Econ 210C Homework 2

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1. VARs

Download data for the Federal Funds Rate, the civilian unemployment rate, and the GDP deflator inflation rate from FRED.

(a) Plot the data. Make sure all graphs are appropriately labelled.

Solution:

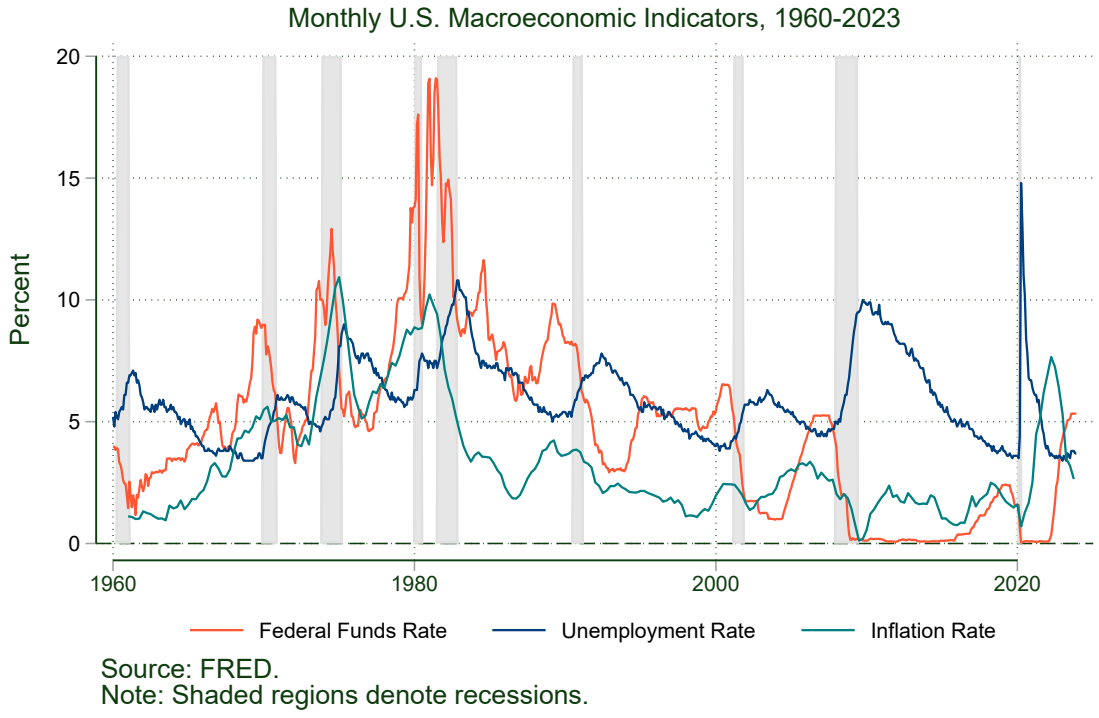


Figure 1: Monthly U.S. Macroeconomic Indicators, 1960-2023

(b) Aggregate all series to a quarterly frequency by averaging over months.

Estimate a VAR with 4 lags from 1960Q1:2007Q4. The ordering of your variables should be π_t, u_t, R_t.

Solution: We estimate a VAR of the form

$$x_t = A_0 + \sum_{s=1}^{4} A_s x_{t-s} + e_t$$

Where

$$x_t = \begin{bmatrix} \pi_t \\ u_t \\ R_t \end{bmatrix}, e_t = \begin{bmatrix} e_{\pi,t} \\ e_{u,t} \\ e_{R,t} \end{bmatrix},$$

A_0 is a 3×1 vector and A_s $s \in \{1, ... 4\}$ are 3×3 matrices.

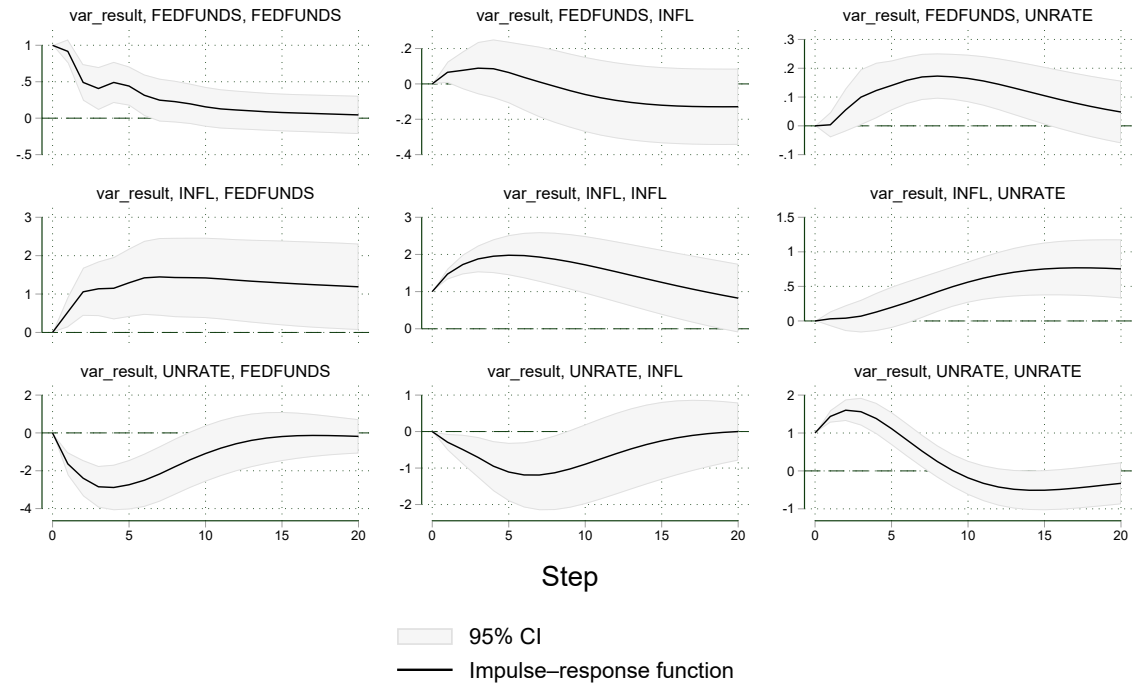


Figure 2: IRF from VAR on π_t, u_t, R_t with 4 lags from 1960Q1:2007Q4

(c) Briefly, explain why it would make sense to end the sample in 2007Q4?

Solution: After 2007Q4 the Federal Reserve implemented a range of monetary policies in response to the recession originated by the 2008 financial crisis. In fact, between 2008 and 2009, the Federal Funds Rate decreased from around 5 to 0 percent. If the VAR is not informed of such recession, it could confound the effect of the Federal Funds Rate with the effect of the recession, specially on unemployment, but also on inflation.

(d) Plot the IRFs from the SVAR with the same ordering. [Optional: add 95% error bands]

Solution: The structural VAR allows for simultaneous causality. Here:

- π_t affects u_t and R_t contemporaneously but not vice-versa.
- u_t affects R_t contemporaneously but not vice-versa.

We now have

$$Ax_t = A_0 + \sum_{s=1}^{4} A_s x_{t-s} + Be_t$$

where:

$$A = \begin{pmatrix} 1 & 0 & 0 \\ . & 1 & 0 \\ . & . & 1 \end{pmatrix}, B = \begin{pmatrix} . & 0 & 0 \\ 0 & . & 0 \\ 0 & 0 & . \end{pmatrix}$$

- A: Imposes restrictions in the contemporaneous relationships between the endogenous variables. If we want u_t not to contemporaneously affect π_t, then $A_{12} = 0$, conversely, allowing for π_t to have a contemporaneous effect on u_t will be achieved by not restricting A_{21}, so that it is estimated in the SVAR. This explains our A matrix, where we do not restrict A_{21} (effect on π_t of u_t), A_{31} (effect of π_t on R_t), A_{32} (effect of u_t on R_t). Note that if these 3 coefficients were 0, A would be the identity matrix and we would be back in the VAR model.
- B: Imposes restrictions between the contemporaneous shocks and endogenous variables. This matrix is diagonal so that each variable is only contemporaneously affected by its shock.

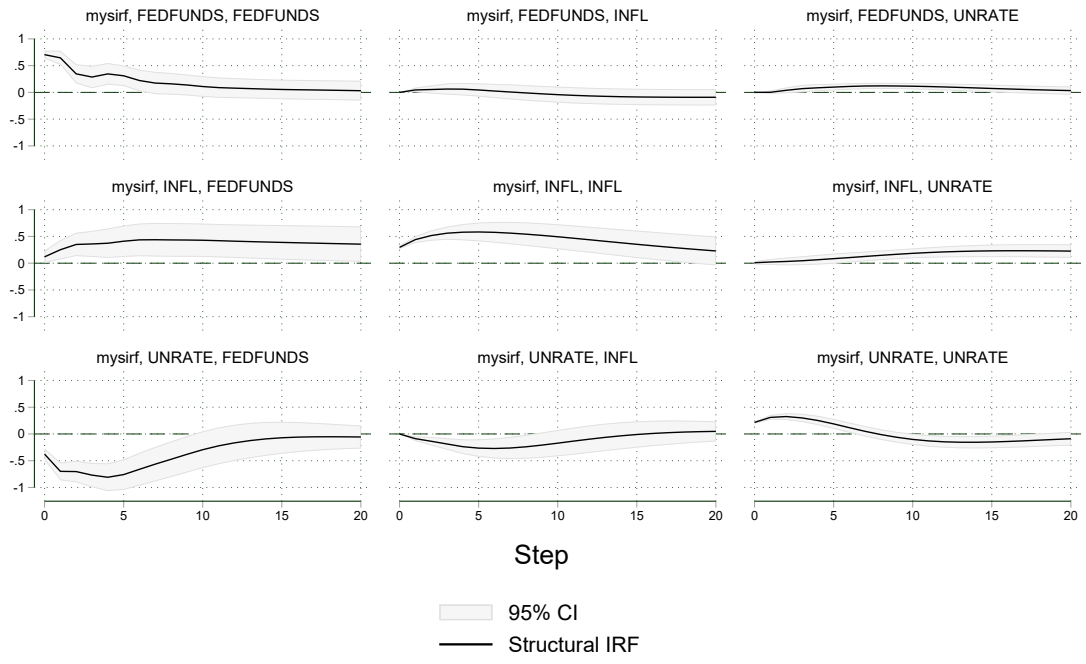


Figure 3: IRF from SVAR on π_t, u_t, R_t with 4 lags from 1960Q1:2007Q4

(e) Briefly, interpret your results.

Solution: In the VAR approach, we see that a shock in R_t leads to a short run increase in inflation and unemployment rate. A shock in inflation produces an increase in R_t and unemployment (more lagged). As for unemployment rate, it produces a decrease in R_t and inflation. While inflation and unemployment have a humped-shaped IRF with respect to their own shock, R_t decreases after being exposed to a self-shock.

The fact that the monetary shock produces an increase in inflation is probably misleading and explained by monetary policy, which might imply that some of the monetary shocks we observe are instead a decision based on higher expected inflation in the future.

In the SVAR IRF we observe the magnitudes are smaller but most directions remain. The IRF of inflation to R_t is flat and not statistically different than 0, which suggests the inclusion of contemporaneous effects in the SVAR addresses a part of the bias, however, we still don't observe the negative response we would expect if the omitted variables bias was completely treated.

(f) Plot the time series of your identified monetary shocks.

Solution: Our identified monetary shocks are the estimated residuals of estimating the interest rate via the SVAR statistical model described above.

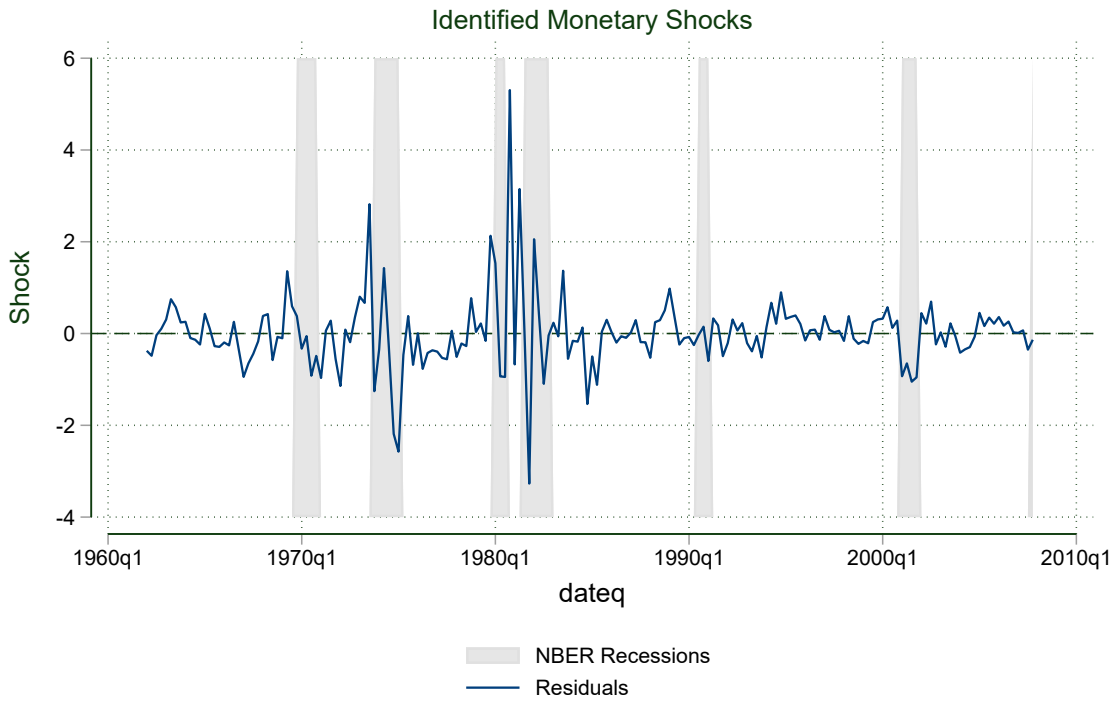


Figure 4: Monetary Shocks Identified as SVAR Residuals on Interest Rate

(g) What are the identified monetary shocks in 2001Q3 and 2001Q4? How should one interpret these shocks?

Solution: The identified monetary shocks are -1 and -0.9 in 2001Q3 and 2001Q4. Following 9/11, the FED cut interests rates from 3.5 to 3% and from 3% to 2.5% between September and October 2001. This is captured by the 2001Q2 to 2001Q3 0.83 and 2001Q3 to 2001Q4 1.36 decline in R_t. These reductions were not predicted by the SVAR, which explains the negative monetary shock at that date in Figure 4.

2. Romer shocks

(a) Download the Romer-Romer shocks from my website and merge it with your VAR dataset. Set the values of the Romer shocks to zero before 1969Q1.

(b) Following Romer-Romer, construct the IRF from the estimation equation

$$y_t = \alpha + \sum_{s=1}^{8} \beta_s y_{t-s} + \sum_{s=0}^{12} \gamma_s RR_{t-s}$$

where $y_t \in [\pi_t, u_t, R_t]$ are the outcome variables and RR_t are the Romer shocks estimated from 1960Q1:2007Q4. [Optional: add 95% error bands]

Solution:

Figure 5: IRF from VAR on π_t, u_t, R_t with 8 lags, controlling for Romer Residual RR_t and 12 lags from 1960Q1:2007Q4

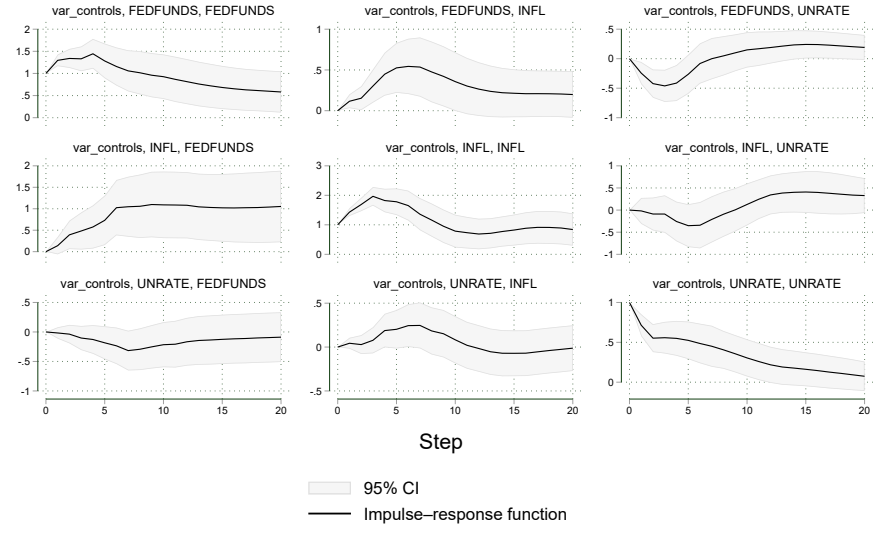
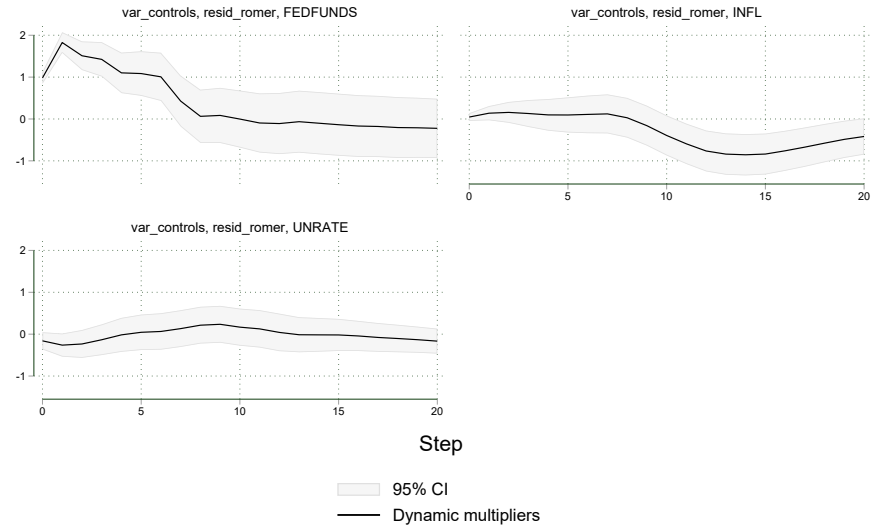


Figure 6: IRF: Impulse of RR_t and Response on π_t, u_t, R_t



(c) Now estimate an SVAR ordered RR_t, π_t, u_t, R_t with four lags from 1960Q1:2007Q4 and plot the IRFs. [Optional: add 95% error bands]

Solution:

Figure 7: IRF from SVAR on RR_t, π_t, u_t, R_t with 4 lags from 1960Q1:2007Q4

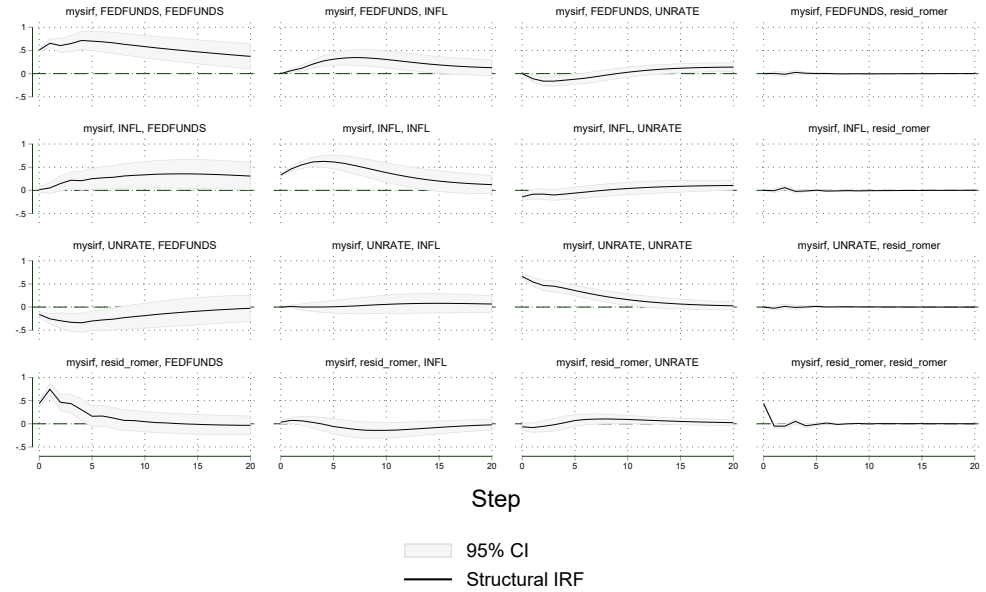
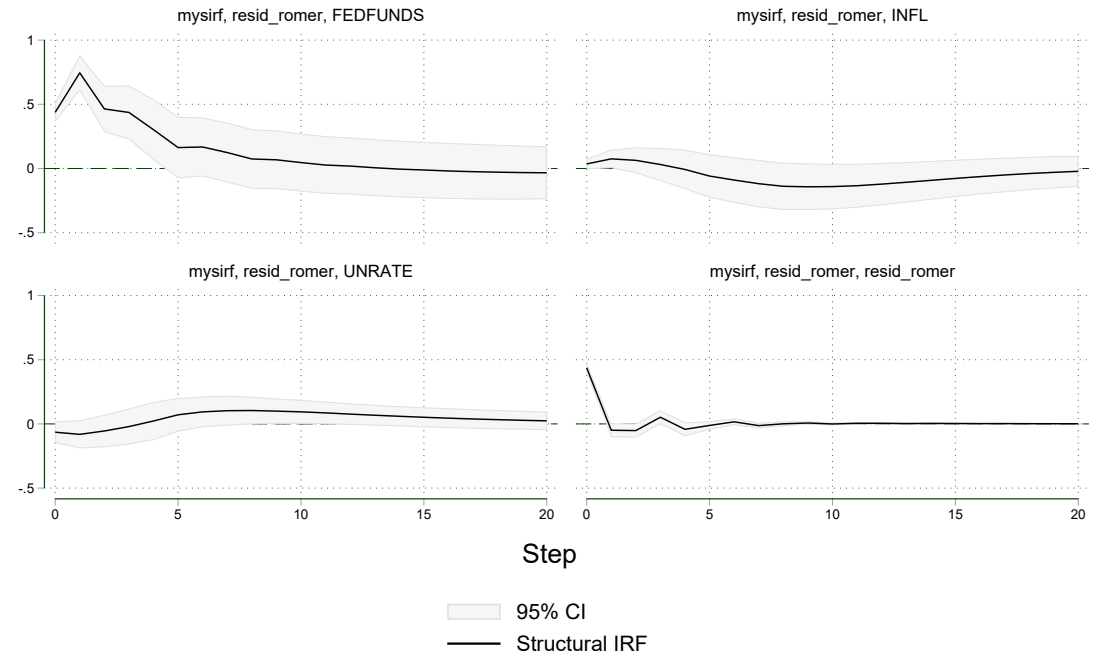


Figure 8: IRF: Impulse of RR_t and Response on RR_t, π_t, u_t, R_t



(d) Briefly, explain why it is sensible to order the Romer shock first in the VAR.

Solution: As explained in 1(d), the structural VAR allows for simultaneous causality. If in 1. we allowed for π_t to affect u_t and R_t contemporaneously but not vice-versa and u_t to affect R_t contemporaneously but not vice-versa; here, with this new ordering, we are allowing RR_t to affect π_t, u_t and R_t contemporaneously but not vice-versa, π_t to affect u_t and R_t contemporaneously but not vice-versa, and u_t to affect R_t contemporaneously but not vice-versa. The assumptions are therefore the same as in 1(d), with the aggregation of the fact that RR_t enters the system, and it does so by being first in the granger direction. This new assumption is sensible, because there are reasons to believe RR_t is exogenous and not anticipated (more on this on the next question), so the claim that it affects other variables contemporaneously but it is itself not caused from them is credible.

(e) Compare the IRFs for the Romer shocks from the two methods. How are they different, and why?

Solution: It is first important to understand what RR residuals are. The original Romer-Romer (2004) shocks, "resid_romer" are the monetary policy shocks based on the original Romer-Romer

(2004) regression. The authors built a series on intended funds rate movements around FOMC meetings, capturing the endogenous relationship between interest rates and economic conditions. Then, they use the Federal Reserve's internal forecasts of inflation and real activity to purge the intended funds rate of monetary policy actions taken in response to information about future economic developments. They regress the change in the intended funds rate around forecast dates on these forecasts. The residuals from this regression are captured by "resid_romer". This serie, therefore, captures changes in the intended funds rate not taken in response to information about future economic developments. It can be claimed that "resid_romer" are monetary shocks free of endogenous and anticipatory actions.

In this context, the correct specification for including an exogenous variable (here, RR_t and its lags) into a system of equations of endogenous variables is adding it as a control to the VAR (2b), not including it in the system as an extra endogenous variable as we did in the SVAR (2c).

The inclusion of this variable (and its lags) in the VAR model allows us to study the response of inflation with respect to those interest rate shocks that were most plausibly exogenous, i.e. RR residual instead of R_t. Figure 6 shows the expected sign, solving the price puzzle reported earlier. Here, a shock in Fed interest rates would cause a decrease in inflation, as would be expected.

As in question 1, the SVAR results vary from the VAR ones most notably in the fact that effects are of smaller magnitude/size. For the three variables analyzed, the IRF graphing their response to RR_t shocks under VAR with controls or SVAR are similar in shape, but smaller in magnitude.

Most notably, in Figure 8 we can observe that the response of inflation to a monetary shock RR_t is not statistically different than 0, and very similar to the IRF of π_t with respect to R_t in Figure 3 (Part 1.d.). This is due to the misspecification of the model. When we add RR_t to the system of equations, we allow for the whole system to respond to it endogenously, complementing and introducing feedback between the endogenous variables and it. Also, we allow for previous values of inflation, fed funds rate and unemployment to impact RR_t which we know should not hold. With respect to this last point, the SVAR does a fairly good job in identifying the Romer Residuals as exogenous because the IRF of any other variable in the model on them is flat (last column Figure 7). However, concerning the first point, the fact that other endogenous variables feedback each other is misleading, as the effect of RR_t on π_t (Figure 8) shows. What is happening here is that while RR_t should decrease inflation, it contemporaneously rises R_t which as stated earlier has a positive effect on inflation. In conclusion, allowing contemporaneous feedback, in this scenario, nets out the effect of the monetary shock on inflation.

(f) Compare the VAR IRFs for the Romer shocks with the VAR IRFs for the SVAR shocks in Question (1d). How are they different, and why?

Solution: In the VAR specification for the Romer shocks, the IRF with respect to RR_t shows a negative response of inflation to a monetary shock, and no significant reaction of unemployment. As for the Fed interest rate, it jumps but then decreases, stabilizing in 7 quarters.

In question 1(d), a shock in R_t produced a decline in R_t, an almost 0 increase in inflation (but no decline) and a small increase in unemployment rate.

This happens because in 1(d) the monetary shock was not necessarily well represented with the R_t shock. Here, in contrast, we use an exogenous series for monetary shock, which is arguably uncorrelated with real variables or anticipation effects, allowing us to control for the omitted variable issue that explains the price puzzle.

(g) Compare the Romer-Romer the identified monetary shocks in 2001Q3 and 2001Q4 with the SVAR identified monetary shocks. How are they similar / different?

Solution: The identified monetary shocks are -1 and -0.9 in 2001Q3 and 2001Q4, while the Romer Shocks were -0.16 and -0.57 in 2001Q3 and 2001Q4. The reason is the Fed updated it's forecast following 9/11, so the predicted monetary policy response in the Romers model can capture a part of these shocks, leaving a smaller fraction to the residual.
More generally, the residuals identified in the SVAR model on question 1 have spikes more frequently associated to recession periods when compared to the R&R shocks. The only negative spike that is associated with a recession is the Volcker recession. This is done in purpose, as Romer and Romer (2004) argue that the Fed's decision of increasing the interest rate was exogenous of real variables at the time, and in fact produced an unemployment spike.

Figure 9: