The Generalized Cochrane Critique, Interest Rate Endogeneity, and the Price Puzzle

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Abstract

In this paper, I explore the Cochrane critique and its implications for empirical macroeconomics.

1 Introduction

In simplest terms, the Cochrane critique of the Taylor rule, outlined in Cochrane (2011), is thus: if monetary policy was perfectly set such that the Fed was always achieving its goal variables, the coefficients on the inflation and output gaps would be zero. In this paper, I argue that the Cochrane critique is a problem to all empirically estimated economic models of monetary policy. The reason is because, in recent decades, monetary authorities have become better at setting policy to achieve goal variables, such that interest rates have become more endogenous.

For example, Willis and Cao (2015) ask, "Has the U.S. Economy Become Less Interest Rate Sensitive?" It is possible that the answer to this question is yes, that the U.S. economy has become less interest rate sensitive. It is also possible that monetary policy has simply become better at achieving its employment objective. Imagine a monetary authority that exclusively targets the unemployment rate. In every period, the monetary authority sets the interest rate such that it will achieve its employment objective. Interest rate movement would then be completely endogenous, and the 'relationship between interest rates as an impulse and employment as a response would break down.

This could also be an explanation for the price puzzle often encountered in the monetary shock literature. It is possible that monetary authorities only tighten policy during periods when inflation is expected to rise, and loosen policy only when inflation is expected to fall. Monetary authorities may not be perfect at achieving their inflation target, allowing for wiggle room, such that rising interest rates do not completely offset rising inflation. Within the context of a model that allows monetary authorities wiggle room for their inflation objective, this could naturally result in an observation that higher interest rates Granger cause higher inflation. Later in this paper, we will observe various models of monetary shocks that encounter a price puzzle, and separate the observations into separate time periods. Invariably, the price puzzle is more pronounced in more recent data.

2 A quick review of the literature

Monetary policy shocks and the price puzzle are some of the most widely studied topics in macroeconomics, and most of the things I have done in this paper have been done previously by other authors. Christiano et al. (1999) is the seminal paper in the monetary shock literature, establishing the general form of how monetary shocks have been calculated ever since.

Boivin et al. (2010) use a factor-augmented VAR (FAVAR) to explore many of the issues I will soon explore. First they confirm that real GDP was more responsive to interest rate innovations in the pre-1979Q3 period than in the post-1984Q1 period. The time-varying nature of monetary policy is also confirmed in ?? (fau).

Second, Boivin et al. (2010) find that in a standard VAR, the price puzzle is very sensitive to model specification. The inclusion of the commodities price index did not solve for the price puzzle, but a measure of inflation expectations did. Their FAVAR did not encounter a price puzzle.

3 Models of monetary policy shocks

3.1 A simple VAR approach

In this section, I observe a simple VAR model of monetary policy shocks of the form:

$$\mathbf{y_t} = \alpha + \sum_{n=1}^{p} \mathbf{A_n} L^n \mathbf{y_t} + \epsilon_\mathbf{t}, \tag{1}$$

$$\mathbf{y_t} = \begin{pmatrix} ln(\text{Industrial Productivity}_t) \\ ln(\text{CPI}_t) \\ ln(\text{Commodity Price Index}_t) \\ \text{Fed Funds Rate}_t \end{pmatrix}. \tag{2}$$

With $p = 12$ lags (monthly). The parameters are estimated using a Cholesky decomposition of the residuals in the given order of the $\mathbf{y_t}$ matrix outlined in equation (2). This model is estimated three times, using three different samples in line with the structural break assumed in Willis and Cao (2015):

1. 1969,M1–2007,M12
2. 1969,M1–1984,M12

3. 1985,M1–2007,M12

Orthogonalized impulse response functions (OIRFs) from these samples are included in Appendix A.

The price puzzle is more pronounced in the most recent sample than in the whole period of 1969-2007. The price puzzle barely exists in the period of 1969-1984: in the very short-term, prices seem to rise, and then fall in the long-run. This very immediate short-run increase is not a concern if we consider that monetary policy operates with lags.

3.2 Proxy SVAR with narrative shocks as an instrument

A proxy structural VAR (PSVAR) is a relatively new concept in econometrics, developed independently both by Stock and Watson (2012) and Mertens and Ravn (2014). The idea is to use an external data series, Z_t, which can be calculated from a DSGE model, a narrative, or any other series of data developed outside of the model. So long as this series is not orthogonal to the relevant structural shocks ϵ_t^m (in other words, $E(Z_t \epsilon_t^m) \neq 0$), and is orthogonal to other shocks, it can be used as an instrumental variable to identify the relevant shocks. I use the methodology outlined in the unpublished appendix to Mertens and Ravn (2014) to solve for the PSVAR. The MATLAB code I use that solves for the PSVAR is provided by Ramey (*forthcoming*). For the model in this section, I take the model from Section 3.1 and incorporate the monetary policy shocks from Romer and Romer (2004) as the instrumental variable. To solve for the PSVAR, the order of the VAR can change such that the relevant variable is first, not last. In fact, one of the primary benefits of the PSVAR is the fact that the Cholesky ordering is not needed–this allows for contemporaneous responses of other variables to the fed funds rate.

The relevant equation we need to solve is:

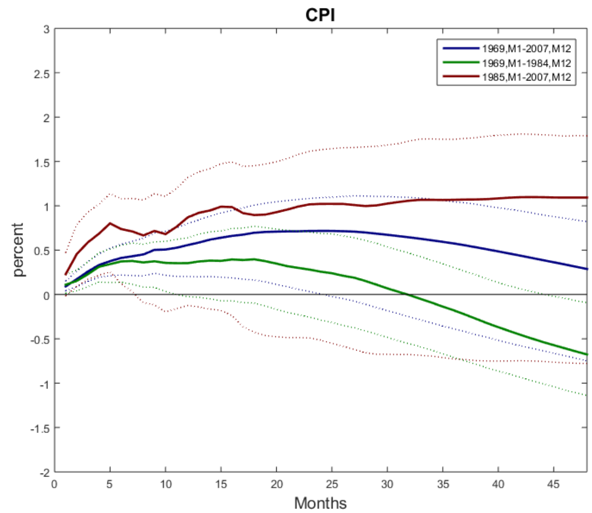

Figure 1: Response of CPI to fed funds rate innovations, calculated with a proxy SVAR using Romer and Romer (2004) narrative shocks as an instrumental variable.

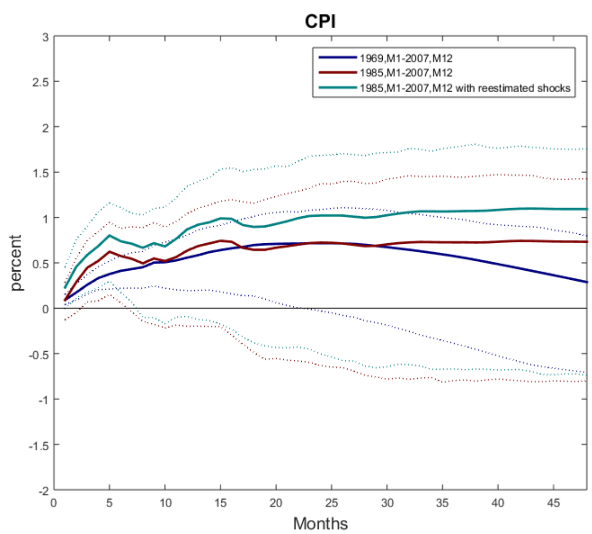

Figure 2: Response of CPI to fed funds rate innovations. Coefficients of the narrative shocks for the 1985-2007 period are reestimated and shown in the teal line.

$$u_i = \widetilde{\theta}_{X-i} u_{x-i} + \sigma_i \epsilon_i \tag{3}$$

Where u_i is the residual of the reduced form VAR for the fed funds rate, u_{x-i} is the VAR residuals for the additional variables, and ϵ_i is the external shock series from Romer and Romer (2004). First u_{x-i} regressed onto u_i using the externally defined series as the instrument (Z_t). The 3×1 residual vector of this regression, defined v_{x-i}, is then used as an instrument for the reverse calculation, i.e. the regression of u_i onto u_{x-i}, and the resulting 1×1 residual is defined v_i. Note that this equation gives us an unbiased estimate of $\widetilde{\theta}_{X-i}$. Then, the scalar σ_i can be solved for using the variance of v_i. Once we have solved for equation (3) and also a similar equation for u_{x-i}, the IRF is then relatively straightforward to calculate using standard methodology.[1] The results of this exercise, separated into three different samples, are provided in figure 1 as an impulse response function.[2]

Because of the possibility of a structural change in the Volcker era, I use the Romer and Romer (2004) series with reestimated shocks for the later sample period; the reestimated shocks come from Ramey (*forthcoming*) for the period from 1983-2007, which is sufficiently close enough to the sample periods considered by Willis and Cao (2015). Unfortunately this doesn't help solve the price puzzle; in fact, the results produce an even larger price puzzle than the original coefficients, as seen in figure 2.

[1] Mertens and Ravn (2014) note that no additional identifying restrictions are needed because by design due to the specifics of how the variables respond contemporaneously to one another.

[2] Interestingly enough, by necessity the unorthogonalized IRF is equal to the orthogonalized IRF because σ_i is a scalar, so the lower triangular matrix of the Cholesky decomposition of σ_i is simply $\sqrt{\sigma_i}$. If the externally defined shocks were being instrumented onto multiple variables in the VAR, then orthogonalization of the innovations in the IRF would be relevant.

4 What's going on?

In a blog post from 2012, Nick Rowe[3] describes the problem succinctly with a metaphor:

> *Everybody knows that if you press down on the gas pedal the car goes faster, other things equal, right? And everybody knows that if a car is going uphill the car goes slower, other things equal, right?*
>
> *But suppose you were someone who didn't know those two things. And you were a passenger in a car watching the driver trying to keep a constant speed on a hilly road. You would see the gas pedal going up and down. You would see the car going downhill and uphill. But if the driver were skilled, and the car powerful enough, you would see the speed stay constant.*
>
> *So, if you were simply looking at this particular "data generating process", you could easily conclude: "Look! The position of the gas pedal has no effect on the speed!"; and "Look! Whether the car is going uphill or downhill has no effect on the speed!"; and "All you guys who think that gas pedals and hills affect speed are wrong!"*

In all of the models above, the problem is simply that monetary policy has become more effective at targeting its goal variables (such as inflation), leading the models to produce unintuitive results even when ostensibly controlling for future expectations via a commodity prices index.

Cochrane (2011)'s critique of the Taylor rule actually applies to the VAR and PSVAR analyses applied before in this paper:

[3] http:worthwhile.typepad.com/worthwhile_canadian_initi201207why-are-almost-all-economists-unaware-of-milton-friedmans-thermostat.html

> *There is no basis for all the obvious devices, such as excluding variables from the policy rule, using instruments, assuming that the right-hand variables of policy rules are orthogonal to the disturbance, or restricting lag length of disturbances. (Lag-length and exclusion restrictions as approximations are not a big problem; restrictions to produce identification are.) Not only might these problems exist, but theory predicts that most of them do exist.*

Despite doing all of the things that Cochrane lists as "obvious devices," the models outlined in this paper fail to consolidate empirical data with the obvious implications of what tightening monetary policy should do to inflation. The price puzzle is an obvious aberration with respect to how monetary policy seems to work in the real world: at the threat of higher inflation, the Federal Reserve will increase interest rates more than 1-for-1 with the increase in inflation. Taken literally, the price puzzle would imply explosive inflation if the Fed pursued such a policy: higher inflation would cause the Fed to increase interest rates, which would then cause higher inflation.

The evidence seems to suggest that Cochrane's critique can be generalized to all macroeconomic models of monetary policy, not just the Taylor rule. The appeal of vector autoregressions with a broad basis of macroeconomic variables is that they are relatively simple to calculate, but in the words of Cochrane (2011), they disregard the "edifice of theoretical coherenceexplicit underpinnings of optimizing agents, budget constraints, clearing markets, and so forth that is the hallmark achievement of the new-Keynesian effort."

The biggest and most obvious critique of a model of monetary shocks is the untenability of estimating it using empirical data. But if standard models even with their bells and whistles cannot consistently avoid the price puzzle, these models are untenable in their results, which is arguably no more useful than models that are untenable in their parameterization. In each case, the models do not work well.

There is however another much easier solution: incorporate expectations of every single variable. Gertler and Karadi (2015) use high frequency identification on fed funds futures in their model of monetary policy shocks, using that as an instrumental variable in their PSVAR. They do not encounter a price puzzle.

The natural extension of this is to incorporate *more* expectations in our models. The expected path of GDP, inflation, and the fed funds rate, in tandem at any period t, create a benchmark not only for surprise movements in the fed funds rate, but whether these surprise movements result in surprise movements in output and inflation. To be clear, there are still endogeneity issues with this sort of model–for example, if the monetary authority consistently hits goal variables but markets incorrectly predict the instrument level, then a simple version of this model would predict that monetary policy shocks (defined as the deviation between expected and actual interest rates) would have no effect on output. This is actually not a significant issue with modifications: such a model could instead distinguish between the markets' misinterpretation of the monetary policy reaction function and actual effects of the monetary policy shock.

Unfortunately, data on market expectations are incredible scarce at the moment, with only a few proxy series such as BlueChip estimates. In order to study this further, there is a case for more liquid macroeconomic aggregate futures markets to be made.

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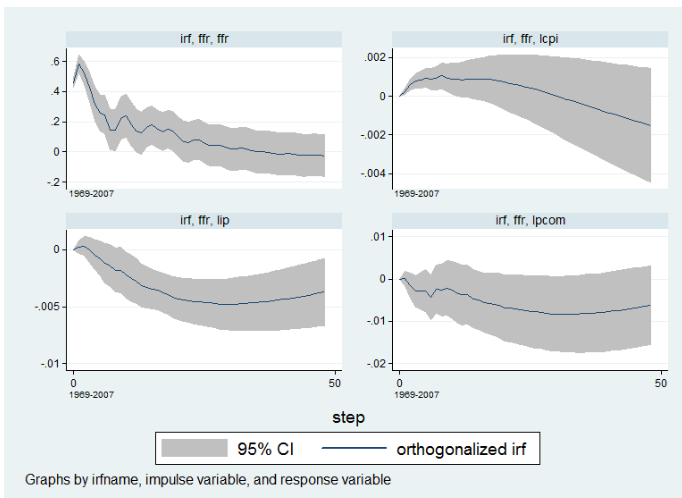
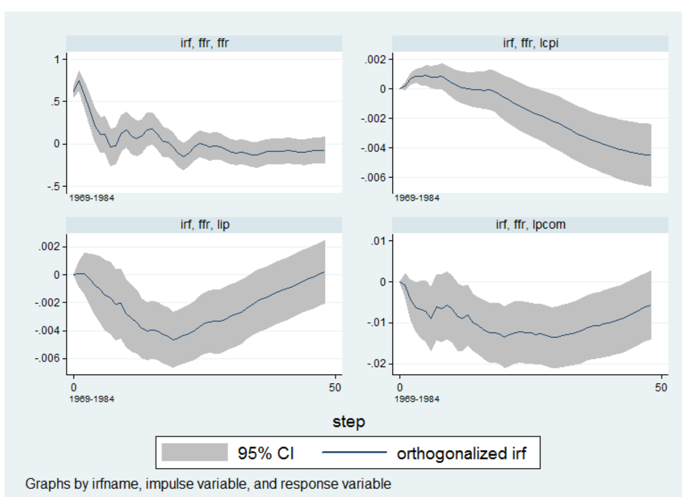
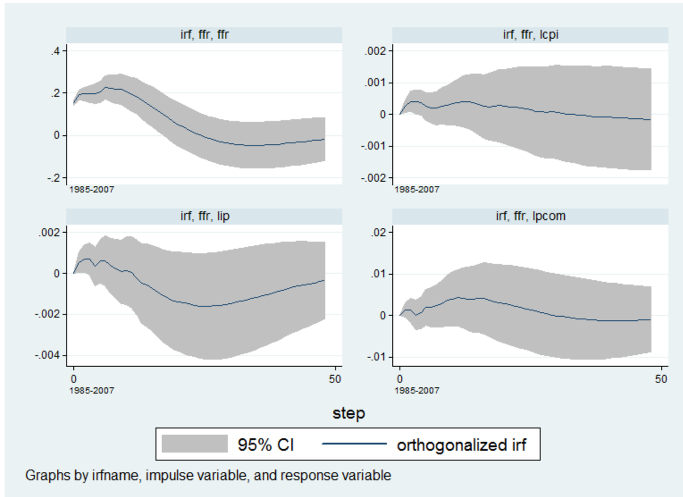
Appendix A: OIRFs from Section 3.1

The impulses in each OIRF is the fed funds rate, and the responses are, clockwise from the top-left corner: the fed funds rate, log CPI, log industrial productivity, and log commodity price index.

The OIRFs are respectively for the periods: 1969,M1–2007,M12; 1969,M1–1984,M12; and 1985,M1–2007,M12.






irf, ffr, ffr
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1985-2007
step
95% CI
orthogonalized irf
Graphs by irfname, impulse variable, and response variable