



# Using private forecasts to estimate the effects of monetary policy<sup>☆</sup>

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## ABSTRACT

I develop a methodology that uses the forecasts of market participants and of policy makers to estimate the effects of monetary policy on output and inflation. My approach has advantages over the standard practice of fitting a vector autoregression to the data. I apply my methodology to data on output, interest rates and prices. I find that, even using the Federal Reserve Board's Greenbook forecasts to control for the policy maker's information set, prices rise initially in response to a monetary contraction. This finding undermines the standard justification for including an index of commodity prices in VARs.

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## 1. Introduction

Questions concerning the effect of monetary policy on output and inflation lie at the heart of macroeconomics. The key step in any analysis of the monetary transmission mechanism is the identification of exogenous shocks to monetary policy. In this paper, I use the forecasts of market participants to estimate the effects of monetary policy on output and inflation.

Current practice involves fitting a linear model, called a vector autoregression or VAR, to the data and identifying monetary shocks off of the model's forecast errors. Sims (1980) introduced VARs to empirical macroeconomics. At the time, he was troubled by the "incredible" identification assumptions made by large scale macroeconomic models. In their place, he proposed regressing each of a set of variables on its own lags and lags of the other variables. The main advantage of this approach was that it could capture very complex patterns in the data with only minimal identifying assumptions. A large empirical literature has developed using VARs to analyze the effects of monetary policy on output and prices.<sup>1</sup> In addition, many authors use VARs to motivate and evaluate their theoretical models.<sup>2</sup>

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<sup>1</sup> See, for example, Bernanke and Blinder (1992), Leeper et al. (1996), Bernanke and Mihov (1998). Christiano et al. (1998) provide a survey of this literature.

<sup>2</sup> See, for example, Rotemberg and Woodford (1997) and Christiano et al. (2005).

Recently, the appropriateness of the VAR methodology has come into question. The most common criticisms are its time-invariant linear structure, the low correlation between the forecasts generated by the VAR and those generated by private markets, and, in the absence of appropriate conditioning information, the occurrence of a “price puzzle”—the tendency for the price level to increase following a monetary contraction.

This paper makes two contributions. First, I develop a methodology that uses market forecasts and policy maker forecasts to estimate the effects of monetary policy on output and the price level. With this methodology I am able to control for the information set of policy makers in a more direct manner than is possible with a simple linear VAR. Second, I use this methodology to estimate the effects of monetary policy on output and prices at various horizons. My results shed light on the “price puzzle.” I conclude that the price puzzle cannot be explained by the possible exclusion of information available to the policy maker.

My methodology is best understood in comparison with the standard practice in the VAR literature. VAR analysis involves three steps: first, fit a linear model to data on variables of interest, such as output, interest rates and prices, and generate a set of reduced-form errors; second, identify the structural disturbances to the variables from the reduced-form errors; and third, use the estimated model to analyze the effect that these disturbances have on the endogenous variables. This last step implicitly involves regressing the reduced-form errors at various horizons on the structural disturbances. The main role that the VAR plays in this analysis is to generate the forecasts that give rise to the reduced-form errors employed in steps one and three. I use market-based expectations and the expectations of policy makers in place of the VAR forecasts at these points.

The advantage of my methodology is that market-based forecasts and policy maker forecasts provide the conditional expectation of the variables of interest based on all information currently available. The VAR, however, only provides the best linear forecast based on the subset of variables that are included in the VAR system. For VAR researchers this raises the delicate issue of what variables to include in the system.<sup>3</sup> The “price puzzle” is a classic example of the difficulties involved in this choice. In VARs with a small number of variables there is a tendency for the price level to increase following a monetary contraction. Many researchers find this result difficult to accept. They argue instead that there must exist some variable not included in the VAR that causes inflation and that the Federal Reserve is responding to information correlated with that variable. Their “solution” is to include an index of commodity prices in the VAR.<sup>4</sup> When this is done the price puzzle disappears.

This raises the question, however, of how one knows when the correct specification has been reached. To some the thought process used to justify the inclusion of commodity prices seems circular. *Cochrane (1994)* states that, “empirical researchers typically fish for VAR specifications to produce impulse-responses that capture qualitative monetary dynamics, for example as described in *Friedman (1968)*.” By using market-based forecasts and policy-maker forecasts, I am better able to control for private information without explicitly including more variables in the estimation.

I use my methodology to estimate the effects of monetary policy on output and prices. I use futures market data and Greenbook (GB) forecasts in place of the VAR forecasts.<sup>5</sup> I compare the estimates obtained by using my methodology to the estimates obtained by using a VAR. I have two main results. First, my methodology predicts a stronger effect of monetary policy on output than does the VAR. Second, my methodology predicts that prices rise in response to monetary contractions. This means that the price puzzle remains even after conditioning on the information sets of policy makers. One cannot therefore rationalize the price puzzle by the exclusion of relevant information available to the policy maker.<sup>6</sup> This undermines the standard justification given for including commodity prices in the VAR.

The rest of the paper is organized as follows. Section 2 begins with a brief description of the VAR estimation strategy. It describes my methodology using data on market expectations. Section 3 contains the empirical application. It introduces the data, presents the results, and discusses their robustness. Section 4 concludes.

## 2. Methodology

In order to motivate the use of forecasts to estimate the effects of monetary policy, this section begins with a description of the standard VAR methodology.

Suppose that one is trying to estimate the effect of monetary policy on output and prices and that one begins with data on output  $Y$ , the price level  $P$ , and the short-term interest rate  $R$ . Here  $R$  is the measure of monetary policy. *Bernanke and Blinder (1992)* find that the federal funds rate is a good indicator of monetary policy and that it is very informative about

<sup>3</sup> As *Cochrane (1994)* points out “Shock identification procedures are sensitive to the fact that economic agents and policy makers base their forecasts on more variables than we include in our VARs.”

<sup>4</sup> *Christiano et al. (1996)* state that “The reason that we include a measure of commodity prices in our analysis is to avoid the well-known ‘price puzzle.’” *Sims and Zha (1998)* state that “With this identification, money supply shocks ... have large effects, in the opposite direction, on prices. ... Since we regard it as unlikely that monetary policy contraction quickly produces inflation, we turned to other possible identification schemes.”

<sup>5</sup> Two other recent papers independently use market data to identify the innovations in monetary policy. *Cochrane and Piazzesi (2002)* associate monetary policy shocks with the change in the one month Eurodollar rate that occurs around the time that the Federal Reserve adjusts its target federal funds rate. *Faust et al. (2002)* associate the effect of monetary policy shocks on the federal funds rate with the innovations in the federal funds futures market on the day in which the Federal Reserve alters its target federal funds rate.

<sup>6</sup> This result is consistent with the findings of *Hanson (2004)*. He examines a large number of variables that might be used to forecast inflation, and does not find any correlation between a variable's ability to forecast inflation and its ability to resolve the price puzzle.

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