ECO 328: Three Examples of VARs

These notes discuss three papers that use VARs to estimate the effects of monetary policy, economic uncertainty, and fiscal policy. The final example is the longest because it will introduce u to two additional concepts: the Lucas Critique and forecasting a policy change. We begin with monetary policy:

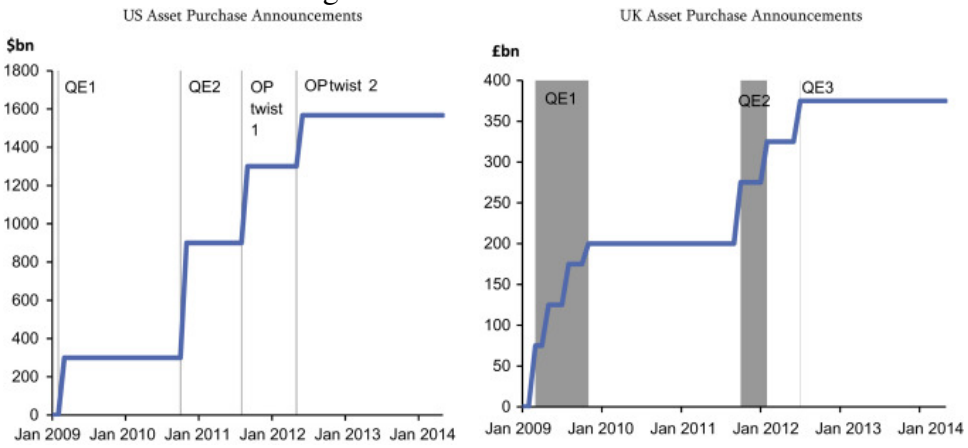
Monetary Policy

Weale, Martin, and Tomasz Wieladek. "What are the macroeconomic effects of asset purchases?." *Journal of monetary Economics* 79 (2016): 81-93.

In Chapter 1, Gali presents some VAR results quantifying the effects of random change to the Federal Funds rate. Here, we will instead focus on non-conventional monetary policy, specifically announcements of large scale asset purchases.

The first question that the authors face is how to measure non-conventional monetary policy. One approach would be to simply use asset purchases themselves. Often, however, in monetary economics, we expect that it is the announcement of policy change, not the policy change themselves, that matter. The authors thus construct two series, one for the U.S. and another for the UK, of asset purchase announcements, divided by GDP.

Figure 1: Asset Purchase data



VAR System: In addition to the asset purchase variable, the authors also include CPI and GDP. To reduce omitted variable bias, the authors also include long-term interest rates and real stock prices. Later, they discuss whether this is sufficient. the data run from 2009m3 to 2014m5, covering the period of quantitative easing following the Global Financial crisis.

Non-Stationarity: The authors are not clear on how they deal with non-stationarity. It is unlikely that they did nothing to address the issue. They may be including cointegrating vectors so that the specification is really a VECM.

Identification: The authors begin by using the same Choelesky decomposition approach that we used in class. They use the following order from most to least exogenous: CPI, GDP, asset purchases, yields, and equity prices. Notice that financial variables are last, implying that these prices may move very quickly. The placement of CPI first is consistent with the ideal of sticky prices. Although we will focus on the results that follow, the authors do discuss a concern:

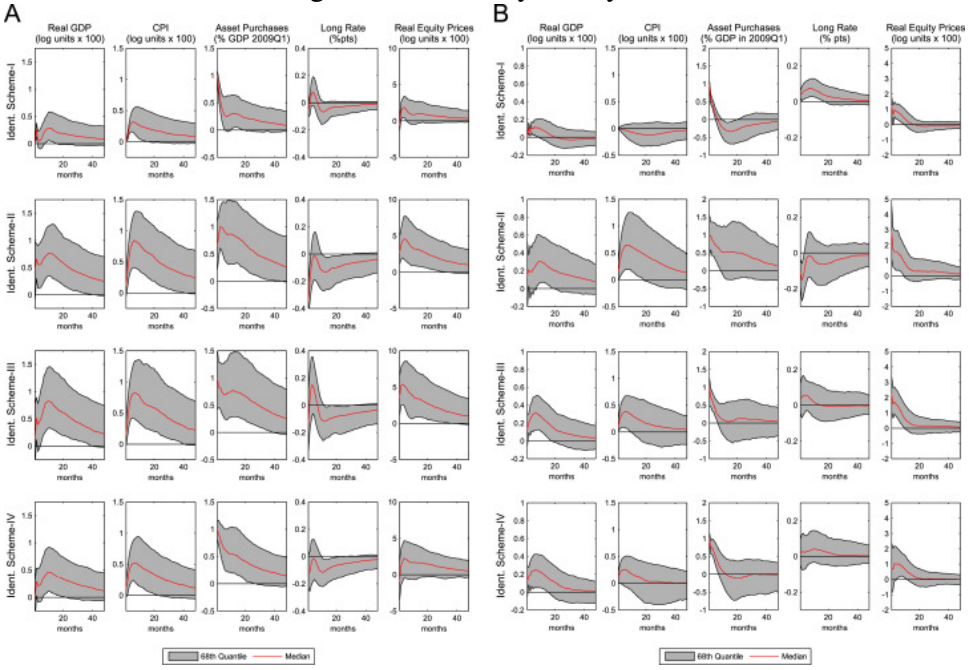
> VAR identification schemes that employ timing exclusion restrictions have been criticized in recent years, on the grounds that such restrictions do not naturally emerge from DSGE models. Canova and de Nicoló (2002), Faust and Rogers (2003) and Uhlig (2005) have therefore proposed identifying shocks by means of the implied signs of the impulse responses that they produce. Clearly, for identification restrictions of this type to be valid, they need to be strongly supported by economic theory.

To address this concern, the authors, as a robustness check, also consider other identification schemes, known as structural vector auto regressions. here, that means using economic theory to impose sign restrictions on the resulting IRFs. Obviously, this would be concerning if the goal of the paper is to test whether the effects are positive or negative. If the goal, however, is more to quantify the effects, then it may be valid.

Results: The main finding is that like, conventional monetary policy, expansionary non-conventional monetary policy boosted output and inflation in both the U.S. and U.K.

An inspection of Fig. 2A and B clearly suggests that regardless of identification scheme, real GDP and the CPI always rise in response to an asset purchase shock. This effect is statistically significant throughout, except for identification scheme I for CPI in the UK. Table A1 in online Appendix A shows the maximum impacts of the median and indicates their significance. For both countries the maximum values for the impact on both GDP and CPI are higher with identification schemes II, III and IV than they are with scheme I. This probably reflects the role that economic theory plays in identifying the effects with these schemes. Averaging across all four schemes, the maximum impact on GDP is 0.58 in the United States and 0.25 in the United Kingdom (Table A1, online Appendix A). The figures for the CPI are 0.62 and 0.32, respectively.

Figure 2: Monetary Policy IRFs



So why was this paper published in a top journal? The theory behind non-conventional monetary policy is not as well developed as that supported conventional monetary policy. This paper thus provides important evidence that it is an effective tool when a Central Bank is stuck near the effective lower bound.

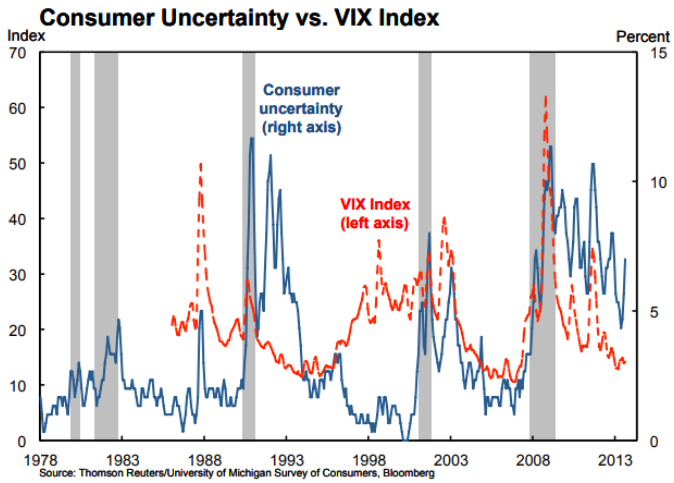
A VAR on Economic Uncertainty

Leduc, Sylvain, and Zheng Liu. "Uncertainty shocks are aggregate demand shocks." textitJournal of Monetary Economics 82 (2016): 20-35.

The next example we consider is the role of economic uncertainty. Event like covid-19 and the war in Iran are examples of events that caused higher uncertainty. The paper's main takeaway is that uncertainty reduced aggregate demand, not aggregate supply. If so, then the main effect of the war in Iran may be deflationary, contrary to conventional wisdom.

Measures of Uncertainty: The authors use two. One is the VIX, a measure of stock price uncertainty calculated through options markets. Te second is a measure of consumer uncertainty taken from a popular survey administered by the University of Michigan. Both are stationary. The VIX starts in 1986. The Michigan survey bagen in 1978.

Figure 3: Measures of Uncertainty



VAR System: The authors also include the CPI, the unemployment rate, and the 3-month Treasury yield. The latter is closely tied to teh Federal Funds rate and may be seen as a measure of monetary policy. because CPI is non-stationary, the authors use the inflation rate instead.

Order: The authors describe their order:

> Thus, we place the consumer uncertainty measure as the first variable in the BVAR model. This Cholesky ordering implies that uncertainty does not respond to macroeconomic shocks in the impact period, but unemployment, inflation, and the nominal interest rate are allowed to respond to an uncertainty shock. In subsequent periods, however, uncertainty responds to all shocks through its relation to the lags of the macroeconomic variables as specified in the BVAR model. Our Cholesky identification strategy here is similar to that in Leduc et al. (2007), Auerbach and Gorodnichenko (2012), and Leduc and Sill (forthcoming).

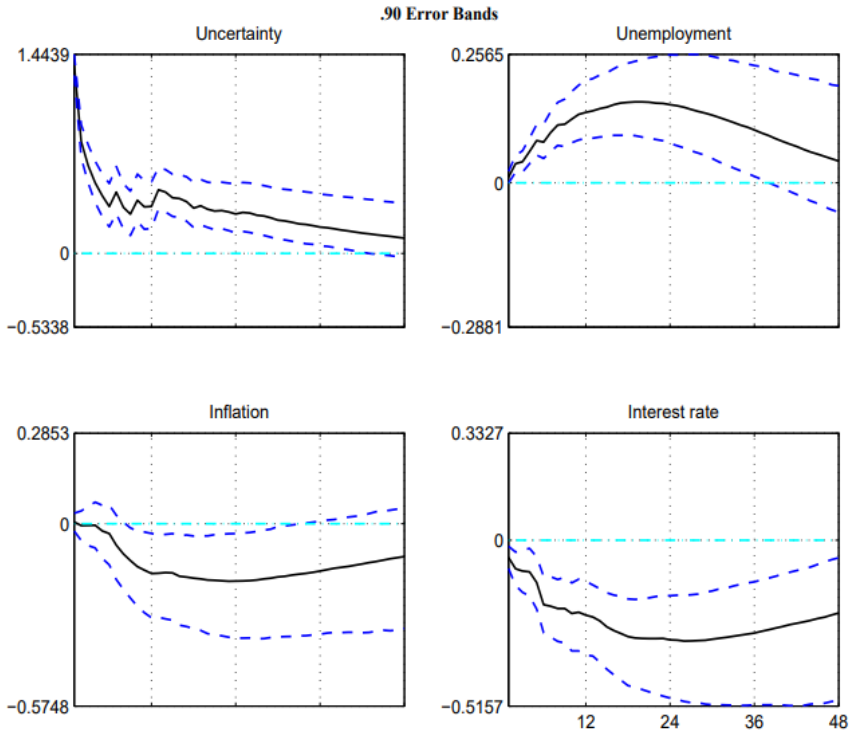
Estimation: The authors are using a Bayesian VAR (BVAR). This is a different way to obtain the basic regression coefficients as opposed to OLS/SUR. With Bayesian estimation, we assume a prior distribution on each regression parameter and then use the data to update these beliefs to obtan a posterior distribution. We will not go into the technical details of how this is done. For this question, i would not expect the results to differ by very much.

Results: The authors find that uncertainty shocks lead to booth loer inflation and lower output. Like increases in the Federal Funds rate, or contractionary fiscal policy, they work to reduce aggregate demand:

> Figure 2 presents the impulse responses in the BVAR model, in which consumer uncertainty is ordered first. For each variable, the solid line denotes the median estimate of the impulse response and the dashed lines represent the range of the 90-percent confidence band around the point estimates. The figure shows that an unexpected increase in uncertainty leads to a persistent increase in the unemployment rate. The increase in unemployment remains significant at the 90-percent level for about three years, with the peak effect occurring about 18 months from the impact period. Heightened uncertainty also leads to a persistent decline in the inflation rate, with the peak effect occurring roughly 20 months from the impact period. The decline in inflation becomes significant at the 90-percent level in about eight months and remains significant for about two years. The rise in unemployment and the fall in inflation suggest that un-

certainty operates through an aggregate demand channel that reduces both economic activity and prices.

Figure 4: IRFs for a Shock to the Michigan Survey



It is not obvious whether uncertainty acts on aggregate supply or aggregate demand. By providing evidence of the latter, this paper made a contribution that allowed it to publish in a top journal.

Fiscal policy

We will follow the March 2004 version of

"Fiscal Policy in the Aftermath of 9/11" by Martin Eichenbaum and Jonas Fisher.[1]

Motivation

[1]Published as Eichenbaum, Martin, and Fisher, Jonas. 2005. "Fiscal Policy in the Aftermath of 9/11," *Journal of Money, Credit and Banking*, vol. 37(1), pages 1-22.

After the terrorist attacks of 9/11/01, the United States implemented a policy of increased government spending and lower taxation. Quantifying the effects of these policies (*.e.g* on GDP and the budget deficit) is important for evaluating the success of these policy changes. In addition, doing so will shed considerable light on many of the policies enacted more recently in response to the Great Recession and covid-19 pandemic.

The main policy in question are the "Bush tax cuts," a series of reductions to income taxes, capital gain taxes, estate taxes, etc. enacted between 2001-2003. In the aftermath of these tax cuts, the U.S. Federal government ceased running budget surplus and began running sizable budget deficits. Policy makers debated whether the tax cuts were largely responsible for these deficits. This paper finds that they were. These tax cuts remained controversial. Eventually some would be made permanent while others would be allowed to expire.

Data and Specification

The authors include the following variables:

1. A deterministic trend. As well established economists, the authors do not discuss the process of testing their data for stationary in great detail. The authors do report that they include a time-trend in their specification. Presumably, this came as a result of unit root testing and the de-trended variables were tested to ensure stationary.

2. The log of per-capita real GDP. As usual, this variable is logged so that the regression coefficient may be interpreted as an elasticity.

3. The log of per-capita real government consumption.

4. The average tax rates on labor (e.g. income taxes) and capital (e.g. capital gains taxes). These variables are not logged because they are already measured as a percentage.

4. The real interest rate. This variable is not logged because it is already measured as a percentage.

5. The surplus to GDP. This figure includes all federal, state, and local debt.

6. Ramey-Shapiro episodes.[2] These represent large and exogenous shocks to government spending. Importantly, they are exogenous to changes in economic conditions. Ramey and Shapiro use a narrative approach to identify such episodes. They find four.

i. 1950:Q3. This represents the immediate aftermath of North Korea's invasion of South Korea that started the Korean War. It is hard to argue that the military expenditures that followed this episode were endogenous both because history clearly shows that the event was unexpected and that the response was motivated by national security, and not macroeconomic, concerns. The authors normalize the size of this shock to 1.

ii.1965:Q1. This date corresponds to the arrival of the first U.S. combat troops in Vietnam. initiating major U.S. involvement in the Vietnam War. The authors normalize the size of this shock to 0.3, representing an increase in defense spending (in terms of % of GDP) that is 30% as large as the shock associated with the Korean War.

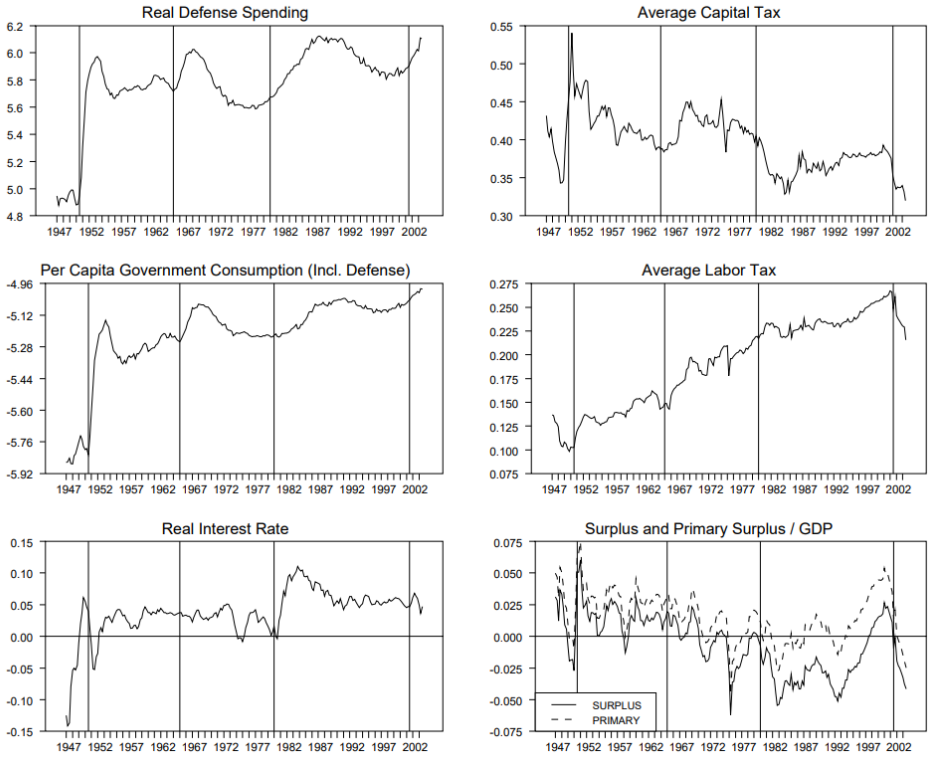
iii. 1980:Q1. This date corresponds to the aftermath of the Soviet Union's invasion of Afghanistan. Although the U.S. did not respond with military intervention, both the Carter and Reagan administrations called for increased defense spending in response. The authors normalize the size of this shock to 0.1.

By isolating these three random and exogenous changes to defense spending, the authors are hoping to identify the effect of such changes on the macroeconomy. Later, they will be interested in using their econometric results to estimate the effect of defense spending initiated in response to 9/11, the fourth Ramey-Shapiro episode.

The econometric methodology is a VAR. We could also attempt to answer this question by using a VAR with just government spending and making a defensible choice about the ordering of the variables. But using the Ramey Shapiro episodes simplifies this process because they appear to be truly exogenous events, they are not a response to any of the other variables in the system.

[2]Taken from: Ramey, V. and M.D. Shapiro. 1998. "Costly Capital Reallocation and the Effects of Government Spending," *Carnegie Rochester Conference Series on Public Policy*, vol. 48: 145-94.

Figure 5: Ramey-Shapiro Episodes



The authors' results are only valid if we agree with their interpretation of i-iii. A look at the data in Figure 1 is worthwhile. Note the following:

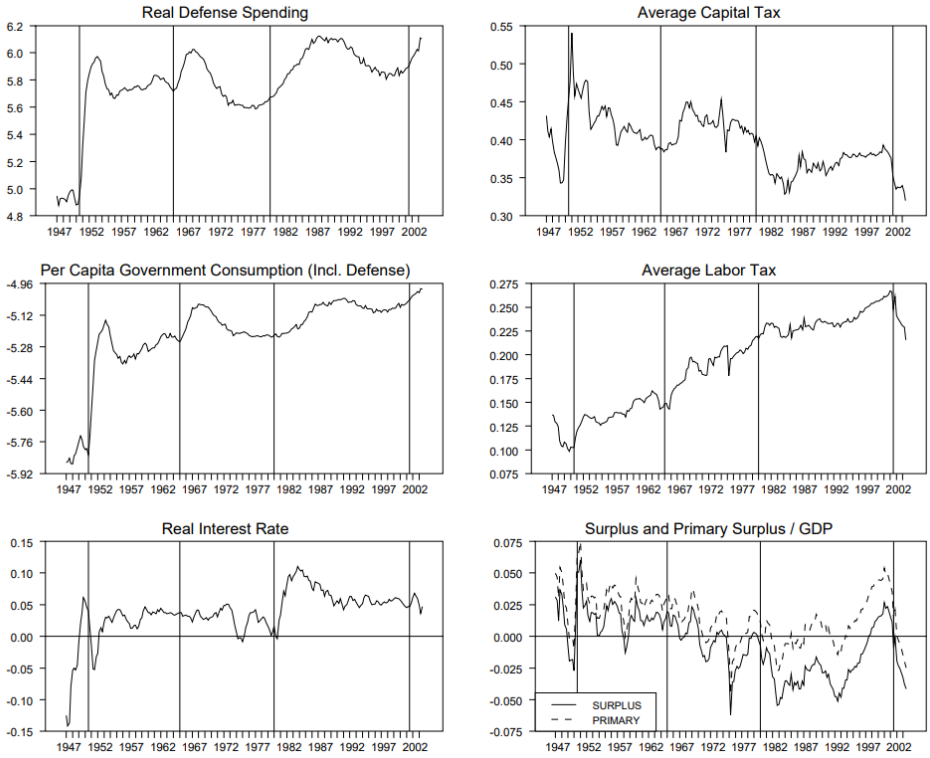
(1,1) and (2,1): In each graph, the vertical lines represent the Ramey-Shapiro episodes. Note that defense spending increases sharply after each of them, especially Korea and Vietnam, This helps make the case that these were unanticipated changes.

(3,1): There does not appear to be a consistent increase in real interest rates following the R-S episodes. This is interesting because conventional theory predicts that increased government spending increases real interest rates and "crowds out" private investment.

(1,2) and (2,2): After the first three R-S episodes, labor taxes rise. Capital taxes also rise after the first two. This pattern is not seen after 9/11 when both types of taxes fall.

(3,2): The surplus/GDP ratio does not fall after the first two R-S episodes. Note that the surplus

Figure 6: Ramey-Shapiro Episodes



falling is the same as the deficit rising. The surplus/GDP ratio does fall faster the last two.

The authors employ the information criteria of Sims (1980) to select a lag length of 6.[3] Their specification thus takes the following form:

$$Z_t = A_0 + A_1 t + A_2(t \geq 1973Q2) + A_3(L) + \sum_{i=1}^{3} A_4(L)\phi_i D_{it} + u_t \tag{1}$$

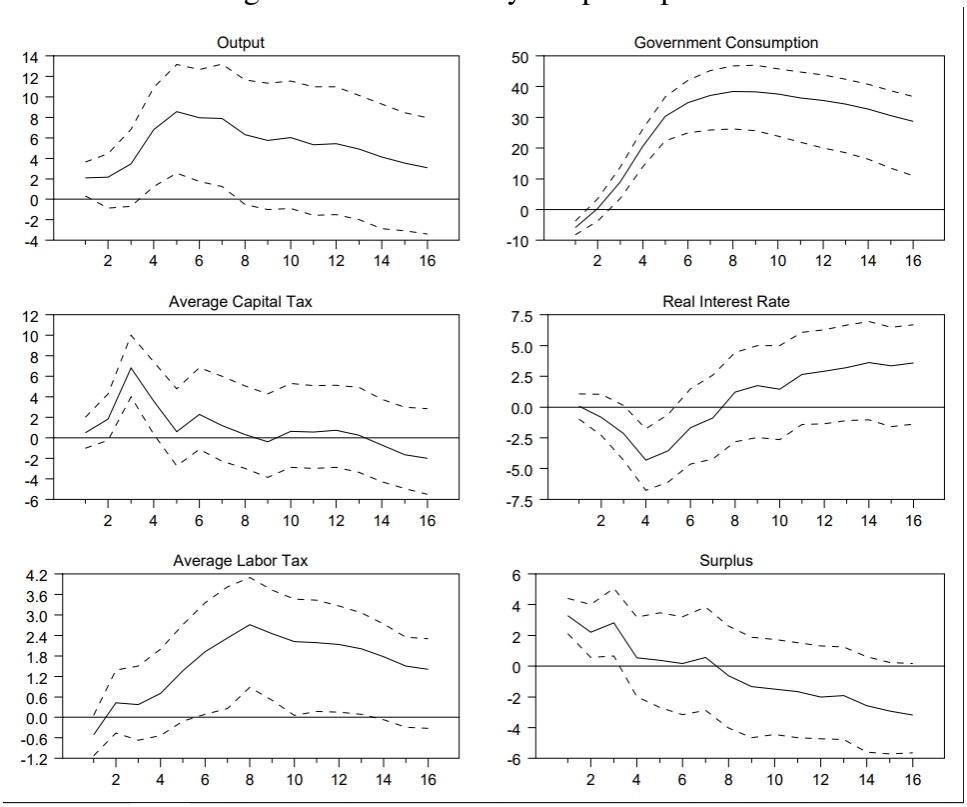
There are a few other features worth mentioning. First, the authors include a vector of dummies for after 1973:Q2. This time is often cited as being the start of a period of decreased productivity growth that had important macroeconomic effects. Footnote 1, however (see page 5), mentions that this has little effect on the results. The ϕs represent the weights on R-S episodes and the authors impose three lags of R-S episodes.

IRFs

[3]This paper will hurt your brain: Sims, C. 1980. "Macroeconomics and Reality, Econometrica." vol. 48: 1-48.

Given (1) estimation is done as described in class. Figure 3 then reports the IRFs. These represent the response to the economy of a Korea War sized shock to defense spending.

Figure 7: IRF to Ramey-Shapiro Episodes



(1,1): Output rises by about 6% after about one year. The effect remains large for several years and is statistically significant for two years at the 95% confidence level. This is a large effect. Keep in mind, however, that this was a very large shock. The effect of Vietnam would be 30% of this (because the authors' econometric model is linear, we need only scale the results).

(2,1): Government consumption (including defense) increases by about 35% after two years. It is still very high after 4 years. R-S shocks are highly persistent. This makes since given the length of the two wars and the Carter-Reagan defense buildup.

Table 1: The prior two results allow us to calculate an estimated government spending multiplier (the change in output over the change in government spending). After 1 year, this is 0.61, after two

years, it is 0.28, after 3 years it is 0.21, and after four years, it is 0.19. These estimates are roughly in line with many other estimates of the government spending multiplier.

To see why this result is important, consider a recent example. In 2009, Congress passed and President Obama signed the American Recovery and Reinvestment Act, a major policy response to the Great Recession. This act included about $500 billion in new spending, in addition to tax cuts. We can use these results to quantify the effect of this bill. At peak, a $500 billion increase in spending will increase output by about $300 billion after one year. To place this figure in context, GDP fell by about $450 from peak to trough in the Great Recession. This is not a bad starting point, but we should consider some caveats:

i. It assumes that the economy's response to a random military event is the same as that to the stimulus package. There are a few reasons why this may not be the case. First, R-S episodes largely consisted of increased defense spending while the ARRA did not. Second R-S episodes did not occur in the middle of a severe recession like the ARRA did.

ii. It assumes that all ARRA spending occurred at once. This is inaccurate. A more careful analysis would have to examine when the spending occurred and not just when the bill was enacted.

(2,1) and (3,1): Both types of tax rates increase after the R-S episode. Capital taxes increase by about 6% while labor taxes increase by about 2.7%. The authors thus characterize tax increases as a "normal" response to a R-S episode. The government thus seems to be trying to pay for military expenditures in real time.

(3,2): The surplus initially rises by about 3% of GDP. To provide some context, recent deficits of about 10% are the largest in recent history while a 3% deficit is considered approximately sustainable. This increase occurs because tax rates rise faster than government spending. The latter is, however, ultimately larger and by about 3 years out, the surplus has fallen by about 2% of GDP.

(2,2): Real interest rates initially fall and then rise. As predicted by theory, they are inversely related to the surplus.

Issues from Estimation

Footnote 6 (page 8) illustrates an interesting econometric issue. The authors report that they bootstrap their IRF confidence intervals using the method of Edelberg, Eichenbaum, and Fisher (1999).[4] But this approach assumes that the dates of the R-S episodes are correct with 100% confidence. If there is uncertainty about these dates, then the confidence intervals from Figure 3 will be misspecified, most likely being too narrow.

The authors solution to this issue illustrates a common way to conduct research. Rather than tackle it directly, they cite Edelberg, Eichenbaum, and Fisher (1999) as showing that this issue does not typically make a difference. It is then up to the reader (and referees and editors), of course, to decide if this is satisfactory.

The authors then ask if the policy response is "unusual." Here, they are defining usual as consistent with their econometric results from the first three R-S episodes. To do this, they start by imputing initial conditions for (1) that are consistent with 2001:Q2 data. They then hit the economy with a R-S episode equal to 0.1 (the size of Afghanistan and one-tenth the size of Korea). Figure 7 plots three scenarios:

1. The solid line based on the actual data.

2. The long dashed line is the forecasted response with the R-S episode.

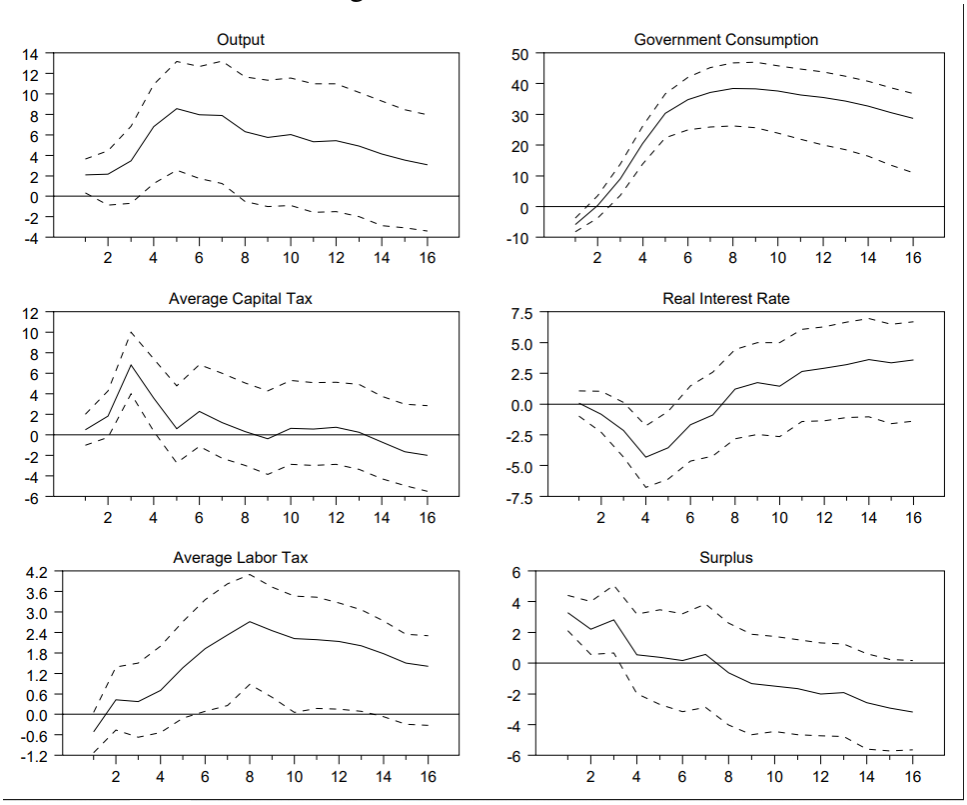
3. The short dashed line is the forecasted response without the R-S episode.

(1,1): Government spending rises in a manner predicted by the model. This suggests that spending policy was fairly typical (relative to past R-S episodes).

(1,2): Output's response is also fairly typical although the actual data display a decrease about 2002 that suggests the real economy was hit with another shock (which is not be part of the forecasts).

[4]Edelberg, W., M. Eichenbaum and J. Fisher. 1999. "Understanding the Effects of Shocks to Government Purchases." *Review of Economics Dynamics*, vol. 2: 166-206.

Figure 8: Counterfactuals



(2,1) and (3,1): Typical policy suggests that the U.S. respond to the R-S episode by increasing taxes on both capital and labor. This did not happen. Instead, actual policy was unusual in that the economy responded by dramatically lowering taxes on both. These are the Bush tax cuts of 2001-03.

(3,2): Under typical policy, changes to the surplus would have been small. But the actual policy (lower taxes) resulted in a deficit of about 4% of GDP by 2003.

(2,2): Real interest rates fall whereas under typical policy they would be expected to rise, This is likely due to monetary policy that is controversial for other reasons.

Collectively, these results suggest a major shift in fiscal policy around 2001. Prior to 2001, the U.S. seemed to to have a passive fiscal policy where higher deficits necessitated higher taxes. Policy after 2001 appears much more active in that deficits do not cause higher taxes.

Lucas (1976)

The authors now seek to address two interesting questions. First, what would have happened to the economy had the U.S. pursued the usual policy of raising taxes in response to the R-S episode. Second, what would have happened to the economy had the U.S. kept taxes unchanged in response to the R-S episode.

These questions cannot be answered using econometrics alone. To understand why, we need to understand one of the most important results in the history of both time series and macroeconomics, the Lucas Critique (1976).[5] To examine this issue, we will temporarily deviate from the current paper to examine this issue in a theoretical model.

We will examine two models. The first is an old model, known as IS/LM. It consists of two equations, an IS curve and an LM curve:

$$y_t = \alpha - \beta r_t + g_t \tag{2}$$

$$y_t = \gamma + \omega r_t + e_t \tag{3}$$

where all parameters are greater than zero and, crucially, they are assumed to be exogenous to policy. The term g_t is government spending. The term e_t is an error term.

Substitution yields:

$$y_t = \frac{\alpha + \frac{\gamma\beta}{\omega} + \frac{\beta}{\omega}e_t + g_t}{1 + \frac{\beta}{\omega}} \tag{4}$$

which may then be estimated:

$$y = a + bg_t + u_t \tag{5}$$

The regression coefficient is then our estimate of the fiscal multiplier. If it is unbiased then:

[5]Lucas, R. 1976. "Econometric Policy Evaluation: A Critique." In Brunner, K.; Meltzer, A. The Phillips Curve and Labor Markets. *Carnegie-Rochester Conference Series on Public Policy*. pp. 19-46.

$$E[b] = \frac{1}{1 + \frac{\beta}{\omega}} \tag{6}$$

If the IS/LM model is the true data generating process, then it is straightforward to obtain and exploit an estimate of the fiscal multiplier.

The Lucas Critique applies when expectations matter. Consider the Geno Smith Model[6]. In this model, only unexpected government spending affects output.

$$y_t = \kappa + \delta(g_t - E_{t-1}[g_t]) + e_t \tag{7}$$

Further suppose that government spending is set according to:

$$g_t = \tau + v_t \tag{8}$$

In words, government spending is a constant plus a white noise, mean zero error term. Equations (7)-(8) are known as the structural model because it includes a non-observable (expectation). If agents are rational, then they know that (8) is how fiscal policy is conducted. It is thus rational to expect:

$$E_{t-1}[g_t] = \tau \tag{9}$$

Inserting (9) into (7):

$$y_t = \kappa + \delta(g_t - \tau) + e_t = \kappa - \tau\delta + \delta g_t + e_t \tag{10}$$

Equation (10) is known as the *reduced form* of the model, meaning that it does not depend on non-observables. Note that the structural and reduced forms of the IS/LM model are the same.

which may then be estimated:

$$y = a + bg_t + u_t \tag{11}$$

[6]This is a variation of Lucas's model, modified for fiscal policy as opposed to monetary policy

Note that (5) and (11) are the same. The two structural models are thus said to be *observationally equivalent*, meaning that any econometric specification can be applied to either of them.

Suppose that this latter model is the true data generating process. Consider the following exercise:

1. Policy makers fail to understand that the regression coefficients from (11) depend on τ. Perhaps they believe that the IS/LM model is the true data generating process.

2. They this mistakenly believe that:

$$E[\frac{\partial y_t}{\partial \tau}] = b \tag{12}$$

3. If (11) is unbiased, then $E[b] = \delta$.

4. Policy makers thus believe that the fiscal multiplier is δ.

5. In reality, the regression parameter a also depends on τ, $E[a] = \tau\delta$. When τ increases by 1 unit, a decreases by the same amount, in expectation. This perfectly offsets the effect from #4. To see this, substitute (8) into (10):

$$y_t = \kappa + \delta v_t + e_t \tag{13}$$

This shows that the true multiplier is zero.

In general the Lucas Critique states that if regression coefficients depend on policy parameters, then changing the policy will change the regression results. If policy A generates result A, then these results will be biased if applied to policy B.

Forecasting: With and Without a Policy Change

Based on the Lucas Critique, we can breakdown forecasting into two types. The first is forecasting without a policy change. We must ask: do our regression coefficients depend on policy

parameters? And if so, are these policy parameters changing in this simulation. There is no econometric test for this, We must rely on economic intuition and theory. If the answer to either question is no, then forecasting is easy. We need only iterate our VAR forward as we have done in the examples from class.

If the answer to both questions is yes, then we cannot use our econometric results to directly forecast else we walk into the Lucas Critique. our regression coefficients will change along with the policy and will become biased. As a result, forecasting is hard. The following process is generally employed:

1. Write down a theoretical model that allows you to conduct the policy change.

2. Fit the theoretical model to the data for the period where you have data (*i.e.* before the policy change).

3. Conduct the policy change in the fitted theoretical model. Report the results.

4. Defend the model's relevance to the post policy change period.

Perhaps no area in economics falls closer to the junction of empirics and theory than forecasting policy changes. When organizations like the Federal Reserve or Congressional Budget Office forecast the effects of policy changes for which there are no data, they typically employ this methodology.

Back to Eichenbaum and Fisher

The authors refer to the Lucas Critique on page 12: "We cannot answer this question using purely statistical models of the sort discussed above because the experiments we wish to contemplate amount to a change in policy. Standard Lucas critique reasoning says we can only conduct this type of experiment in an economic model." They thus proceed to develop a theoretical model. We will not delve deeply into this model. Here are a few of its traits.

1. It is a type of Real Business Cycle Model. Here utility maximizing households choose their levels of labor supply and consumption subject to a budget constraint. Likewise, firms maximize profits subject to a production function.

2. Prices (including wages) are flexible. As a result, monetary policy has no effect on output or employment. This limits the appeal of the results to macroeconomists who believe that sticky prices are important to understanding the effects of fiscal policy.

3. The model is calibrated. This means that numerical values are inserted for general parameters. For example, household are assumed to be indifferent between 1 unit of utility next period (3 month) and 0.99 units today.

Figure 8 demonstrates the theoretical IRFs. If these results are similar to those of Figure 3, the empirical IRFs from the pre-policy change period. They clearly do quite well in matching the responses of real interest rates, output, and the surplus to a R-S episode.

Again note that the authors have chosen their calibration (numerical values) to yield a good match between the empirical and theoretical IRFs.

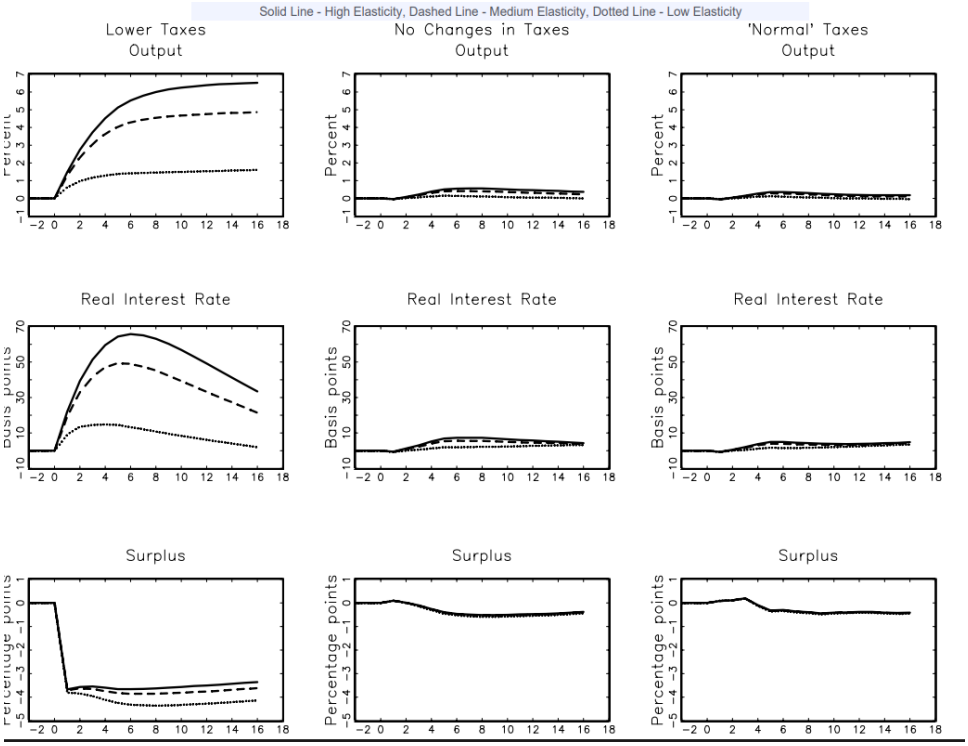
Alternative Policies

Figure 9 displays the forecasted effects of alternative tax policies. There is considerable debate about how elastic labor supply is to changes in the wage. The authors thus report three values. We will focus on the middle value. The simulations consider a R-S episode equal to 0.1.

The authors report three cases. The first column imposes actual (policy change) tax rates into the theoretical model. The second imposes no tax changes (also a policy change). The third imposes the normal tax change, which implies increases to both labor and capital taxes. Because the latter two cases yield similar results, I will focus on the first and third cases.

Row 1: Increased government spending yields a small increase in output under "normal policy." Under the lower tax policy, however, output increases by about 4%. This is consistent with most

Figure 9: Simulation Results



macroeconomic theory. Lower taxes stimulate labor supply which increases output. Note that standard Keynesian type effects are not present here, increasing aggregate demand does not have any effect because this model is non-Keynesian. The effects are entirely through the (labor market) supply side. As a result, they are long lasting, not wearing off after 4 years.

Row 3: Under normal policy, the surplus (deficit) declines (increases) by about 1% after 1 year. Under the lower tax policy, it decreases by about 4%. This result suggests that the vast majority of higher deficits after 9/11 came from neither increased spending nor reduced output, but from a change in policy toward lower taxes.

Row 2: Due to small effects on the surplus, the effect on real interest rates under normal policy is small. Under the lower tax policy, however, real interest rates rise by about 50 basis points (0.5%). This acts to dampen the expansionary effect on output and amplify the effect of increased debt.

Conclusions

This paper is a piece of applied work. It requires enough knowledge of time series to run VARS. It requires enough theory to write down a theoretical model, fit it to the data, and simulate policy changes.

Many other papers address similar questions as this one. Its main findings: a fiscal multiplier about 0.6 at peak, and that the 2001-03 tax cuts increased the deficit by about 3% are consistent with the bulk of the literature.