

Monetary Policy Transmission in Canada - A High Frequency Identification Approach. Additional Appendix

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This is an additional, online appendix for Monetary Policy Transmission in Canada - A High Frequency Identification Approach. There are three sections in this document. In section 1 are additional details and tests for the monetary surprise measure. Next, in section 2 I describe the over-identification test that I use to test for information effects and the results of the test. In section 3 I include the full specification, other impulse response function figures. In section 4 I include a brief discussion of the narrative series for Canada relative to my high-frequency shock series. Finally, in section 5 I include the local projection with an instrumental variable method results.

1 Appendix: Monetary Surprises Measure Additional Details

In this section, I review some of the additional properties of the BAX contracts that were aggregated to the monthly frequency using the Gertler & Karadi (2015) method. In the paper, the external instrument is the BAX2 contract. Figure 4 of the main paper shows that all contracts are roughly similar in movement for the entire period, with only minor differences throughout.

First, in figure 4 of the main paper, the movement and size of shocks are roughly equal between all contract lengths. Volatility and movement in the measure reflect periods of frequent target interest rate movement and economic uncertainty, such as the recession leading from 2007. Significant movement also occurs following long periods of no-change announcements to the policy target rate. For example, in 2015 when the first change in the target rate is made following several years of no-change announcements.

In table (1), I report summary statistics of the four front contract surprise measures. The low and close to zero mean across all four contracts strongly indicates that the series are all distributed similarly for positive and negative shocks. The low correlation between Canada, the UK (Cesa-Bianchi et al. (2020)), and the US (Gertler & Karadi (2015)) series also suggests that the Canadian series is independent. This independence is important as the shock series is measuring the Canadian policy shocks and not international shocks from the US and UK. All series have a low standard deviation as well.

The low skewness and reasonable kurtosis values suggests a distribution close to normal, without heavy tails or shocks away from the most common no-change announcement. This is also present in figure (1). Finally, I examine the kurtosis for autocorrelation effects of the individual series. The autocorrelation examines the exogenous and predictability of the series as an autoregressive series.

In figure (2), I plot the first 20 lags of the autocorrelation. No strong pattern emerges for cyclical, and no single lag coefficient is significant other than the first lag. With a slightly larger first lag outside of the confidence region, the Durbin-Watson (value of 1.944) and Breusch-Godfrey (chi2 of 2.326, P value of 0.1272) tests suggest that the serial correlation at the first lag should not be a significant issue. Although the coefficient is reasonably large, the actual effect should not be of concern.

Table 1: Summary Statistics

	BAX1	BAX2	BAX3	BAX4
Observations	192	192	192	192
Mean	0.00788	0.00066	-0.00011	-0.0011
Minimum	-0.1897	-0.1931	-0.1931	-0.1966
Maximum	0.161	0.217	0.259	0.266
Standard Deviation	0.0326	0.04025	0.0429	0.0445
Skew	-0.0756	0.5385	0.901	0.696
Kurtosis	12.13	9.67	11.26	11.19
Autocorrelation (abs)	0.195	0.201	0.216	0.241
Correlation with US Series	0.0032	-0.0119	0.0136	0.0688
Correlation with Uk Series	-0.0662	-0.0508	-0.0091	0.0072

In figure (3), the narrative and high-frequency series are both plotted. The correlation between the two series reflects this, with a correlation between the narrative series and the adjusted and unadjusted series being 0.112 and 0.144, respectively. This is not unexpected, as the two series plot similar series, although they are formed through different methods and ultimately will vary in the measured effect. This difference of effect is noticeable in the correlation and in the scale of shocks in figure (3).

Table 2: Summary Statistic of CDOR-OIS Spread in Basis Points

Sample	CDOR - OIS		
	Mean	SD	Observations
Jan 2002 to Jun-2007	7.52	3.14	1086
July-2007 to Jun-2009	39.97	19.79	500
Jul-2009 to Dec-2019	30.89	7.35	2618
Full Sample	25.93	14.46	4204

Sample Period from Jan 2002 to Dec 2019. Data from Bloomberg Terminal.

Table 3: Summary Statistics of Monetary Policy Surprises, Categorized by Release of Monetary Policy Report

	BAX1		BAX2		BAX3		BAX4	
	Report	No Release	Report	No Release	Report	No Release	Report	No Release
Mean	-0.0056	0.00758	-0.00672	0.00836	-0.00969	0.00977	-0.0137	0.0106
Std. Deviation	0.0554	0.0456	0.0649	0.059	0.0684	0.0652	0.0720	0.0664
Skewness	-1.397	2.18	-0.618	2.247	-0.5788	2.765	-0.8503	2.74
Kurtosis	11.062	11.17	7.53	12.09	6.069	15.834	5.81	16.249

Monthly level statistics of the monetary policy surprises around the policy announcement.

Categories refer to if there is a monetary policy report released near that date as well.

In table (2) I report the spread of the 3 month Canadian dollar offer rate (CDOR) and the 3 month Overnight index swaps (OIS). This table shows the stability between the spread when excluding the Great Recession period of 2007 to 2009. Even during the 2007 to 2009 period the larger volatility results in a standard deviation of about one half the mean.

In table (3) the summary statistics if a monetary policy report is released during the month and if a report is not released are given. Here, the values stay similar between the two, suggesting that although more information about the economy being released there is only a small effect on the surprise measure for Canada. For the mean values, the sign changes between report and no report release months, but the standard deviation, and variance, stay similar, suggesting that the difference because of the monetary policy report itself is small.

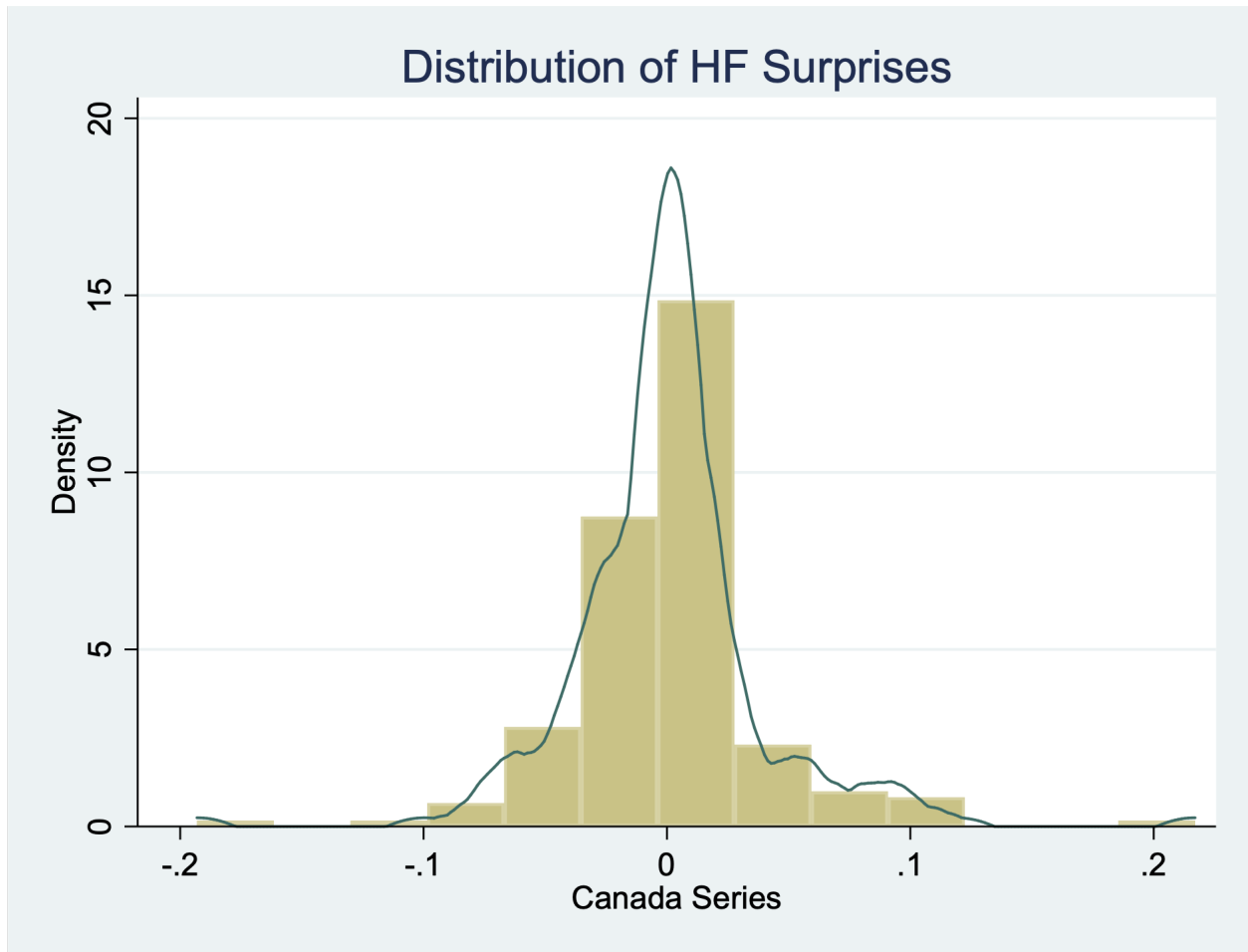


Figure 1: Distribution of the high frequency monetary policy surprises measure BAX2. Kernel density is represented by the line.

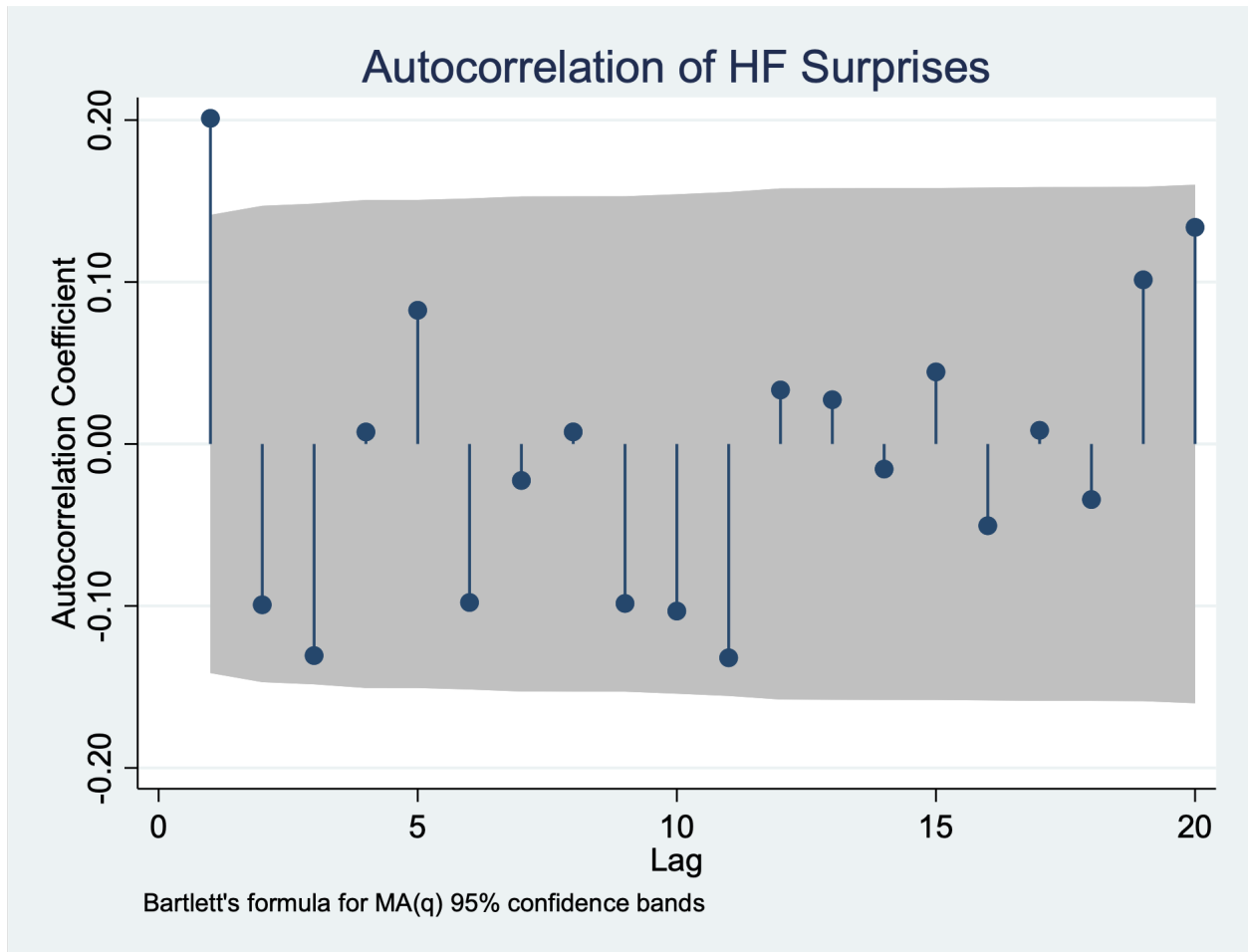


Figure 2: Autocorrelation coefficient of the first 20 lags of BAX2. Only first lag lies slightly outside of the 95% band at 0.2.

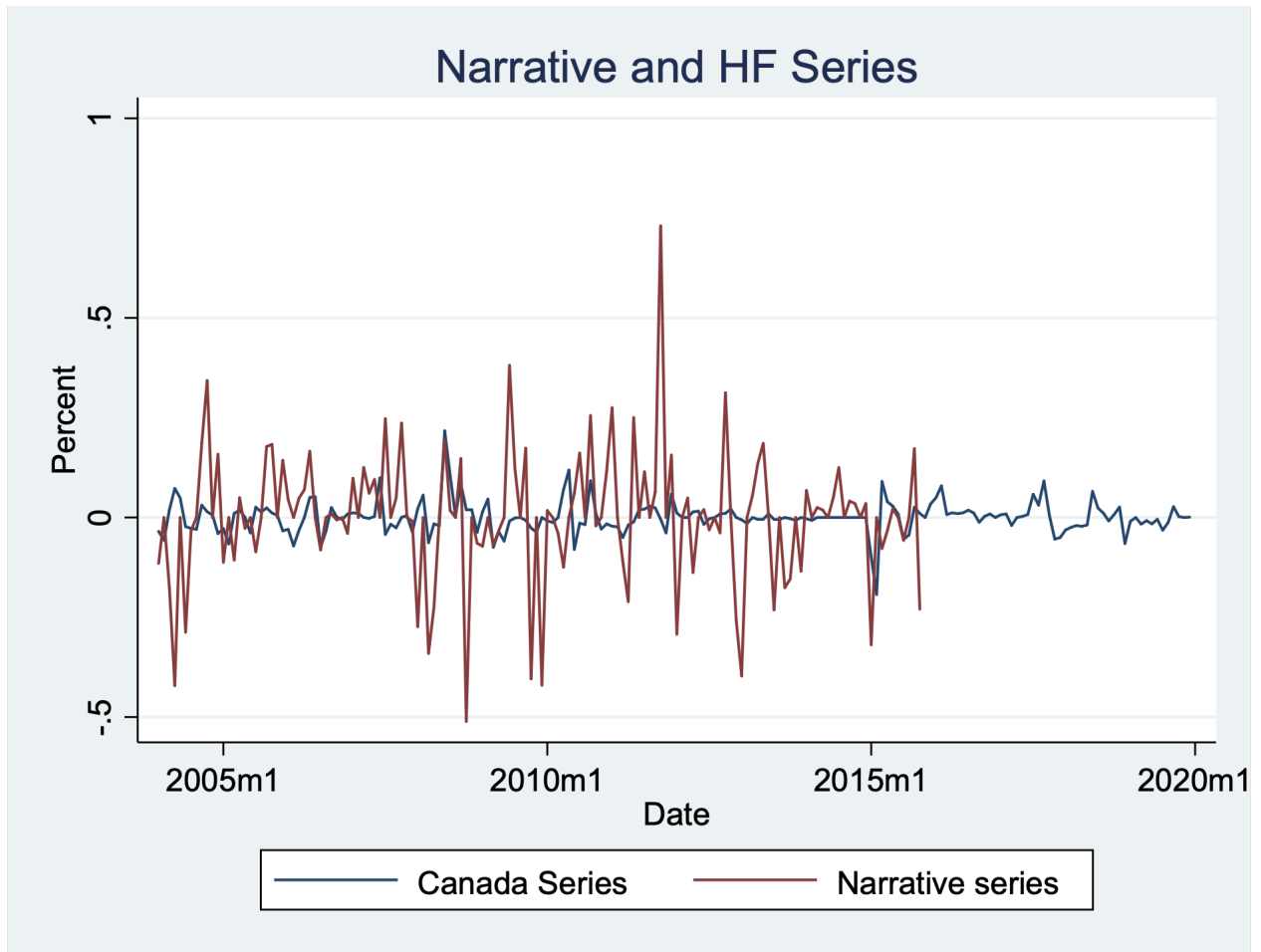


Figure 3: High frequency surprises measure (BAX2) and the Narrative measure series.

2 Testing for Information Effects - An Over-Identification Test

Employing a tight window around the policy announcement ensures that the captured price difference is a response to communicated monetary news alone. However, a potential problem can arise when the communicated policy decision reflects an assessment of future conditions and actions from the BoC. This 'signalling' channel occurs because of the need to communicate future policy planning.¹ If the policy decision contains more than just monetary news, it no longer represents a purely monetary policy shock. Instead, it is a combination of a monetary shock and a signalling shock. This would violate the exogeneity assumption made for IV regressions.

The potential bias from external information into the surprise measure is not unique to the Canadian measure. There are multiple solutions to test or disentangle the information effect previous literature for the US and the UK. Two strong options are the over-identification test from Cesa-Bianchi et al. (2020) and the co-movement with a stock index method of Jarociński & Karadi (2020). The over-identification test uses the narrative measure of monetary policy shocks as a second form of monetary policy shocks.² The co-movement method requires a stock price index, which is not feasible with most policy announcements before North American stock markets open.

2.1 An Over-Identification Test

The over-identification test from Cesa-Bianchi et al. (2020) uses the narrative series to form a set of over-identification restrictions. They use the narrative approach as it explicitly controls for the Central Bank's information set.³ I use the Champagne & Sekkel (2018) Canadian narrative series, which spans from 1980 to 2015. Using the HFI and narrative series, the monetary policy shock is now over-identified, with both measures exogenously identifying a monetary policy shock. With the monetary shock over-identified, we can use the Cesa-Bianchi et al. (2020) over-identification procedure to test if both identify a monetary shock.

¹The BoC, like other Central Banks, holds private information on the economy. This information can influence policy decisions made that day and future decisions.

²Although previously I show that the narrative measure may not show effects in line with standard theory, it does provide an external measure of monetary policy shocks with an established methodology that also controls for the information held and potential signalling effect.

³Romer & Romer (2004) create the first narrative series with US data, with survey and forecast information from the Fed.

To begin the procedure, keep the reduced form residuals from the HFI instrumented VAR in equation (4) of the main paper, with the residuals split into policy and non-policy shocks such that:

$$u_t^p = S_{11}\varepsilon_t^p + S_{12}\varepsilon_t^q, \quad (1)$$

$$u_t^q = S_{21}\varepsilon_t^p + S_{22}\varepsilon_t^q, \quad (2)$$

which combine into a single form such that:

$$u_t^q = S_{21}S_{11}^{-1}u_t^p + (S_{22} - S_{21}S_{11}^{-1}S_{12})\varepsilon_t^q. \quad (3)$$

The second portion is a linear combination of the non-monetary structural shocks, called V_t . Now, we have a vector containing both the HFI and narrative series as a vector of instruments $Z_t = (Z_t^{HF'}, Z_t^{N'})'$. Considering this in the context of the two-stage least squares procedure from the methodology section of the main paper, we have over-identified $S_{21}S_{11}^{-1}$. If we assume that the instruments follow the IV assumptions, then we must have the following hold:

$$E(V_t Z_t') = E(((S_{22} - S_{21}S_{11}^{-1}S_{12})\varepsilon_t^q)Z_t') = 0. \quad (4)$$

To test the condition in equation (4), I use a standard over-identification J-test. Here, we would reject the null, $E(V_t Z_t') = 0$, if the HFI series held signalling or other information outside of the monetary news. Again, this is because the narrative explicitly controls for the information set of the BoC through its construction.

I use the overlap period between both instruments (2004:1 to 2015:9) and the residuals from the baseline model to run the over-identification procedure. Applying the J-test to equation (4), I find that the baseline model variables' p -values all exceed the 0.05 level and thus cannot reject the null. The p -values for each variable vary from 0.08 (mortgage spread) to 0.62 (exchange measure), with an average value of 0.27. The test result is that because the narrative approach controls for information, the Canadian HFI surprise series is not significantly biased because of external

information effects.⁴

⁴The test can also suggest that the rejection of the null occurs because of other implicit assumption failures within the model. Ha & So (2023) show that spillover between Canada and the US for foreign and domestic shocks can be significant and may drive some of the closer results, such as the mortgage spread.

3 Appendix: Full Specification of Figure 11 and Extra Figures

First, I begin with reporting the full specification figures from the transmission section of the main paper.

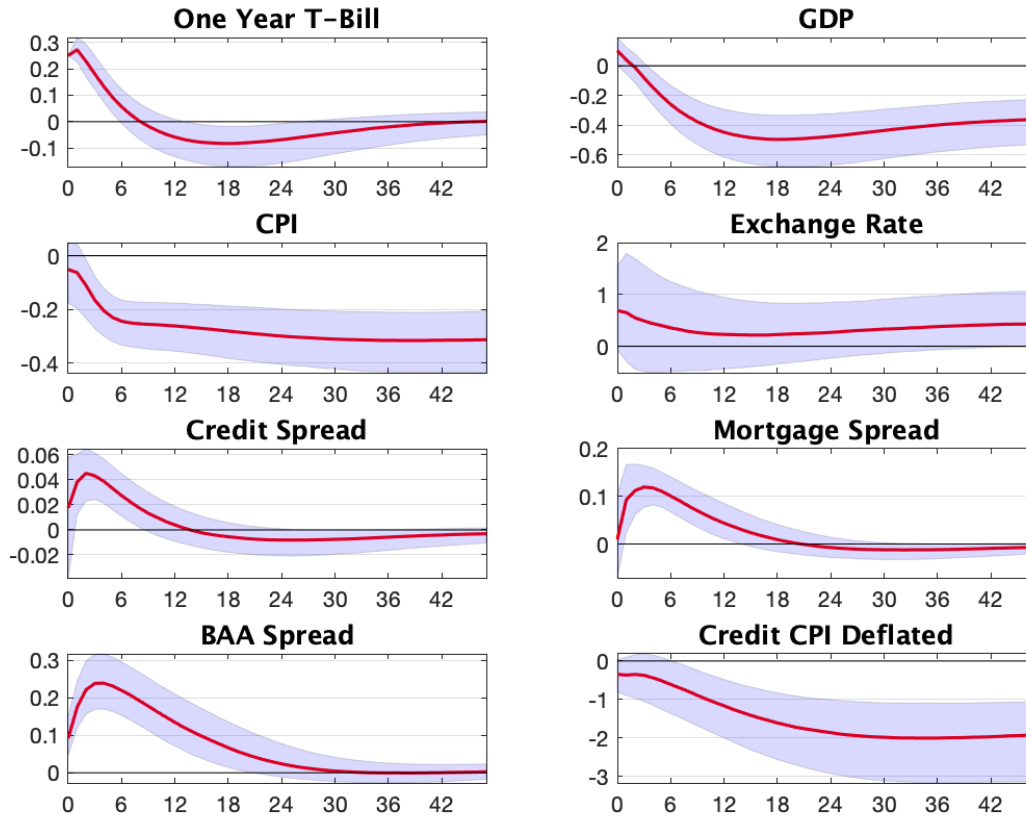


Figure 4: Baseline data with a measure for credit added. Percentage response of the baseline model to a 25 basis points contractionary monetary policy identified with the second contract of BAX around a policy meeting. The red line represents the median response and the blue shaded area the 68% confidence region using the moving block bootstrap method with 5000 replications. All figures use a 48 month horizon. The first-stage regression F-test is 29.475 and the R^2 is 0.1297.

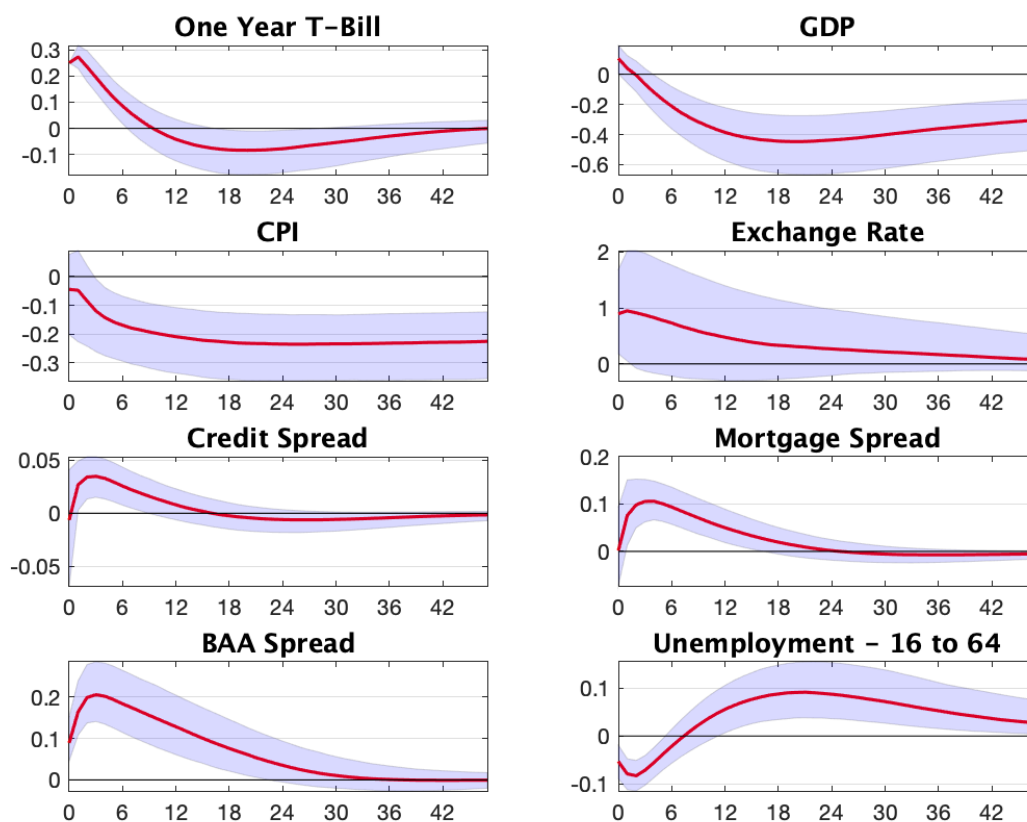


Figure 5: Baseline data with unemployment added. Percentage response of the baseline model to a 25 basis points contractionary monetary policy identified with the second contract of BAX around a policy meeting. The red line represents the median response and the blue shaded area the 68% confidence region using the moving block bootstrap method with 5000 replications. All figures use a 48 month horizon. The first-stage regression F-test is 29.558 and the R^2 is 0.13007.

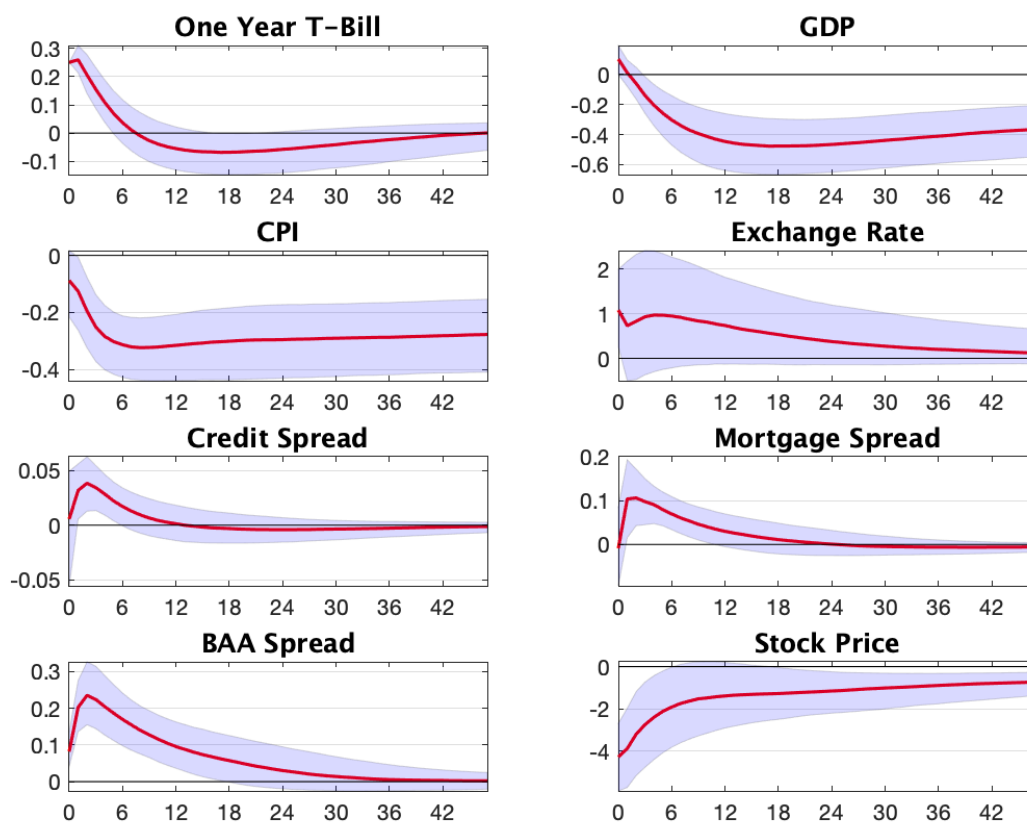


Figure 6: Baseline data with a stock price added in the TSX60 Percentage response of the baseline model to a 25 basis points contractionary monetary policy identified with the second contract of BAX around a policy meeting. The red line represents the median response and the blue shaded area the 68% confidence region using the moving block bootstrap method with 5000 replications. All figures use a 48 month horizon. The first-stage regression F-test is 27.178 and the R^2 is 0.12054.

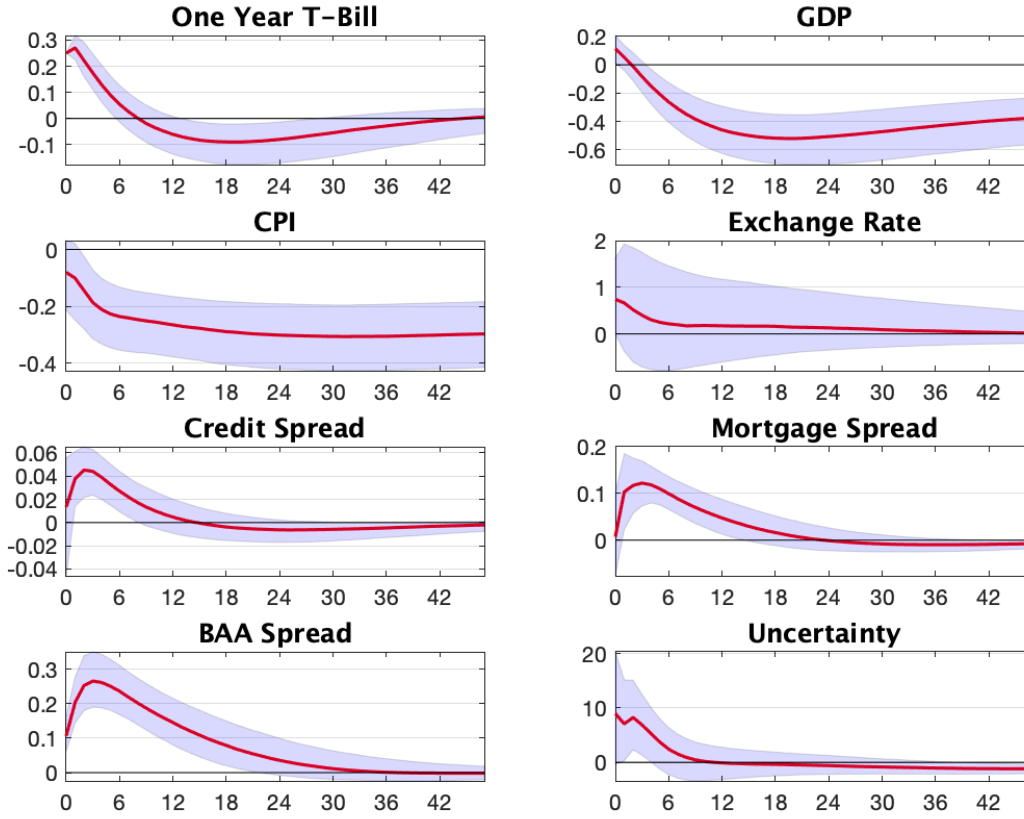


Figure 7: Baseline data with economic uncertainty. Percentage response of the baseline model to a 25 basis points contractionary monetary policy identified with the second contract of BAX around a policy meeting. The red line represents the median response and the blue shaded area the 68% confidence region using the moving block bootstrap method with 5000 replications. All figures use a 48 month horizon. The first-stage regression F-test is 27.313 and the R^2 is 0.12108.

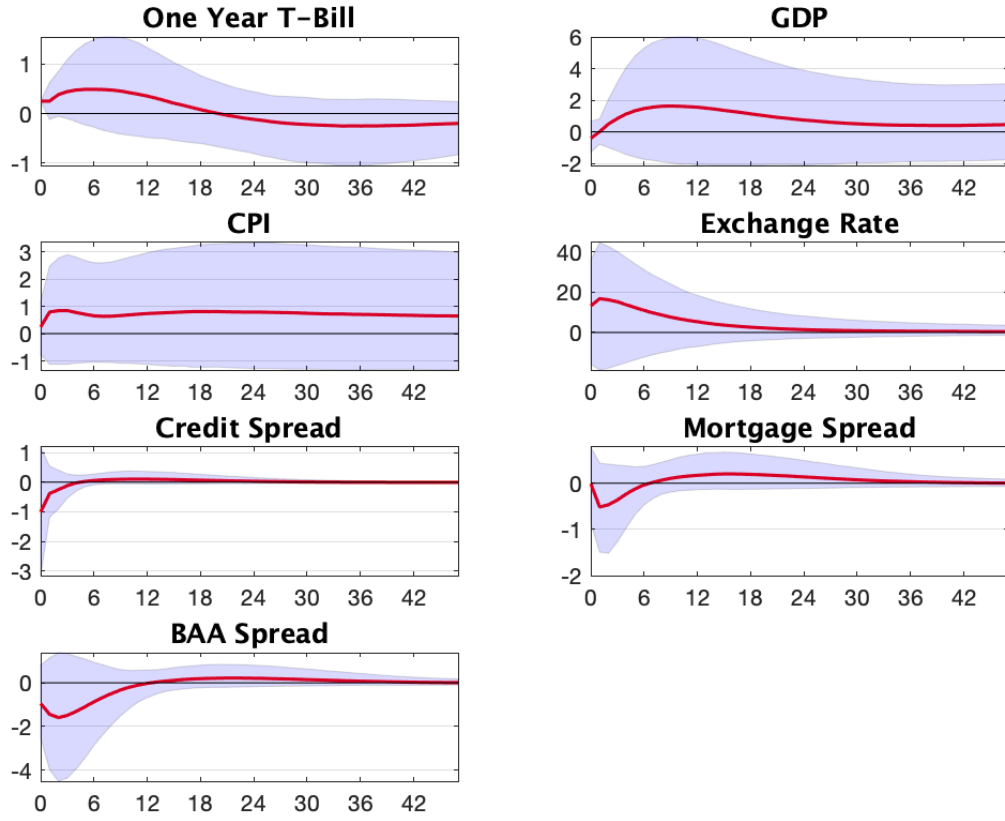


Figure 8: Baseline data with the US HF series used as the instrument. Percentage response of the baseline model to a 25 basis points contractionary monetary policy identified with the second contract of BAX around a policy meeting. The red line represents the median response and the blue shaded area the 68% confidence region using the moving block bootstrap method with 5000 replications. All figures use a 48 month horizon. The first-stage regression F-test is 0.14537 and the R^2 is -0.004641.

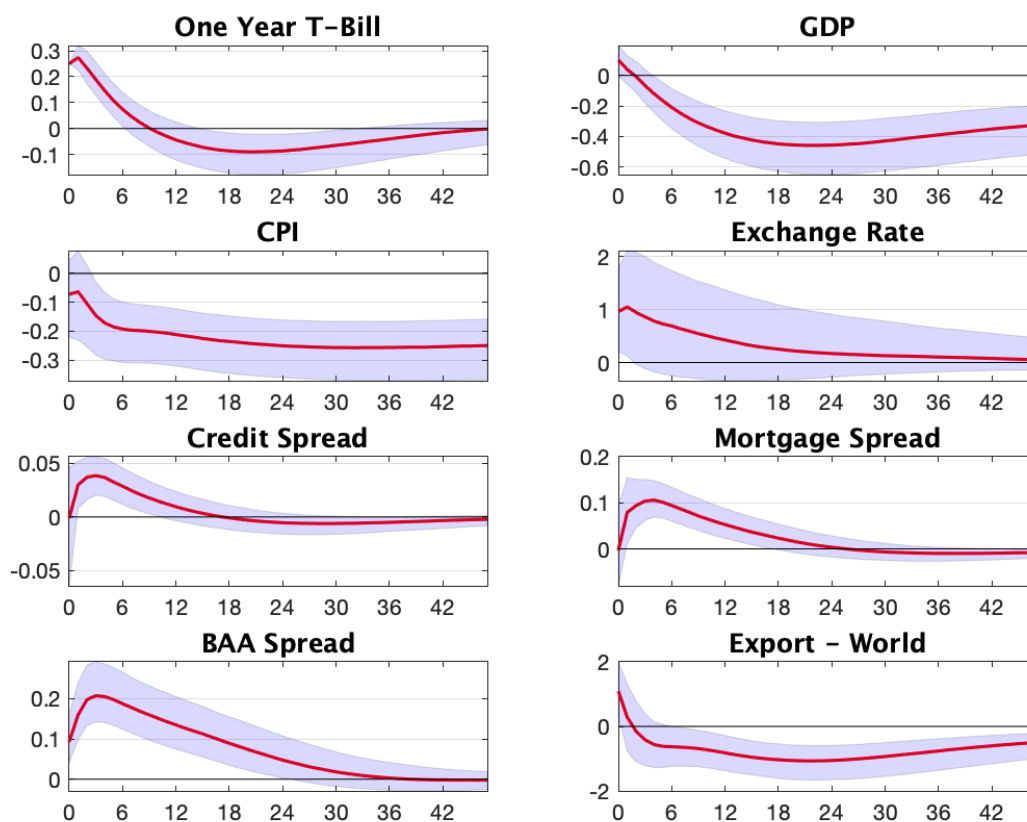


Figure 9: Baseline data with world exports added. Percentage response of the baseline model to a 25 basis points contractionary monetary policy identified with the second contract of BAX around a policy meeting. The red line represents the median response and the blue shaded area the 68% confidence region using the moving block bootstrap method with 5000 replications. All figures use a 48 month horizon.

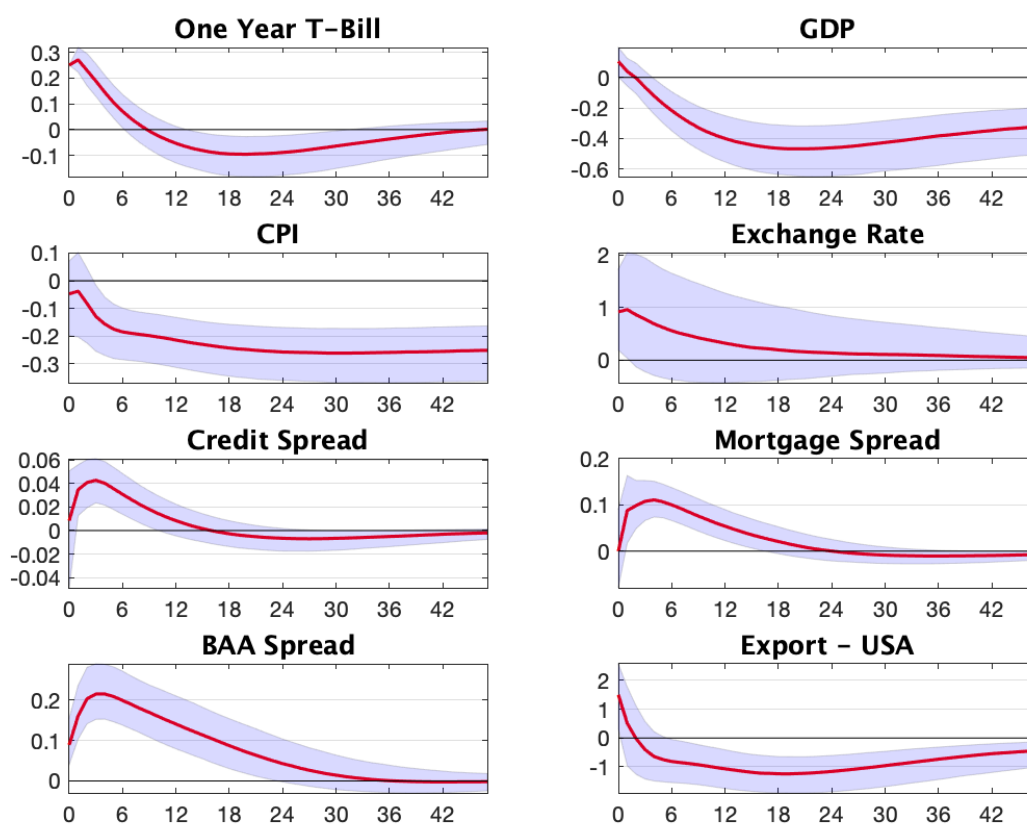


Figure 10: Baseline data with USA exports added. Percentage response of the baseline model to a 25 basis points contractionary monetary policy identified with the second contract of BAX around a policy meeting. The red line represents the median response and the blue shaded area the 68% confidence region using the moving block bootstrap method with 5000 replications. All figures use a 48 month horizon.

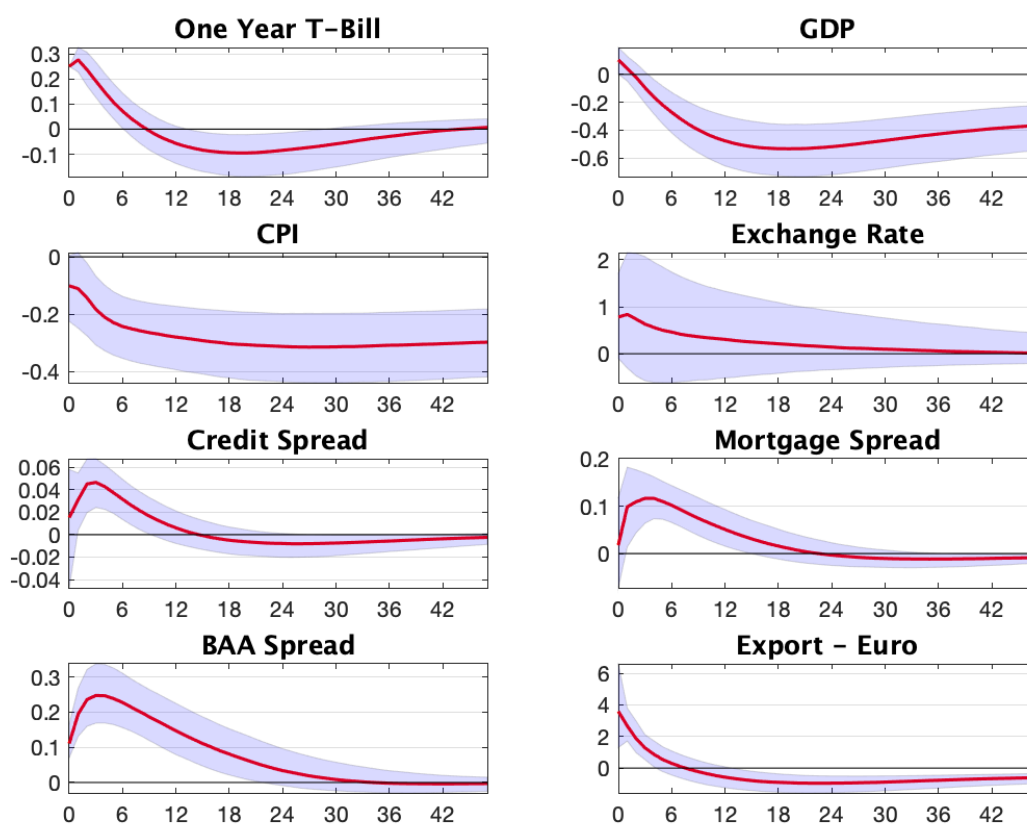


Figure 11: Baseline data with European exports added. Percentage response of the baseline model to a 25 basis points contractionary monetary policy identified with the second contract of BAX around a policy meeting. The red line represents the median response and the blue shaded area the 68% confidence region using the moving block bootstrap method with 5000 replications. All figures use a 48 month horizon.

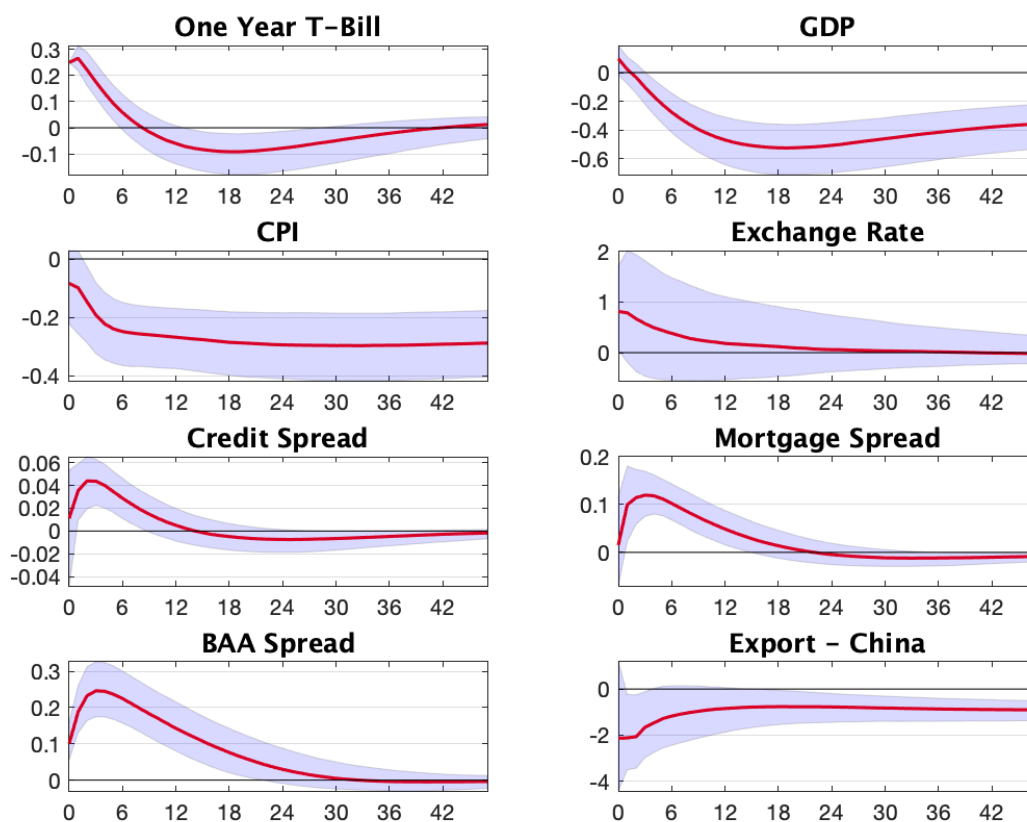


Figure 12: Baseline data with China exports added. Percentage response of the baseline model to a 25 basis points contractionary monetary policy identified with the second contract of BAX around a policy meeting. The red line represents the median response and the blue shaded area the 68% confidence region using the moving block bootstrap method with 5000 replications. All figures use a 48 month horizon.

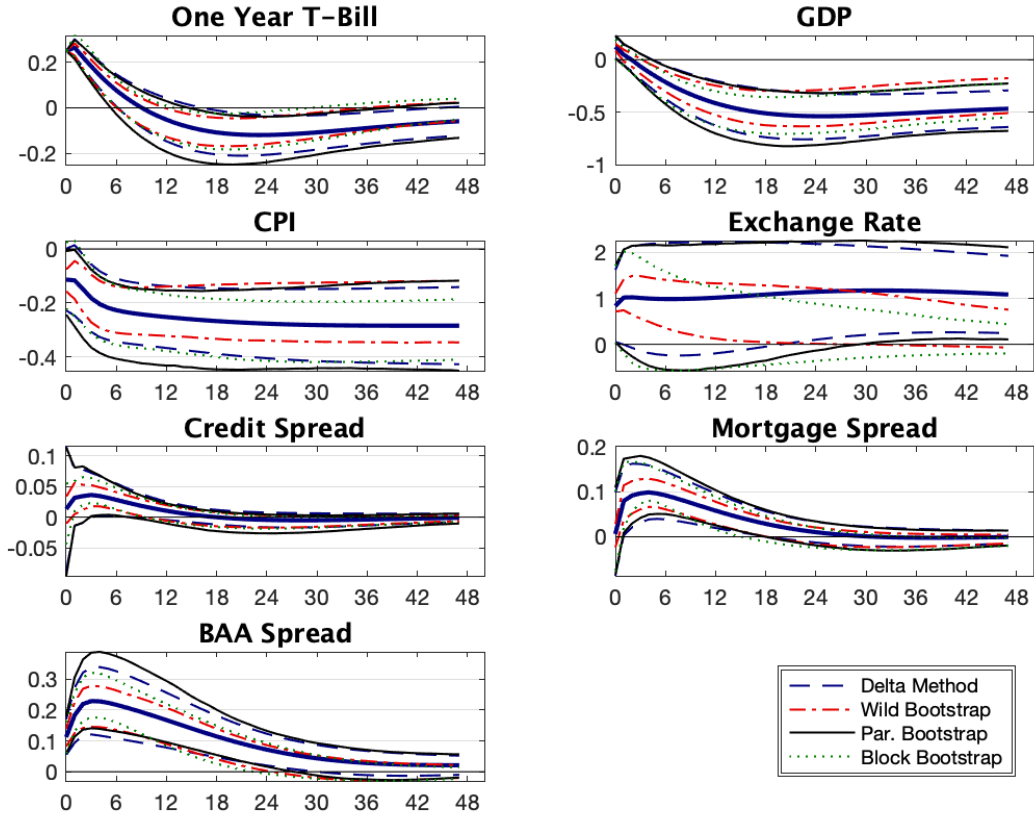


Figure 13: Baseline data and model with varying bootstrap methods. Percentage response of the baseline model to a 25 basis points contractionary monetary policy identified with the second contract of BAX around a policy meeting. The red line represents the median response and the blue shaded area the 68% confidence region using the moving block bootstrap method with 5000 replications. All figures use a 48 month horizon.

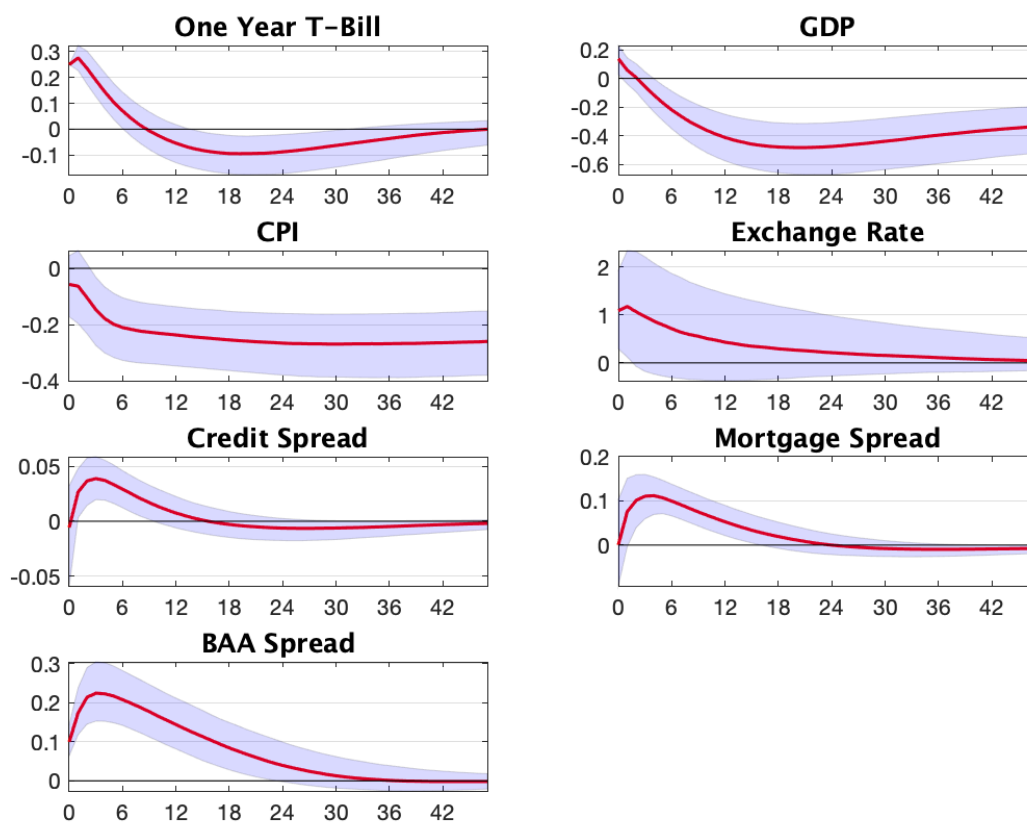


Figure 14: Baseline data with BAX1 as instrument. Percentage response of the baseline model to a 25 basis points contractionary monetary policy identified with the second contract of BAX around a policy meeting. The red line represents the median response and the blue shaded area the 68% confidence region using the moving block bootstrap method with 5000 replications. All figures use a 48 month horizon. The first-stage regression F-test is 31.4827 and the R^2 is 0.13763.

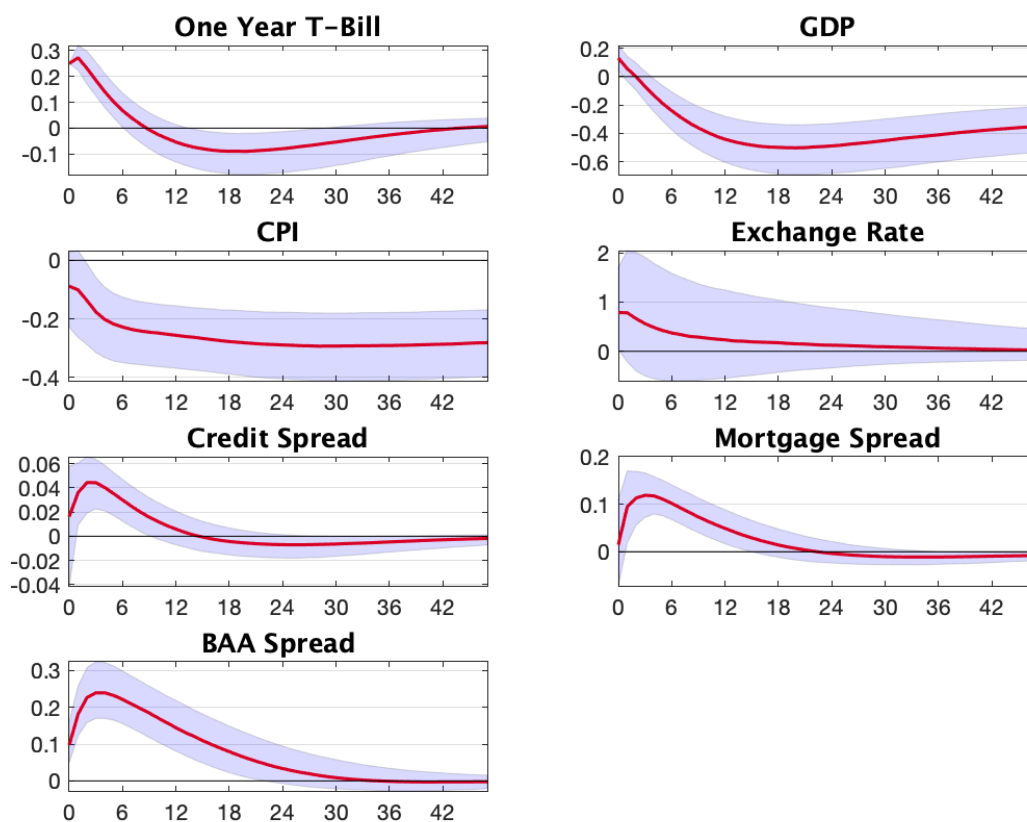


Figure 15: Baseline data with BAX3 as instrument. Percentage response of the baseline model to a 25 basis points contractionary monetary policy identified with the second contract of BAX around a policy meeting. The red line represents the median response and the blue shaded area the 68% confidence region using the moving block bootstrap method with 5000 replications. All figures use a 48 month horizon.

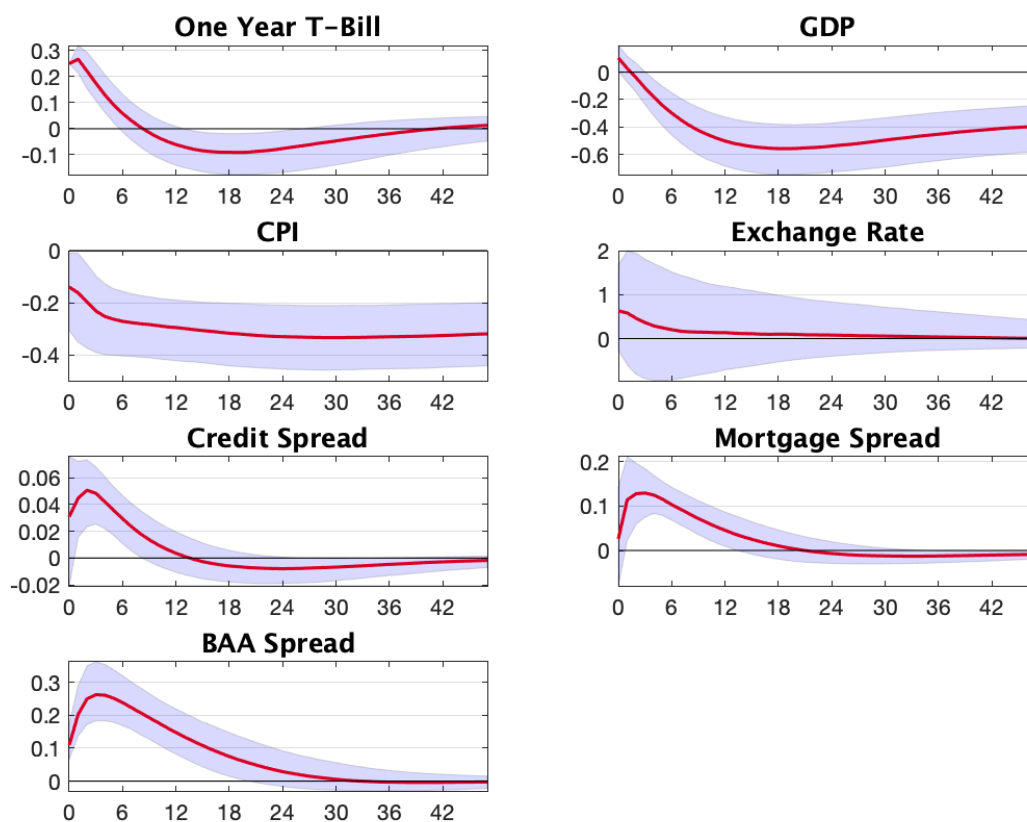


Figure 16: Baseline data with BAX4 as instrument. Percentage response of the baseline model to a 25 basis points contractionary monetary policy identified with the second contract of BAX around a policy meeting. The red line represents the median response and the blue shaded area the 68% confidence region using the moving block bootstrap method with 5000 replications. All figures use a 48 month horizon.

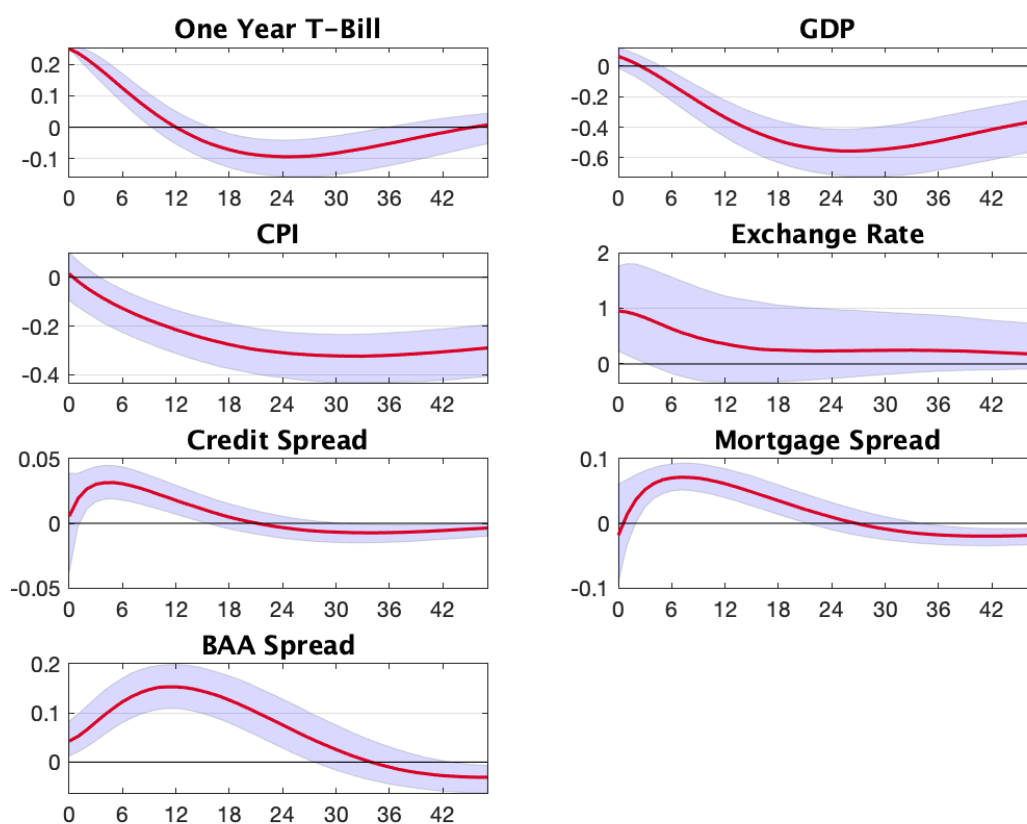


Figure 17: Baseline data one lag. Percentage response of the baseline model to a 25 basis points contractionary monetary policy identified with the second contract of BAX around a policy meeting. The red line represents the median response and the blue shaded area the 68% confidence region using the moving block bootstrap method with 5000 replications. All figures use a 48 month horizon.

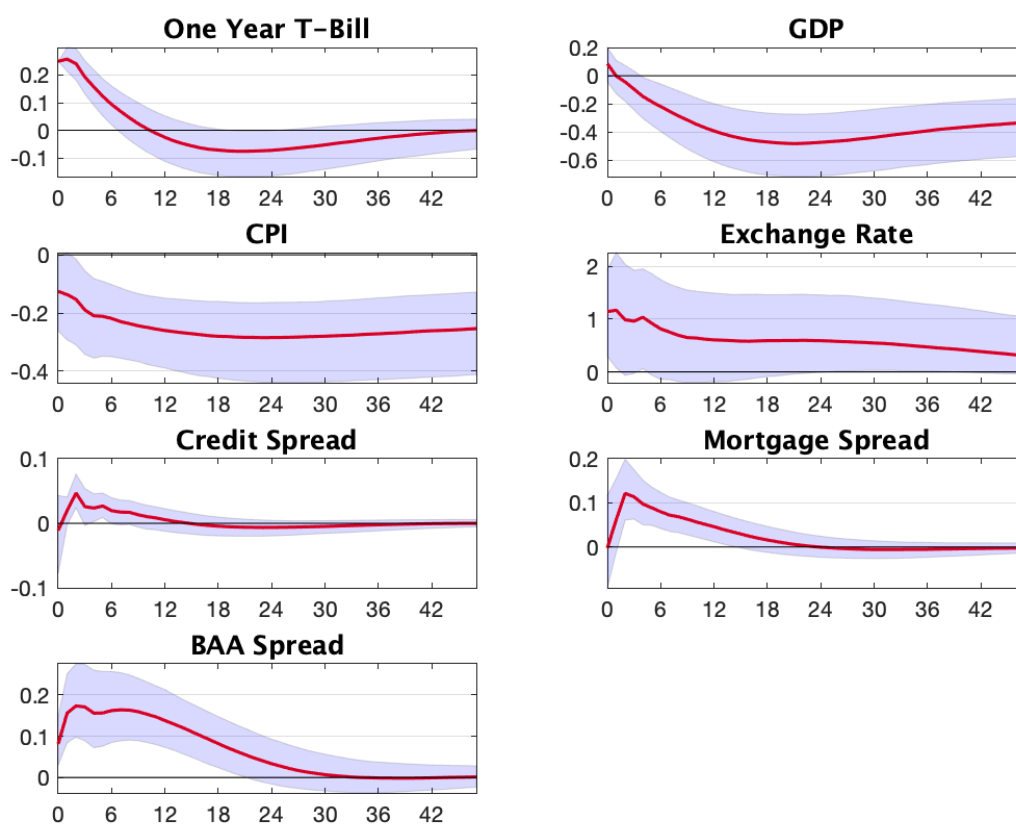


Figure 18: Baseline data three lags. Percentage response of the baseline model to a 25 basis points contractionary monetary policy identified with the second contract of BAX around a policy meeting. The red line represents the median response and the blue shaded area the 68% confidence region using the moving block bootstrap method with 5000 replications. All figures use a 48 month horizon.

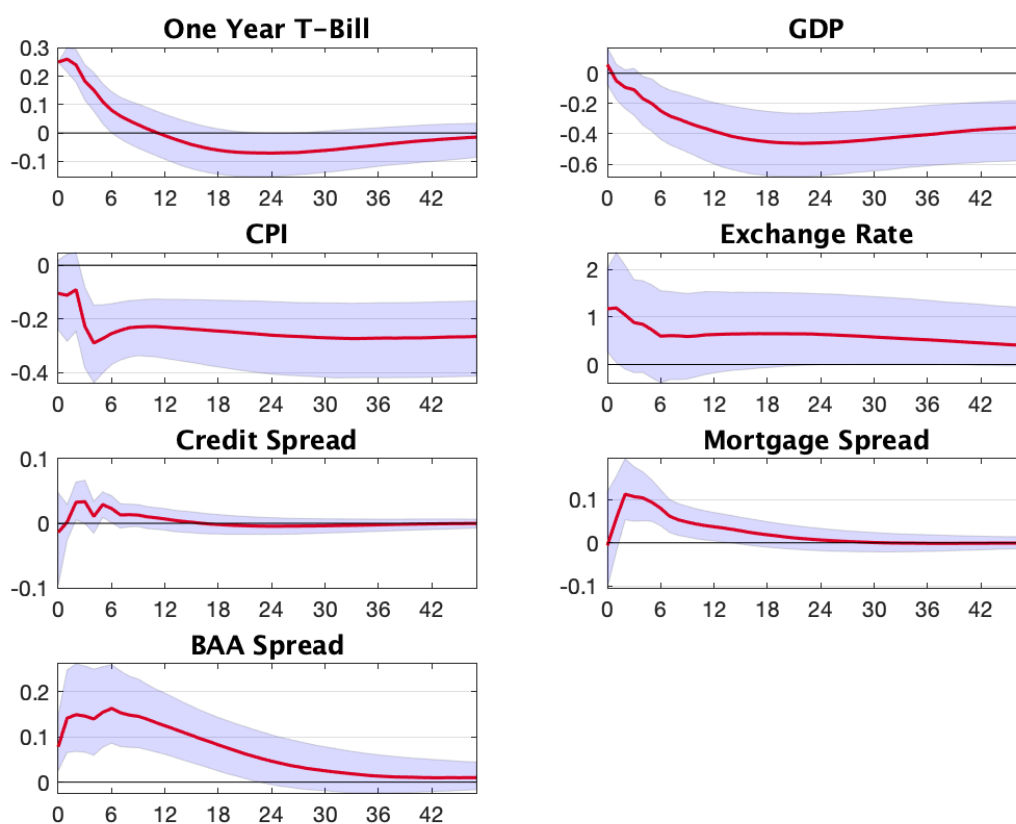


Figure 19: Baseline data four lags. Percentage response of the baseline model to a 25 basis points contractionary monetary policy identified with the second contract of BAX around a policy meeting. The red line represents the median response and the blue shaded area the 68% confidence region using the moving block bootstrap method with 5000 replications. All figures use a 48 month horizon.

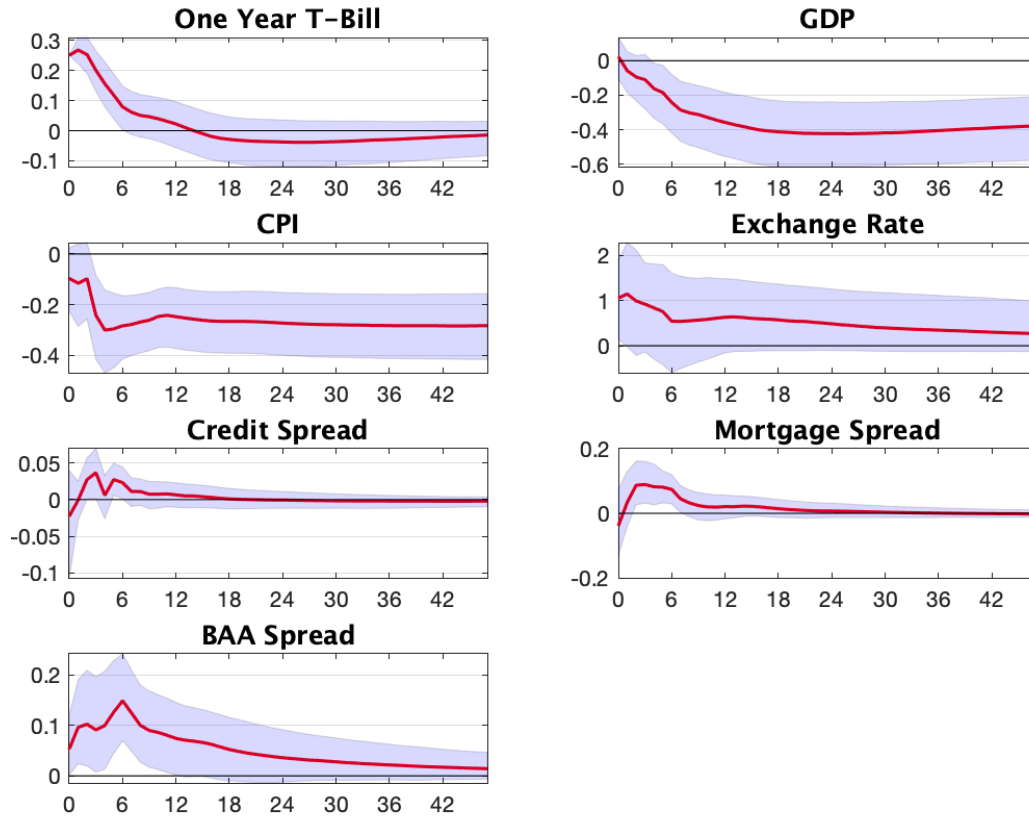


Figure 20: Baseline data five lags. Percentage response of the baseline model to a 25 basis points contractionary monetary policy identified with the second contract of BAX around a policy meeting. The red line represents the median response and the blue shaded area the 68% confidence region using the moving block bootstrap method with 5000 replications. All figures use a 48 month horizon.

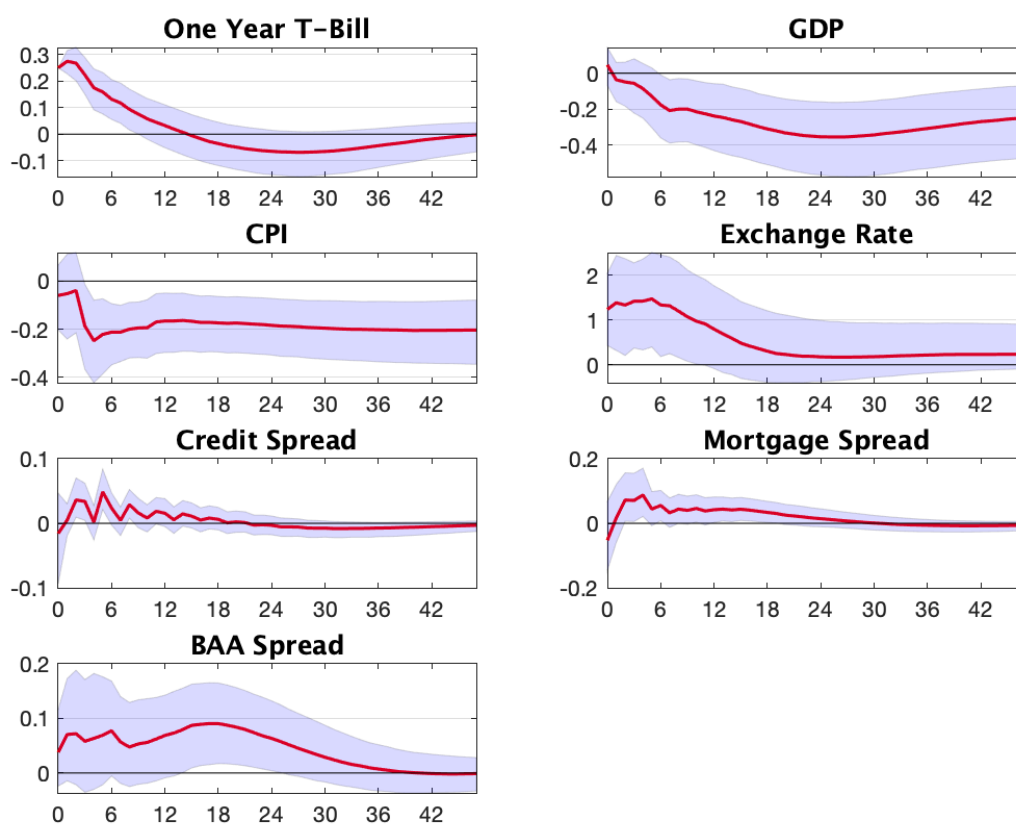


Figure 21: Baseline data six lags. Percentage response of the baseline model to a 25 basis points contractionary monetary policy identified with the second contract of BAX around a policy meeting. The red line represents the median response and the blue shaded area the 68% confidence region using the moving block bootstrap method with 5000 replications. All figures use a 48 month horizon.

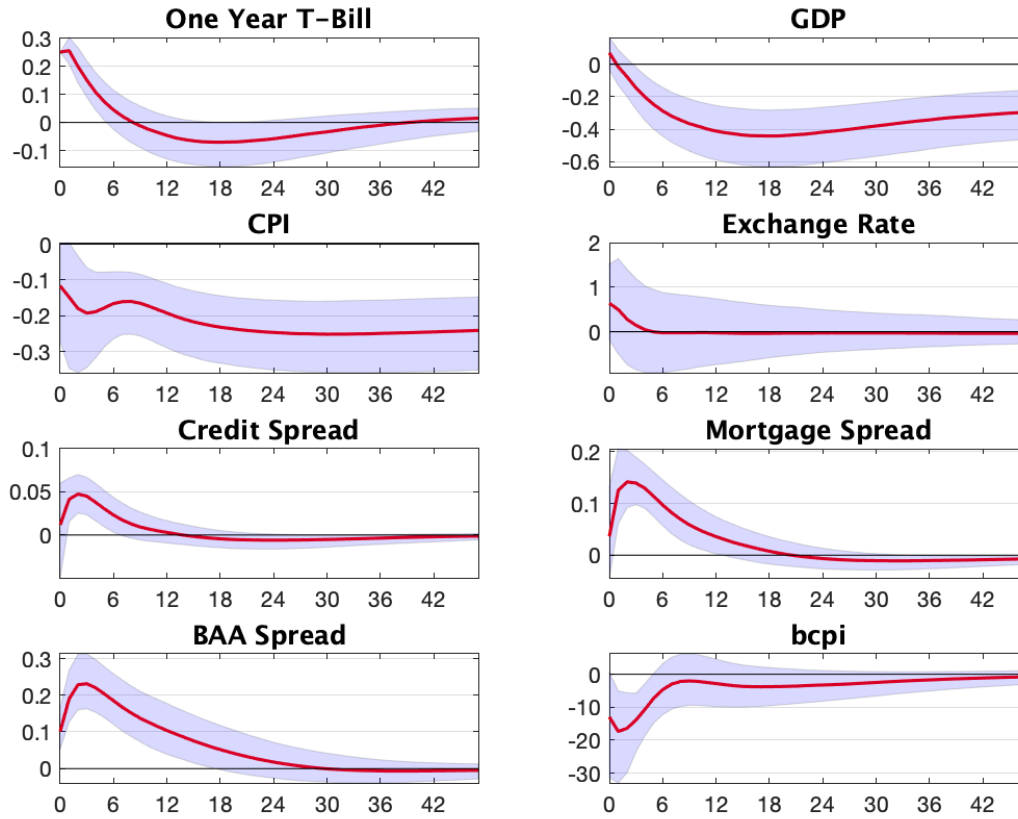


Figure 22: Baseline data with the Bank of Canada Commodity index converted to Canadian dollars added. Information criterion indicated to use 3 lags. Percentage response of the baseline model to a 25 basis points contractionary monetary policy identified with the second contract of BAX around a policy meeting. The red line represents the median response and the blue shaded area the 68% confidence region using the moving block bootstrap method with 5000 replications. All figures use a 48 month horizon.

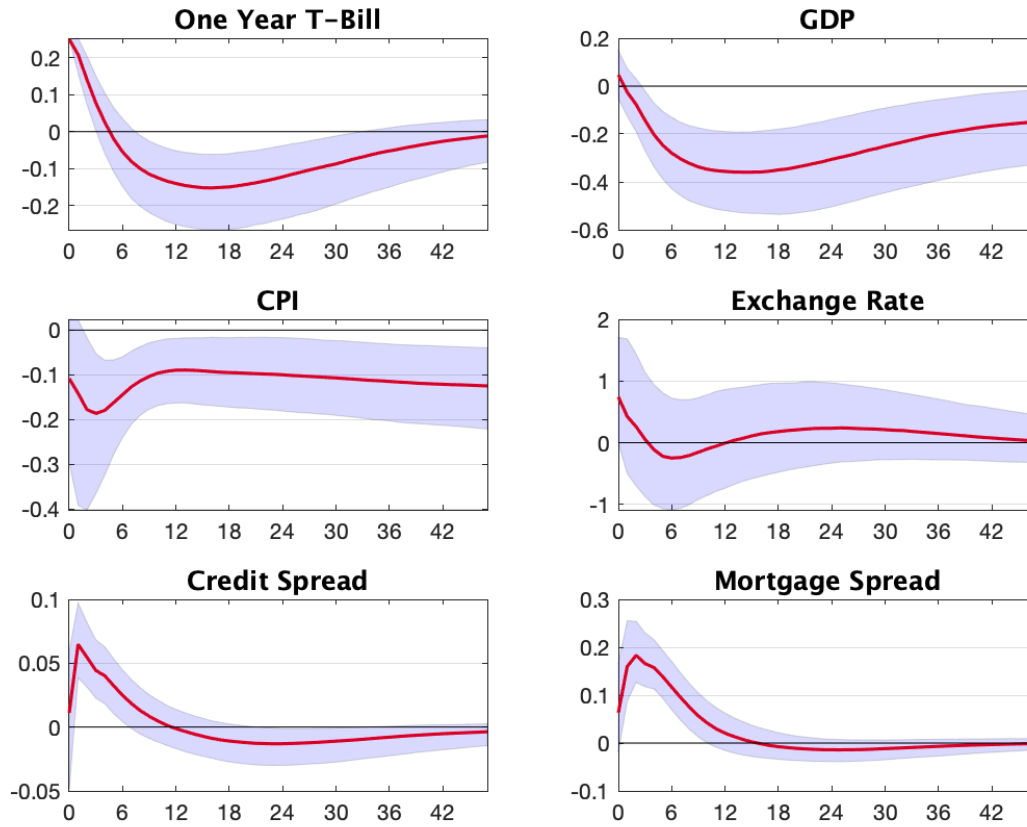


Figure 23: Baseline data with the Bank of Canada Commodity index converted to Canadian dollars, US IP, US FFR, US PCE added. Two lags are used. Percentage response of the baseline model to a 25 basis points contractionary monetary policy identified with the second contract of BAX around a policy meeting. The red line represents the median response and the blue shaded area the 68% confidence region using the moving block bootstrap method with 5000 replications. All figures use a 48 month horizon.

4 Variable Choice and Model Set-Up - Comparison of Surprises and Narrative Measure

Here, I change the model and variable choice to compare the effects of a monetary policy shock when identified with either the narrative or surprises measure. More specifically, I will change the econometric method to a local projections procedure, the number of lags used and the variable choice to be more in line with the method applied by Champagne & Sekkel (2018). Further figures are available upon request.

First the single equation local projections with the Champagne & Sekkel (2018). Originally they had used 48 lags of their shock, in this figure I use 24 lags of their shock and 4 lags for their control variables. I use their specification in this figure. We can see that in this method the narrative measure has a larger effect on GDP than what was previously observed. However, even with a 100 basis point shock, the response peaks at about 1.5 percentage points. This would still be less than the peak response observed with the HFI measure when scaled.

In the next figure, 12 lags are used with the shock. The response of the variables are very similar to those of the previous set, but the response a little muted in comparison. This shows the effect of reducing the number of lags used in this approach, which will be further problematic when the sample is changed to be similar to the sample I have used.

The next figure uses 12 lags and the reduced sample of 1997 to 2015. Here we start to see similar results to those with the SVAR with an external instrument method. GDP has a persistent, although not significant, increase. The price level fluctuates around a significant decrease and no significant change through the full horizon. Little change is observed in the exchange rate.

Finally I use the external instrument method again, with the narrative measure as the instrument and limited to five variables in a similar set up that Champagne & Sekkel (2018) uses. I change the interest rate to be the overnight rate. The response figures are similar to those in the baseline with the narrative measure. The increase in price level declines quickly to zero and stays there throughout the entire horizon.

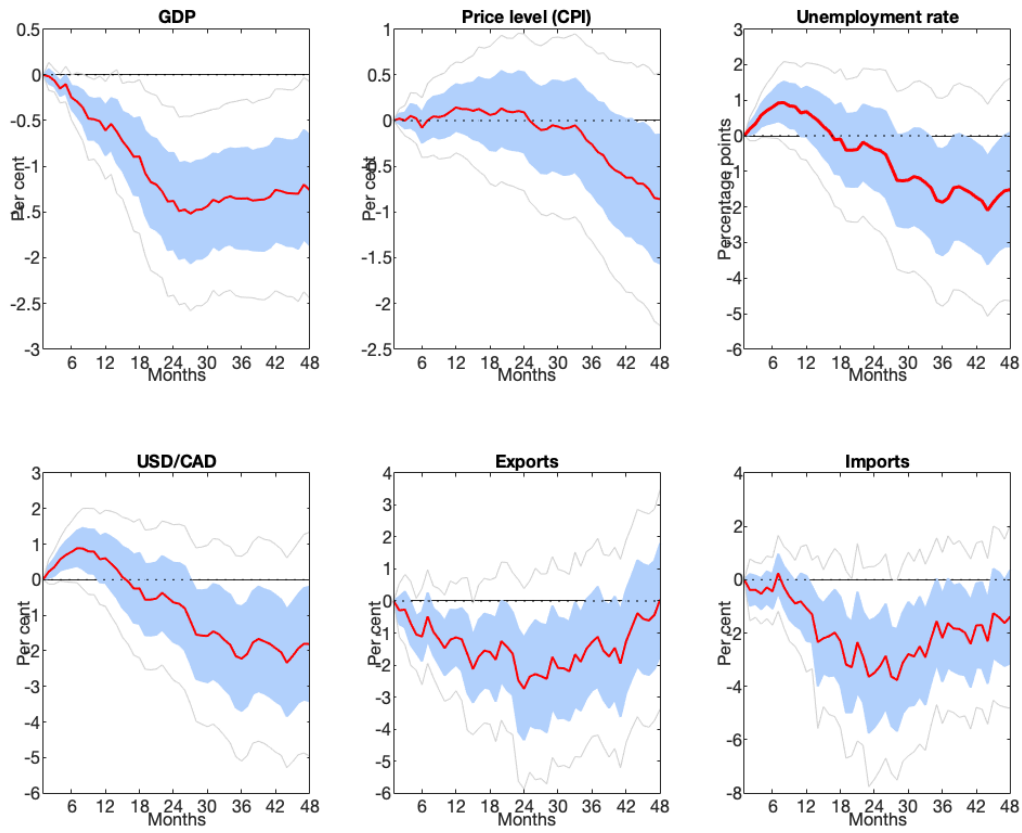


Figure 24: Replication of Champagne & Sekkel (2018) figure (4) with 24 lags of narrative series used, 4 for control variables. 100 basis points contractionary monetary policy. All figures use a 48 month horizon.

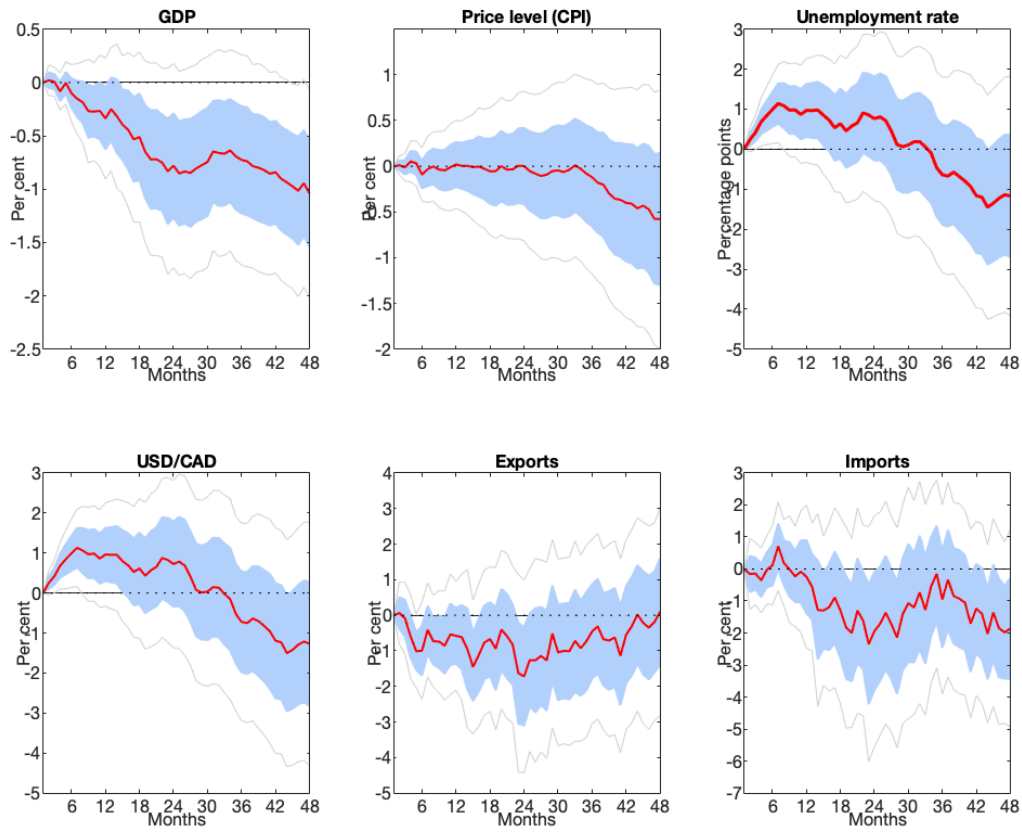


Figure 25: Replication of Champagne & Sekkel (2018) figure (4) with 12 lags of narrative series used, 4 for control variables. 100 basis points contractionary monetary policy. All figures use a 48 month horizon.

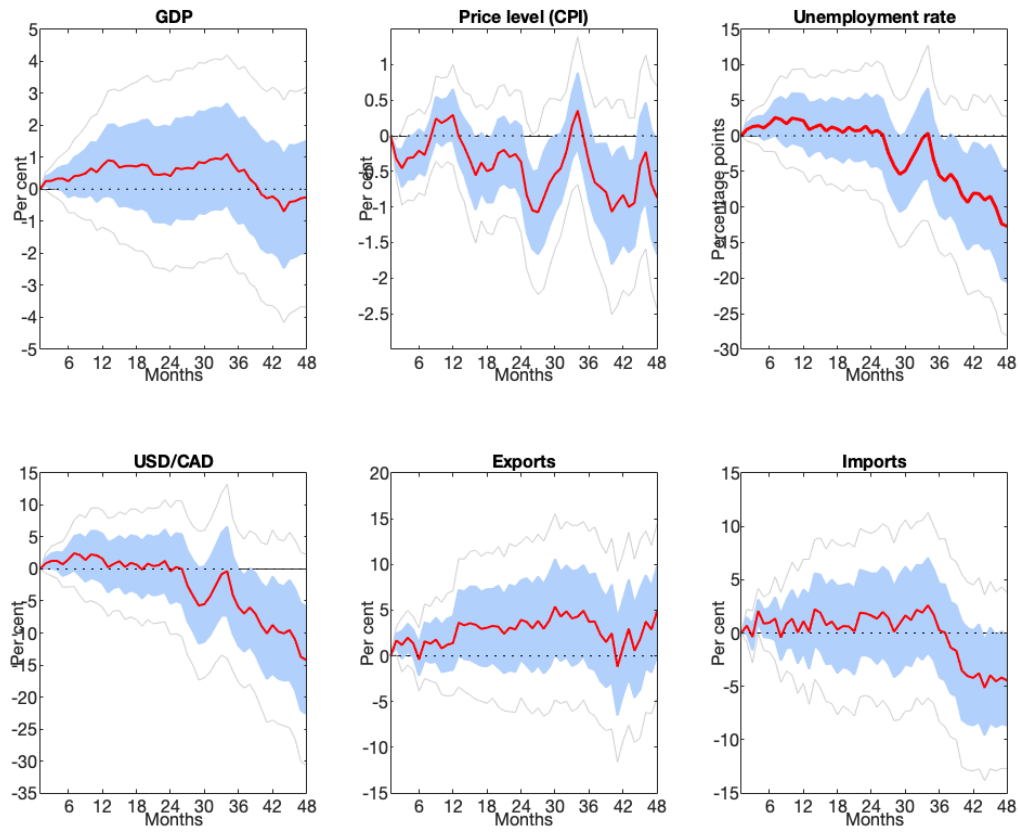


Figure 26: Replication of Champagne & Sekkel (2018) figure (4) with 12 lags of narrative series used, 4 for control variables. 100 basis points contractionary monetary policy. Only 1997-2015:10 for sample used now. All figures use a 48 month horizon.

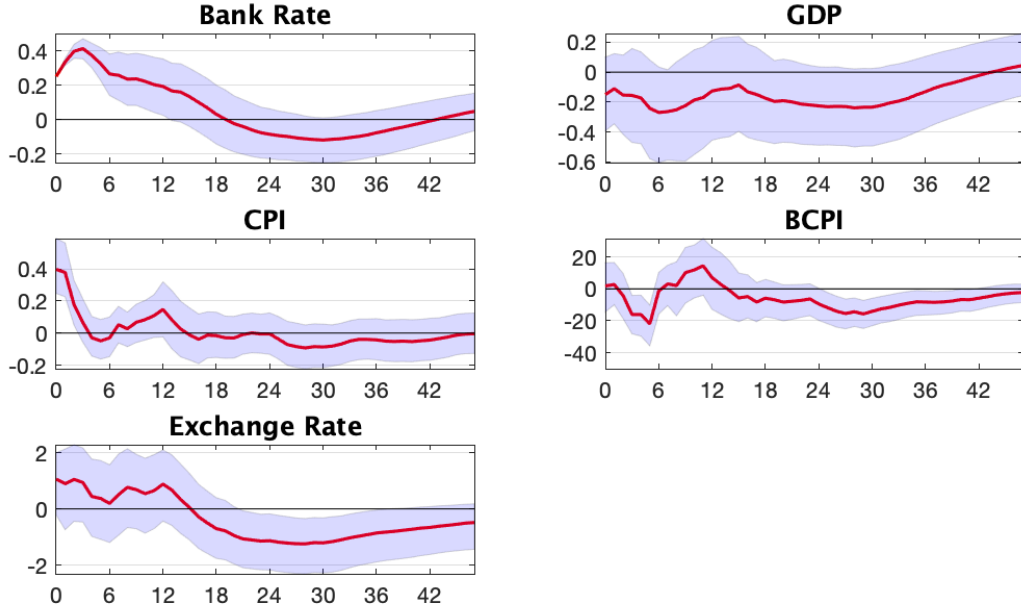


Figure 27: Baseline data, with the overnight rate now instead of the 1-year Treasury Bill rate and 12 lags. Percentage response of the baseline model to a 25 basis points contractionary monetary policy identified with narrative measure. The red line represents the median response and the blue shaded area the 68% confidence region using the moving block bootstrap method with 5000 replications. All figures use a 48 month horizon.

5 Local Projections

Here, I present the results using the local projections method (Jordà (2005)) with an instrumental variable (LP-IV). In Ramey (2016) it is shown that the Gertler & Karadi (2015) instrument does not produce results that are in line with those from the SVAR-IV procedure. Similar to the findings of Bauer & Swanson (2023), I find that the LP-IV procedure with the BAX2 as the instrument produce responses similar to those found with the SVAR-IV method. This result is a little different

than Bauer & Swanson (2023) who find the LP-IV method works with their adjusted for news HFI instrument. I match the LP-IV specification as closely to the baseline model, excluding the US spread measure. I also use two lags, however up to six lags are applied with similar results. The LP-IV regression has the following form

$$Y_{t+h} = \alpha^{(h)} + B^{(h)}(L)Y_{t-1} + \delta^{(h)}Y_t^{1y} + \eta_t^{(h)}, \quad (5)$$

where Y are the same set of variables from the baseline results in the paper, excluding the US spread measure. The horizon length h is set to 40 months, $\alpha^{(h)}$ is a constant and $A^{(h)}(L)$ is a matrix polynomial where the size is dependent on the number of lags, (lags minus one). I estimate equation (5) with two-stage least squares, using the BAX2 contract as the instrument for Y_t^{1y} , which is the one-year treasury bill rate. The sample runs from 2004 until the end of 2019, which is the length of the instrument.

Figure 28 reports the impulse responses to equation (5) for the treasury bill rate, GDP and CPI. The reported confidence bands are at the 90% level. All responses follow from a 100 basis point shock. The results are similar to those in the baseline SVAR-IV. The GDP response has a larger rebound effect in the long run, and returns to zero. The price level is less sticky than the SVAR-IV baseline model, but still has a small effect in the long run. Overall, the responses for the important macroeconomic variables are similar and mostly unchanged compared to the SVR-IV results, suggesting that the method of choice does not impact the results.

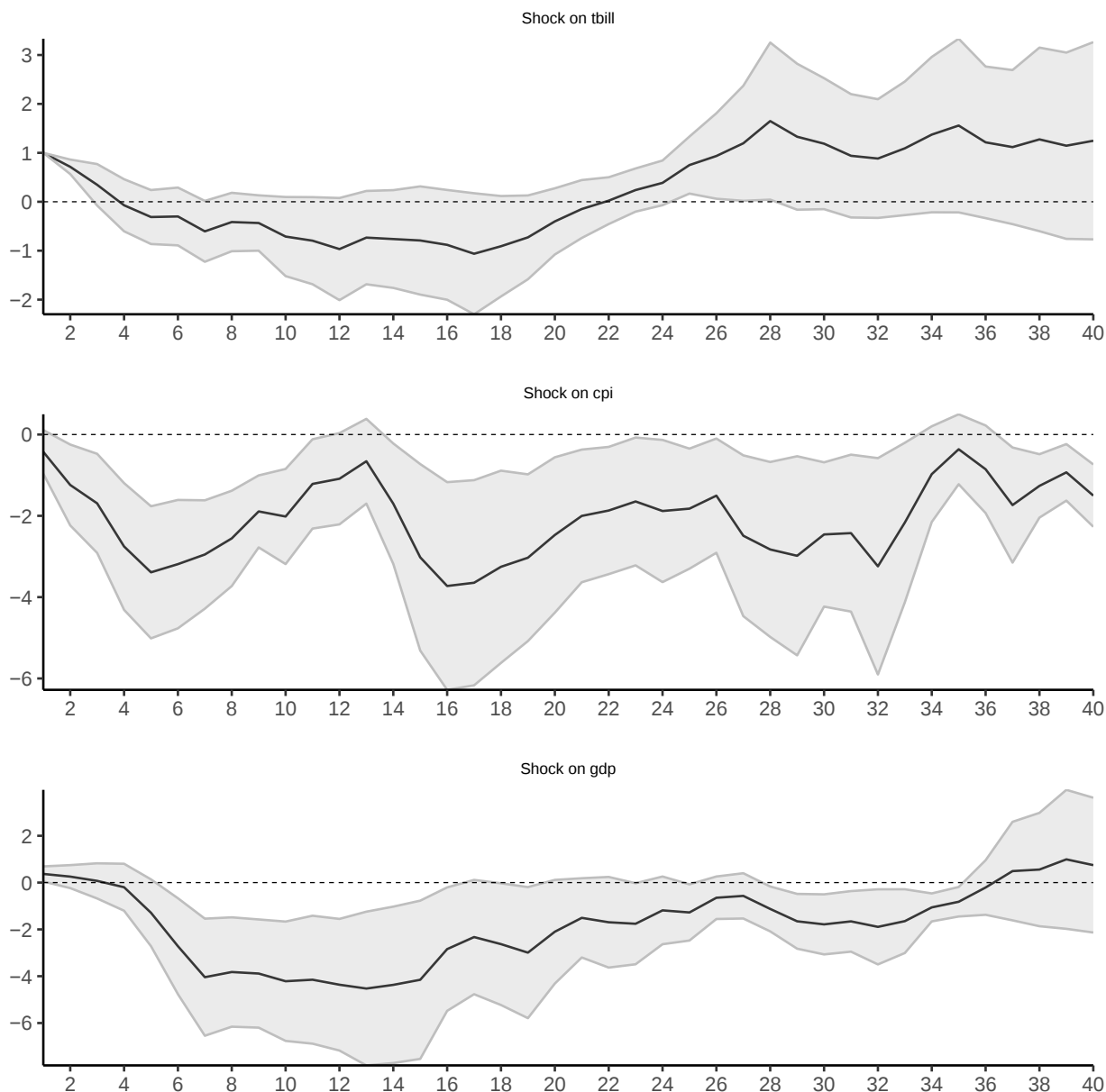


Figure 28: Baseline data, excluding the US BAA spread. Percentage response of the baseline model to a 100 basis points contractionary monetary policy identified with narrative measure. The solid line represents the median response while the shaded region the 90% confidence region. Newey-West standard errors. A 40 months horizon is provided. Data is from 2004:1 to 2019:12.

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