and after (1992-2015) the introduction of IT.⁴⁴ Figure 3 shows the impulse responses of real GDP and the (CPI) price level to a 100-basis-points monetary policy shock for both sub-periods. In the pre-IT period, real GDP falls to a peak effect of -0.6 per cent between 12 to 18 months; the price level does not respond for the first 24 months, but then decreases monotonically, with a peak impact of about -0.8 per cent after 48 months. The confidence bands around the price level response are quite large, reflecting the higher volatility of the price level during this time. For the IT period, we find that the peak effect of monetary policy on real GDP is stronger at close to -1.0 per cent and is achieved between 18 and 24 months after the shock, slightly later than in the pre-IT period. Similarly, following the monetary policy contraction, the price level decreases with a peak impact of -0.4 per cent. The peak effect of the monetary policy shock on the price level is reached faster during the IT period, about 30 months after the shock.⁴⁵ Overall, we find that monetary policy shocks have a slightly stronger impact on GDP, but smaller impact on the price level after the introduction of the IT regime. Conditional on monetary policy shocks, our results are consistent with a small flattening of the Phillips curve.

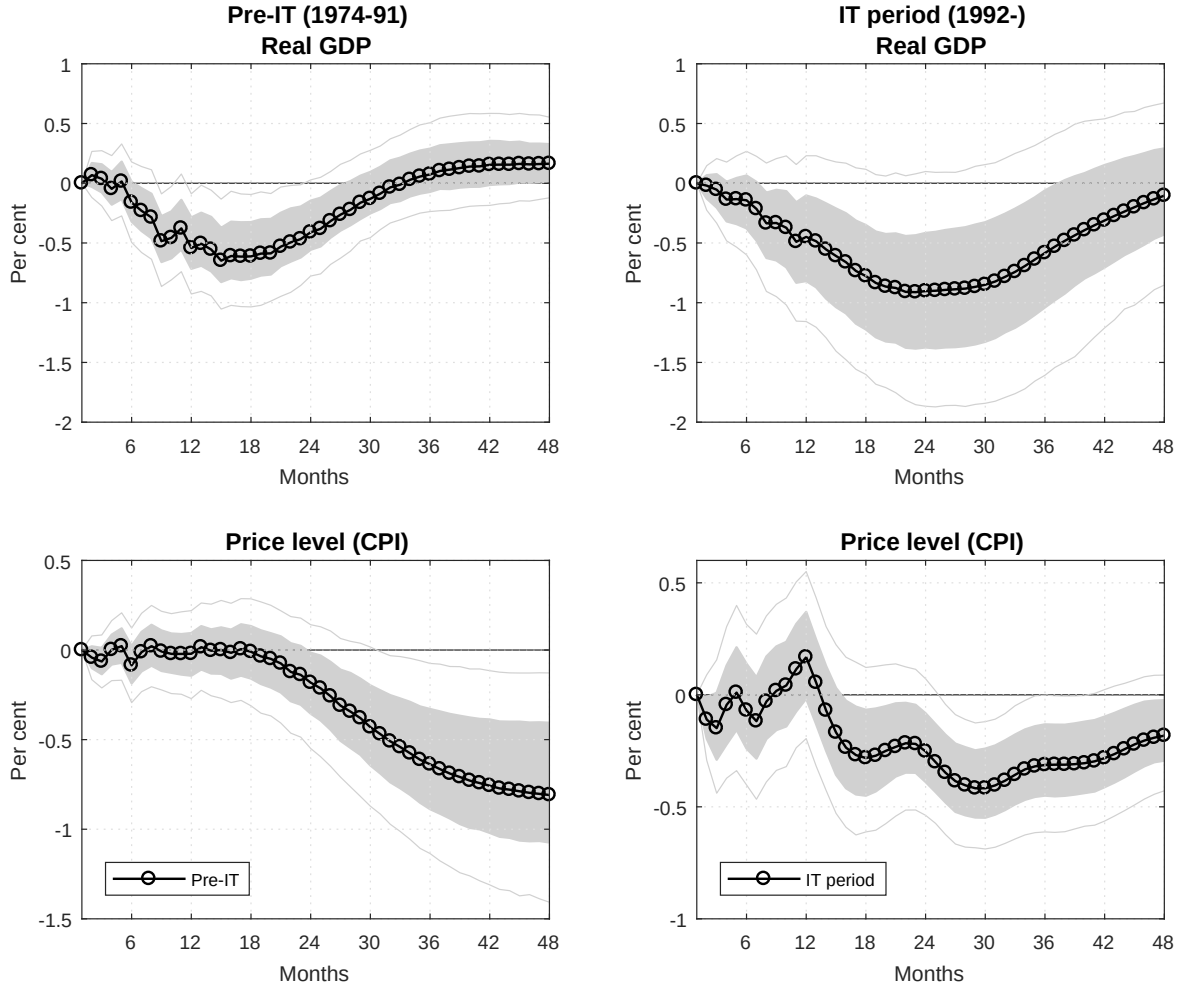
It is interesting to note that our results for the more recent period contrasts strongly with those for the R&R shocks for the post-1988 U.S. sample (Barakchian and Crowe (2013) and Ramey (2016)). Although we do find a slightly muted impact of our estimated monetary policy shocks on the price level since 1992, a positive increase to these shocks

⁴³Ramey (2016) revisits and updates traditional VAR approaches for identifying monetary policy shocks and corroborates Barakchian and Crowe (2013) findings that identified contractionary monetary policy shocks lead to positive inflation and real activity responses in the post-1988 U.S. sample. She concludes that the conduct of monetary policy has improved to the point that identifying exogenous monetary policy changes has become very challenging.

⁴⁴This is the same split used in the first stage to estimate the monetary policy shocks. Note that we estimate our baseline VAR with only 12 lags, given the smaller number of observations for the subsamples. Otherwise, the VAR specification is exactly the same as in Section 3.1.

⁴⁵In Appendix D.4, we show the results of a related exercise where we estimate the first-stage regression using the full sample, but then examine the effects of monetary policy separately for both subsamples, as done here. Results for the pre-IT period are very similar to those in Figure 3, but are drastically different for the IT period. This is because the first-stage regression estimated on the full sample is dominated by the highly volatile pre-IT period, resulting in monetary policy shocks for the IT period that clearly reflect endogenous responses to expected real GDP and inflation.

Figure 3: Macroeconomic effects of MP shocks before and after inflation targeting



Notes: Impulse responses to a 100-basis-point contractionary monetary policy shock along with the corresponding 68 and 95 per cent confidence bands. The left and right panels show the impulse responses for the pre-IT period (1974:M4–1991:M12) and the IT period (1992:M1–2015:M10), respectively. The VAR includes log real GDP, log CPI, log BCPI and the measure of monetary policy shocks. $P=12$.

are still clearly associated with a contraction in economic activity.

3.3 Comparison with other countries

In this section, we provide a direct comparison of our results with those from the narrative literature for the U.S. and the U.K. To do this, we use [Cloyne and Hürtgen \(2016\)](#)’s U.K. shocks (estimated up to 2007) and the U.S. R&R shocks updated to 2007.⁴⁶ This exercise

⁴⁶For a broader comparison with the literature on the effects of monetary policy, see Appendix C.2.

also assesses whether the effects of monetary policy remain similar when we remove the Great Recession and the subsequent recovery from the sample.⁴⁷ Since we just highlighted the importance of accounting for a break in the Bank of Canada’s reaction function when deriving our measure of monetary policy shocks, we thus re-estimate the U.S. and U.K. shocks to also account for changes in the conduct of monetary policy in these countries and assess whether the effects of monetary policy remain robust. To do this, we break the first-stage estimation into two parts, as we did for our Canadian shocks series.⁴⁸ Finally, we use the shock series in VARs for the U.S. and the U.K., separately, and estimate the effects of a 100-basis-point monetary policy shock.⁴⁹ Figure 4 presents the impulse response for the U.S. (left) and the U.K. (right).

The red (dashed) lines show the impulse responses for the shocks estimated without break. For the U.S., the responses are smaller than in the original R&R paper.⁵⁰ The peak decline for industrial production is about 1.4 per cent between 12 and 18 months, while the price level does not react for a year but then falls steadily to reach -2.0 per cent after four years. Now, when one accounts for a break due to a change in the monetary policy reaction function (black line with diamonds), the implications of a monetary policy shock differ markedly.⁵¹ For instance, industrial production has a similar response for the first 18 months, but then retreats faster following the shocks estimated with a break. We see that the red line (no-break shocks) lies outside the 68 per cent confidence bands for the last two years. The difference for the price level is also important: using the break-shock series, the decline is more pronounced, with the price level ending 2.8 per cent lower after four years. As mentioned above, in light of the findings in Barakchian and Crowe (2013), it should not be surprising that accounting for a break in the monetary policy reaction implies different

⁴⁷For this exercise, we estimate our shocks up to 2007 instead of 2015.

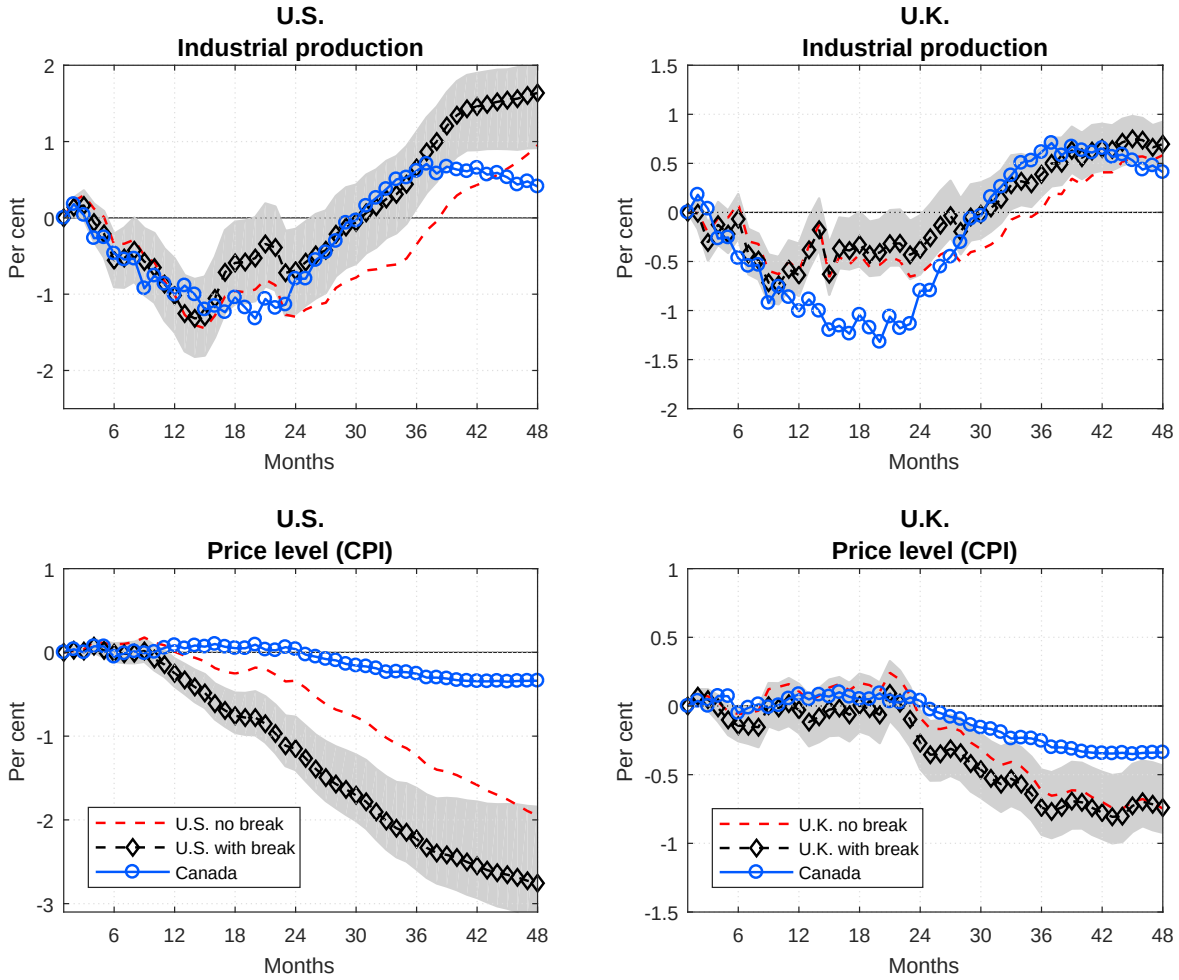
⁴⁸For the U.S., we break the estimation between 1983 and 1984, coinciding with the beginning of the “Great Moderation” period (e.g., McConnell and Perez-Quiros (2000)). For the U.K., we impose a break which coincides with the introduction of IT (i.e., between 1992 and 1993), the same break date also considered by Cloyne and Hürtgen (2016). Note that if we use other break dates such as 1979 (Volcker period) for the U.S. and 1997 (Bank of England independence) for the U.K., we get similar results.

⁴⁹As above, we use a standard VAR with output, the price level, a commodity price index and the measure of monetary policy shocks. Note that due to data availability at a monthly frequency in the U.S. and U.K., we also use industrial production as the measure of output for Canada to facilitate comparison.

⁵⁰The differences with the VAR results in the original R&R paper comes from a different sample period (1969-96) and a different VAR specification (R&R’s VAR includes: IP, PPI, and the cumulated shocks). Both account for the smaller effects we find here.

⁵¹The shaded area represents the 68 per cent confidence bands.

Figure 4: Macroeconomic effects of monetary policy: Evidence from the U.S. and U.K.



Notes: Impulse responses to a 100-basis-point contractionary monetary policy shock from a VAR including log industrial production, log CPI, log commodity price index and the measure of monetary policy shocks, along with the corresponding 68 and 95 per cent confidence bands. $P=24$. Monthly data. Sample for the U.S. is 1969:M1-2007:M12. For the U.K.: 1975:M1-2007:M12. For Canada is: 1974:M4-2007:M12.

effects from the R&R shocks.

The right-hand side of Figure 4 shows that a similar pattern does not emerge for the U.K. using the [Cloyne and Hürtgen \(2016\)](#) shocks. Both the no-break and with-break shocks series imply very similar responses of industrial production and the CPI level. Following a contractionary shock, industrial production peaks at about -0.7 after 12 months for both shocks series; similar as in the U.S. case, the effects of the shocks estimated with a break fade away faster, although the difference is not very significant. The CPI price level responses to the two shocks are virtually similar: they are roughly flat for the first two years, and

then decline to end 0.8 lower after four years. These results suggest that although the Bank of England officially began targeting inflation in 1993, it did not dramatically change its reaction function very much in a way that affects the estimation of monetary policy shocks in the narrative tradition.⁵²

Figure 4 also shows our baseline effects of monetary policy for Canada for a shorter sample (ending in 2007). The blue lines (with circles) shows our baseline results, but using industrial production instead of real GDP. Two things stand out: first, industrial production’s peak response for Canada is similar as in the U.S. and larger than in the U.K.; it peaks at about -1.4 per cent between one and two years following the shock. Second, the CPI response is substantially weaker in Canada than in both countries; at a peak effect of -0.4 per cent after four years, it is about one-sixth of that in the U.S. and half that of the U.K. (using the shocks estimated with a break for both countries). These results suggest that the slope of the Phillips curve is steeper in the U.S. (and the U.K.) than in Canada.⁵³ This is in line with the New Keynesian small open economy model of [Gali and Monacelli \(2005\)](#), who show that the slope of the Phillips curve is decreasing on the degree of openness of the economy. Canada is the typical textbook open economy country, with a large degree of openness; it is thus unsurprising that inflation in Canada is more reactive to international developments than in larger, less open economies.

4 Additional Results and Robustness Exercises

In the sub-sections below, we provide additional results and assess the robustness of our main results to different specifications. First, we estimate the effects of monetary policy shocks with [Jordà \(2005\)](#)’s local projections method instead of a VAR specification; second, we use the local projections model to estimate the effects of monetary policy on other macroeconomic and trade variables; third, we assess whether the standard VAR with the policy rate instead of our shocks series yields the well-known price puzzle ([Sims \(1992\)](#)),

⁵²[Cloyne and Hürtgen \(2016\)](#) estimate the effects of monetary policy only for the U.K. inflation-targeting period (1993–2007) and show that they are broadly in line with their baseline results for 1975–2007. Industrial production reacts slightly more and inflation less during the inflation-targeting period, in line with our results for Canada in Section 3.2.

⁵³For example, a regression of the inflation on the output gap and its own four lags yields coefficients on the gap of 0.14 for Canada and 0.28 for the U.S.

Eichenbaum (1992)); fourth, we use different measures of the price level in the VAR and test the robustness of our results; fifth, we test the robustness of our results to alternative first-stage specifications.

4.1 Single equation results and the effects on other macro variables

In order to make our results as comparable as possible to previous literature, we have opted to use our shocks series within a standard VAR model. Nonetheless, single regression approaches such as Jordà (2005)’s local projections have increasingly been used to investigate the effects of economic shocks in general, and monetary policy shocks in particular.⁵⁴ The flexibility of the local projections setup allows for the assessment of the effects of monetary policy shocks on other macroeconomic variables that are more difficult to cast within a VAR. For instance, given that Canada is a small open economy, quantifying the effects on trade variables and the exchange rate is of particular interest as monetary policy shocks also affect GDP and inflation through the exchange rate channel. Consequently, in this section we first examine the responses of GDP and the price level within this single equation model and see if they are in line with those from the baseline VAR. Then, we assess the effects on the unemployment rate and trade variables. Specifically, the local projection model we estimate is the following:

$$x_{t+h} - x_t = c + \Phi_h(L)z_{t-1} + \beta_h\epsilon_t + \mu_t, \quad (4)$$

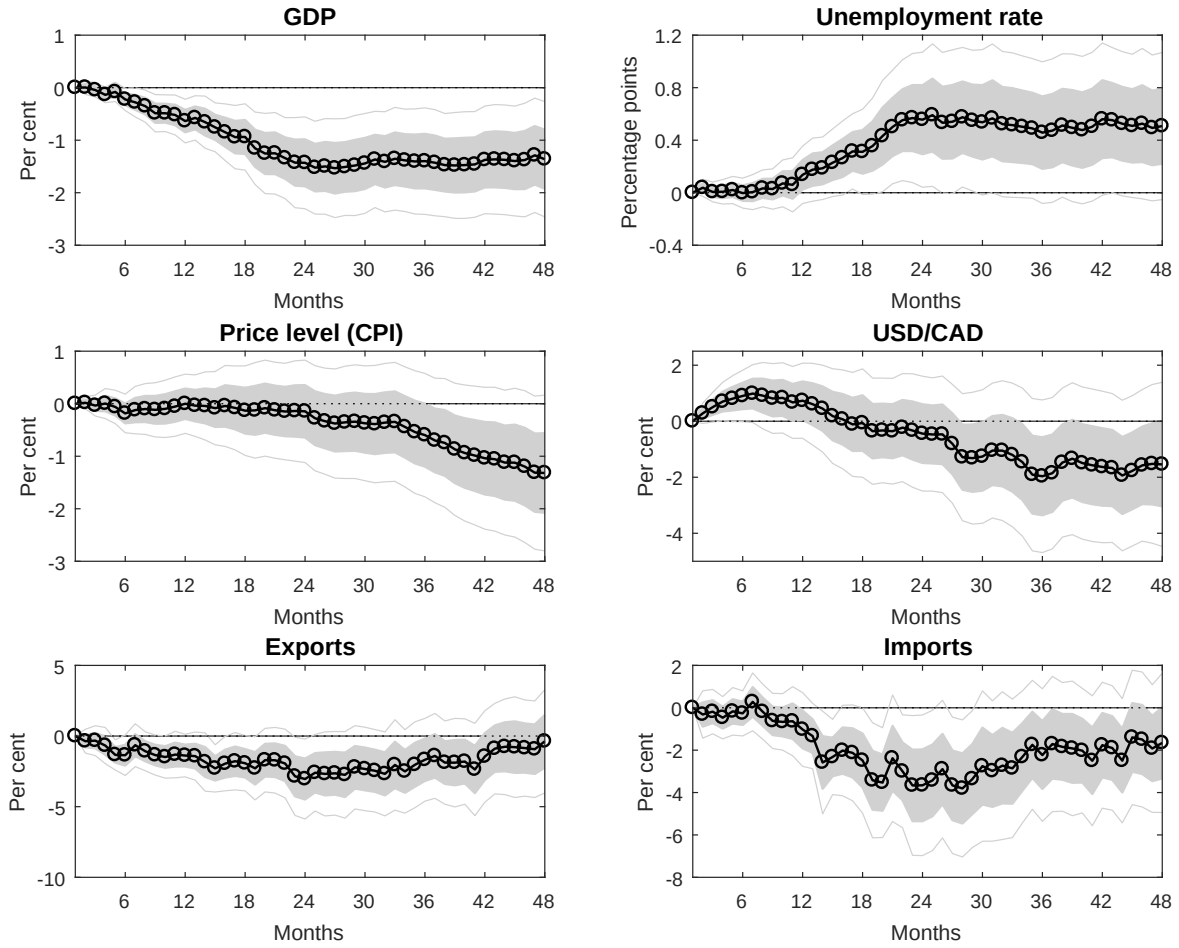
for $h = 0, 1, 2, \dots, 36$. The variable of interest is x , $\Phi_h(L)$ is a polynomial lag operator, z_{t-1} is a vector of controls, and ϵ_t is our measure of monetary policy shocks.

Figure 5 shows the impulse responses to a 100-basis-point contractionary monetary policy shock. The results for real GDP and the CPI are very similar to the ones obtained from the baseline VAR. A distinctive quantitative feature is that the responses of monthly GDP and the CPI are somewhat stronger than the ones from the VAR model. Following the monetary policy shock, the price level stays flat for two years, but then falls by over

⁵⁴For recent examples, see Owyang et al. (2013), Auerbach and Gorodnichenko (2013), Fieldhouse et al. (2017), Ramey and Zubairy (2017), among many others.

1.0 per cent after 48 months, whereas real GDP falls by 1.3 per cent and the decline is more persistent.⁵⁵ For the first two-to-three years, the impulse responses from the local projections are very similar to those from the VAR, but exhibit much more persistence afterward. These results are consistent with the more persistent response of the policy rate in the local projections model relative to the VAR. Note that the divergence in monetary policy effects from the shocks estimated with and without a break discussed in Section 3 above is also very apparent when using local projections (see Appendix D.8 for details).

Figure 5: Single equation approach



Notes: Impulse responses to a 100-basis-point contractionary monetary policy innovation using local projections model with corresponding 68 and 95 per cent confidence intervals. The local projections model includes (monthly) log real GDP, log CPI, log BCPI, log nominal USD/CAD exchange rate, log exports, log imports and our new measure of shocks. Sample: 1974:M4 to 2015:M10.

⁵⁵These larger responses with single regressions are also found by [Coibion \(2012\)](#) for the U.S. and by [Cloyne and Hürtgen \(2016\)](#) for the U.K.

The response of the unemployment rate is flat for 12 months and then rises by about 0.5 percentage points throughout the next three years, as shown in the upper right panel of Figure 5.⁵⁶ Trade variables also respond strongly to monetary policy shocks: the nominal USD/CAD exchange rate does not react on impact, then rises for about 15 months and then slowly declines, ending almost 2 per cent lower after four years. This response of the USD/CAD exhibits a slow initial overshoot but then declines in accordance with the uncovered interest parity condition. This depreciation of the Canadian dollar leads to a peak imports decline of 4.0 per cent while the decline in economic activity drags exports down by 3.7 per cent after 24 months despite the currency depreciation. Overall, the trade balance closely follows the path of the USD/CAD exchange rate: it worsens in the first 15 months as the Canadian dollar appreciates following the policy rate increase, and then improves afterward as the currency depreciates.

4.2 The price puzzle

Sims (1992) first documented the observation that a monetary policy tightening is followed by an increase in the price level when measured in conventional VARs employing observed interest rates and the recursive identification strategy. Dubbed the “price puzzle,” this observation has raised doubts about the validity of the recursive identification assumption and paved the way to a large literature that proposed various methods to resolve this puzzle, such as expanding the VAR with oil or commodity prices or using factor-augmented VARs.

For Canada, we also find a large price puzzle when we replace our exogenous shock series with the Bank Rate as the policy instrument in the VAR specification and use the standard recursive identification strategy. Panel C of Figure 6 shows price level response to a one percentage point increase in the Bank Rate in our VAR (blue, dashed line) along with the analogous price response to our new measure of shocks (circled line). The response is large and positive throughout the four years shown, and lies largely outside the 95 confidence bands of our main estimates.⁵⁷ Interestingly, the real GDP response exhibits a stronger

⁵⁶As shown in Appendix D.1., the peak response is similar to the one from a large VAR including the unemployment rate.

⁵⁷In Appendix C.1, we plot the impulse price response along with the corresponding 68 and 95 confidence bands and show that the price puzzle is significant at 95 per cent for almost three years. Note that if we add other variables in this VAR (such as the unemployment rate), we also find a price puzzle.

(-1.4 per cent) and much more persistent response than with our new narrative shocks, somewhat similar as the response to the no-break shocks in Figure 2.

R&R and Cloyne and Hürtgen (2016) document that the narrative identification strategy solves the price puzzle obtained using conventional recursive VAR methodology for the U.S. and U.K., respectively. However, we showed above that our identification strategy must also critically account for a break due to the introduction of IT in Canada, to ensure that monetary policy shocks are correctly identified. For sake of completeness, we further show in Panel C of Figure 6 the responses of real GDP and the price level to a shock estimated exactly as in R&R (red line with dots).⁵⁸ Following this shock, the price level exhibits a price puzzle for about three years before ending about 0.2 per cent below its initial level. As a result, the plain R&R identification strategy is not enough to correctly identify monetary policy shocks for Canada.

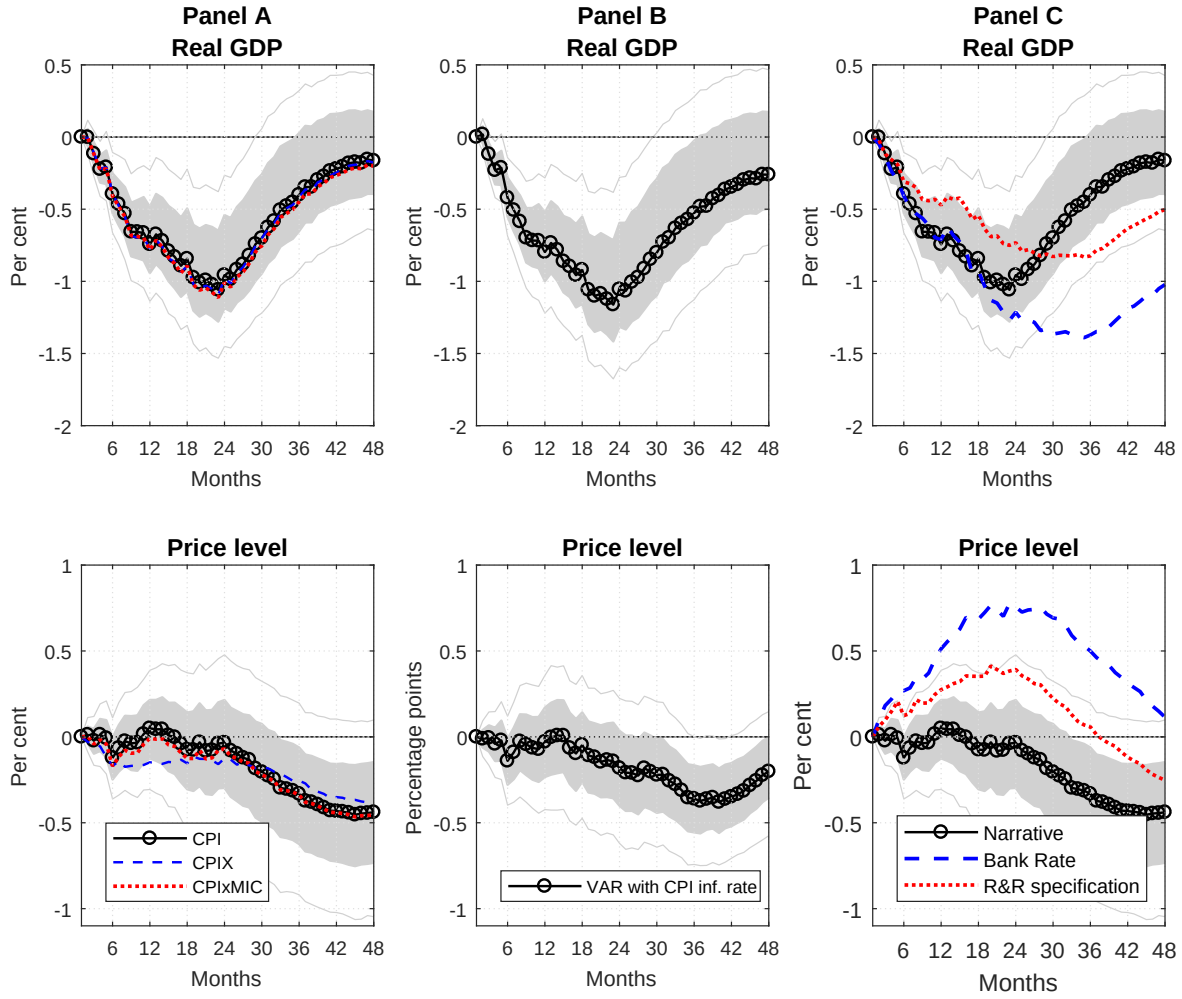
4.3 Different price measures

Our baseline VAR results in Section 3 pertain to using total CPI as the price measure. In Canada, two other important indicators of inflation in Canada are computed from (i) the core CPI (CPIX), which excludes the eight most volatile components of CPI, and (ii) CPI excluding mortgage interest costs (CPIxMIC). Panel A of Figure 6 presents robustness exercises to using these alternative measures of the price level in the VAR: the CPIX (dashed blue line) and the CPIxMIC (dotted red line). As is clear from the impulse responses of real GDP and the price level, our baseline results are robust to using different measures of prices.

In Panel B of Figure 6, we further test the robustness of our results to estimating a VAR with the 12-month CPI inflation rate instead of the CPI price level. The upper chart shows that the real GDP response is similar to our baseline results, whereas the 12-month inflation rate stays flat for 18 months and declines by 0.4 percentage points afterward. This peak impact is broadly consistent with the decline in the price level found in Figure 2, although inflation declines sooner than the price level. This might be due to the same lag structure (24 months) as for the baseline VAR with the price level. If we incorporate

⁵⁸For this R&R specification, we estimate the shocks without a break and without accounting for the U.S. FFR and the nominal U.S. / CAD exchange rate.

Figure 6: Robustness to different price measures and the price puzzle



Notes: Impulse responses to a 100-basis-point contractionary monetary policy shock from our baseline VAR (solid black line with circles) with corresponding 68 and 95 per cent confidence bands. Panel A: alternative price measures; log CPIX (dashed blue line) and log CPIxMIC (dotted red line). The VARs include log real GDP, a price measure, log BCPI, and the new measure of shocks. Panel B: VAR with log real GDP, the 12-month CPI inflation rate (instead of the price level), log BCPI, the new measure of shocks. Panel C: VAR with Bank Rate instead of the new measure of shocks (blue, dashed line) and VAR with shocks estimated using R&R's specification (red, dotted line). $P=24$. Sample: 1974:M4 to 2015:M10 for all VARs.

more lags (e.g., 36 months) in our baseline VAR, we also get a faster decline of the price level (see Panel B of Appendix Figure D.5).

4.4 Alternative first-stage specifications

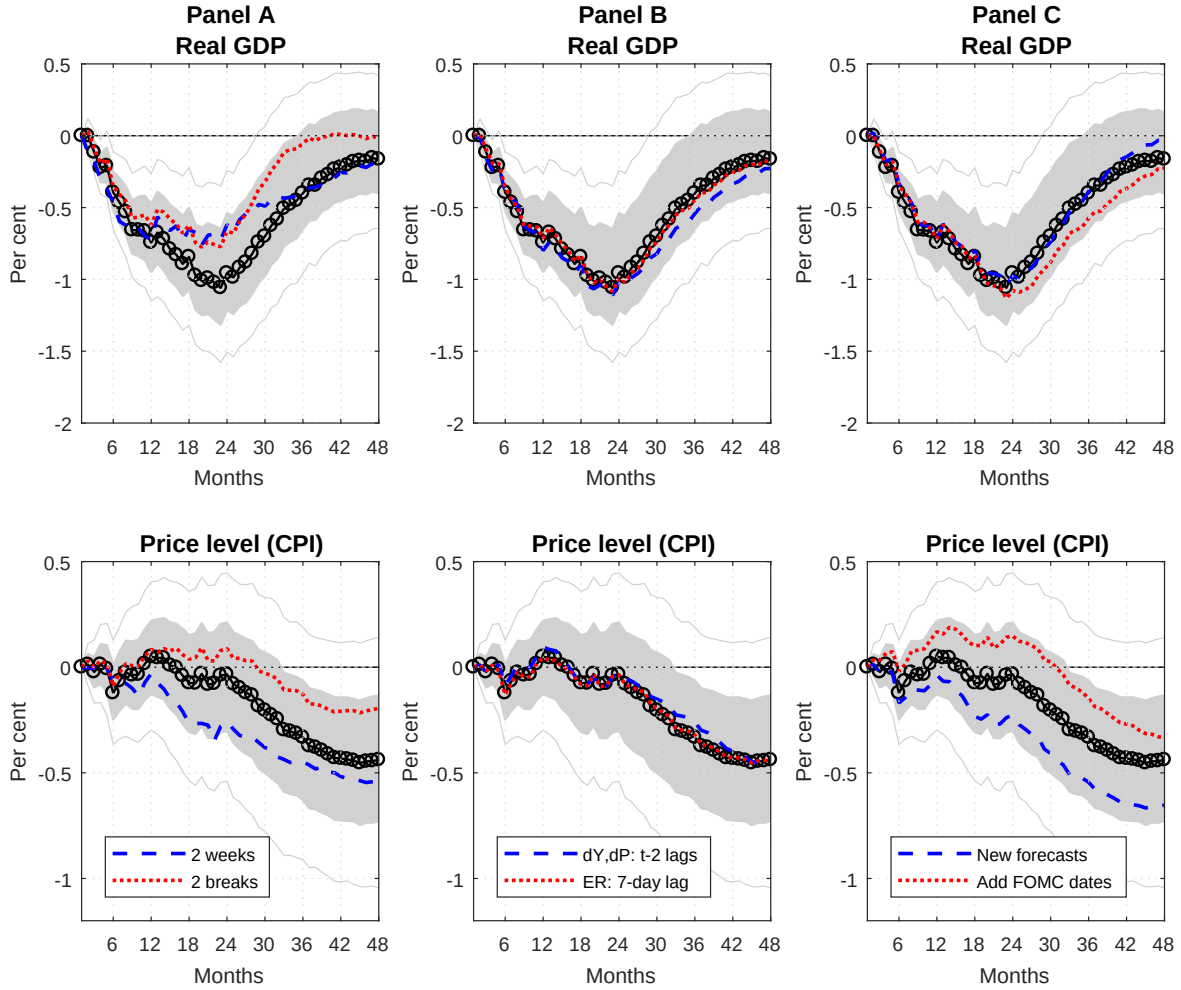
In this section, we examine the robustness of our baseline results to different first-stage specifications. First, as mentioned in Section 2, we consider meetings that are at least four weeks apart during the 1980s up to May 1994, where Bank Rate changes occurred frequently. In Panel A of Figure 7, we test the robustness of our results by considering all meetings that are at least two weeks apart for that period (dashed blue line), as done in Cloyne and Hürtgen (2016).⁵⁹ The responses of real monthly GDP and CPI inflation are both qualitatively similar to our main results, although the CPI response declines faster and ends just below -0.5 per cent after four years. The peak decline of real GDP is smaller relative to our baseline estimates (-0.75 per cent), but ends at the same level after four years.

Second, we consider a specification where we add another break (in 2008) when estimating our shocks in the first-stage regression. Canada went through the financial crisis relatively smoothly compare with many other countries, and the Bank of Canada did not use quantitative easing nor did the policy rate hit the zero-lower bound during the crisis. Nonetheless, one could argue that the conduct of monetary policy changed since 2008. Although we showed earlier that our results are robust to stopping our estimation in 2007, here we assess whether our results are robust to adding adding a break in 2008 when estimating the shocks. Consequently, we estimate our first-stage regression in three parts: 1974-1991, 1992-2007, and 2008-2015. The impulse responses are shown by the red (dotted) lines in Panel A of Figure 7. They exhibit a similar pattern as our main estimates, well within both confidence bands, although both GDP and the CPI peak responses are weaker than our main estimates.

Third, in Panel B we modify the set of first-stage regressors in two ways: (i) we add second lags of real-time GDP growth and inflation (dashed blue line), and (ii) we use a one-week lag (instead of two-week) for the USD/CAD nominal exchange rate in the first-stage regression (dotted red line). Some observers could argue that adding a second lag of real-time data captures better the behavior of policy-makers; moreover, choosing the level and change two-weeks of the exchange rate before a monetary policy decision, for

⁵⁹This increases the number of meetings (i.e., observations in our first-stage regression) from 337 to 549.

Figure 7: Robustness to different first-stage specifications



Notes: Impulse responses to a 100-basis-point contractionary monetary policy shock using our new measure of shocks (solid black line with circles) with corresponding 68 and 95 per cent confidence bands compared with shock series of different first-stage specifications. VARs include (monthly) log real GDP, log CPI, log commodity prices, and one of the different shock series. The alternative shocks series are estimated from different specifications of equation (1): Panel A—meetings at least two weeks apart between 1980 and 1994 (dashed blue line), and adding a second break (2007–08) in the estimation of the shocks (red, dotted line); Panel B—adding second lags of real-time inflation and GDP growth (dashed blue line) and including 7-day lag of the USD/CAD exchange rate (dotted red line) instead of 14-day lag; Panel C—all new forecast dates included as meetings, even if the intended policy rate did not change (dashed blue line); add meeting dates defined as 2 days after FOMC, if no meeting in that week. $P=24$. Sample: 1974:M4 to 2015:M10.

example, is an arbitrary choice. For both cases, impulse responses are virtually identical to our baseline results.

Finally, in Panel C we test the robustness of our results to including additional ob-

servations (i.e., meetings) to our first-stage regression. Recall that before the beginning of the FADs in December 2000, monetary policy decisions were not announced and thus we cannot identify meetings that happened without changes in the policy rate. We test two different alternative approaches here: (i) we treat as meetings the instances when the intended policy rate was unchanged but a new set of staff forecasts was released;⁶⁰ and (ii) we define as meetings when an FOMC announcement occurred in the U.S. and there was no change in our intended policy rate during that week.⁶¹ In both cases, the responses of real monthly GDP are virtually unchanged while the CPI exhibits a stronger response when we add new forecast dates and a weaker response when we add the FOMC dates. These results for the CPI level suggest that adding meetings with new forecasts (dashed blue line) add relevant real-time information from staff projections while under the second case (dotted red line), it is possible we do not have enough real-time data or forecast information to carefully control for the state of the economy prior to these added policy decisions (as no new forecasts are released). All in all, although these responses differ slightly from our baseline estimates, they are within the 68 per cent confidence bands.

5 Conclusion

Quantifying the effects of monetary policy is one of the most enduring questions in macroeconomics. The estimates vary markedly across the literature: on the one hand, many papers identifying the exogenous component of monetary policy using different VAR models obtain modest responses of output and inflation to monetary policy shocks. On the other hand, papers relying on R&R’s narrative identification strategy find larger effects of monetary policy. The identification of monetary shocks is complicated by the fact that important shifts in the conduct of monetary policy have occurred in the U.S. and other countries.

This paper tackles these issues for Canada by applying the narrative identification strategy of R&R. We construct a new, rich dataset of real-time data and forecasts from the Bank of Canada’s staff projections going back to the early 1970s, and coupled with a series

⁶⁰This adds 18 meetings to our first-stage regressions.

⁶¹Some commentators have argued that the Bank of Canada often acted right after the FOMC; we thus define a meeting as the date two days after an FOMC meeting occurred (when we did not already have a meeting defined in that week). This adds 108 observations to our set of meetings.

of intended changes in the target policy rate, we derive a new measure of monetary policy shocks for Canada. Canada is an interesting case study as it is a textbook small open economy, closely linked with the U.S. It also experienced a clear change in the conduct of monetary policy, as the Bank of Canada has been operating within an IT framework since 1992.

We show that our new measure of monetary policy shocks crucially departs from R&R on two aspects: first, the monetary policy reaction function includes U.S. interest rates and the USD/CAD exchange rate; second, it accounts for the change in the Canadian monetary regime following the adoption of IT. Before the introduction of IT, changes in the target policy rate are explained mostly by changes in the USD/CAD exchange rate and U.S. interest rates, while they have been significantly more centered around the staff forecasts of output and inflation since. We find that a 100-basis-point monetary policy shock from our new measure generates a peak decline in real GDP and the (CPI) price level of 1.0 and 0.5 per cent, respectively. Furthermore, we show that not accounting for the change in monetary regime leads to monetary policy shocks that generate a price puzzle and show clear signs of endogeneity. Given the break in the conduct of monetary policy in Canada, we investigate whether the effects of monetary policy have changed after the introduction of IT. We find that although real GDP reacts modestly more and the price level slightly less during the IT period, the responses are qualitatively similar. These results sharply contrast with those of [Barakchian and Crowe \(2013\)](#) who find that since 1988, a contractionary monetary policy shock raises output and inflation in the U.S.

We compare our estimates for the effects of monetary policy in Canada with those of the U.S. and the U.K. from the narrative literature. We find that monetary policy shocks in Canada generate output effects that are in line with those of the U.S. and stronger than in the U.K.; however, the price level response is weaker in Canada than in those countries. One implication of this result is a flatter Phillips curve in Canada relative to the U.S. and the U.K., consistent with New Keynesian small open economy models, which find that the slope of the Phillips curve is decreasing with the degree of openness of the economy.

Our results offer new evidence on the effects of monetary policy in small open economies and highlights the importance of acknowledging the institutional changes in the conduct

of monetary policy when identifying monetary shocks. In doing so, we provide a new data set and a new measure of monetary policy shocks for Canada and hope that these data will provide interesting avenues for future research.

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