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How should monetary policy respond to changes in the relative price of oil? Considering supply and demand shocks ☆

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ABSTRACT

This paper examines optimal monetary policy in a New Keynesian model where supply and demand shocks affect the price of oil. Optimal policy fully stabilizes core inflation when wages are flexible. The nominal rate rises (falls) in response to the demand (supply) shock. With sticky wages core inflation falls (rises) in response to the demand (supply) shock. Impulse response functions from a VAR estimated with post-1986 U.S. data show minimal movement in core inflation in response to both shocks. The federal funds rate rises (falls) in response to the demand (supply) shock, consistent with the predictions from the theoretical model for policy that stabilizes core inflation.

1. Introduction

A long tradition in the literature on monetary policy and oil prices has been to assume that the relative price of oil is exogenous to the model being considered.[1] One of the motivations for this setup was the view that exogenous supply shocks, particularly due to OPEC, were the fundamental driver of oil prices. Kilian (2009), however, has provided evidence that demand shocks are also important in determining the price of oil, and that macroeconomic aggregates may respond differently to these shocks even though they also cause the price of oil to increase.

This raises an interesting question about whether or not monetary policy should respond differently to a rise in the price of oil driven by demand rather than supply. One way to answer this question is to construct a theoretical model, solve for the optimal monetary policy, and then examine the impulse response functions of interest rates and inflation variables to see if they differ in important ways in response to supply and demand shocks. In this paper I do just that by looking at the

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[1] Examples of this approach include Leduc and Sill (2004), Dhawan and Jeske (2007), Blanchard and Gali (2010), and the previous version of this paper, Plante (2009). Further examples of the exogenous price assumption can be found in the literature that explores how oil prices affect the macroeconomy, including, but not limited to, Finn (2000), Rotemberg and Woodford (1996), and Kim and Loungani (1992). Some recent work has begun to model endogenous oil prices, including Bodenstein et al. (2008) and Nakov and Pescatori (2010).

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optimal responses that come from a welfare maximizing policy, done from the timeless perspective, in a New Keynesian model with a non-distorted steady state.

Bodenstein et al. (2008), considering the same type of optimal policy, showed that when wages and prices are sticky an exogenous oil supply shock brings about a rise in core inflation and a decrease in nominal wage inflation. The reason for this result is that the supply shock exogenously increases the price of oil which reduces the marginal product of labor. Optimally the real wage should fall and higher core inflation helps bring about this adjustment. Echoing the results of Aoki (2001), there is no explicit attempt to stabilize the price of oil because it is a flexible price and as such there are no distortions associated with movements in that price. As a consequence, there is also no explicit attempt to stabilize CPI inflation.

In this paper, I show that there are fundamental differences in the optimal responses when the increase in the price of oil is due not to an oil supply shock but to a demand shock, which in this paper is modeled as a productivity shock in the non-oil sector. While core inflation optimally rises in response to an exogenous oil supply shock, it falls in response to the demand shock. Even though the productivity shock drives up the price of oil, on net it increases the marginal product of labor, the opposite of what occurs with the supply shock. With sticky nominal wages this calls for core inflation to fall so as to help push up the real wage.

In the case where wages are flexible the model exhibits the "divine coincidence," in that there is no tradeoff between stabilizing core inflation and the output gap. This leads optimal policy to fully stabilize core inflation regardless of the nature of the shock. However, even in this simpler case some important differences remain in the responses of other variables. Specifically, I show that the nominal interest rate rises in response to the demand shock but falls in response to the supply shock. The reason for this is that the two shocks push the return to capital in the opposite direction. Given that the model is Wicksellian, the nominal interest rate moves in the same direction as the return to capital.[2]

The welfare implications of some alternative policy rules that stabilize core inflation, CPI inflation, or nominal wage inflation are also examined. Policy rules that stabilize core or nominal wage inflation produce relatively minor welfare losses in all of the cases considered, so long as the response to inflation is not too weak. The costs of stabilizing CPI inflation, however, depend upon the relative importance of supply and demand shocks. When productivity shocks are the sole driver of oil prices, stabilizing CPI inflation performs relatively well. When exogenous oil supply shocks drive the relative price of oil, however, this policy produces high losses compared to stabilizing core inflation or nominal wage inflation.

The final contribution of this paper is to take the model's predictions about monetary policy to the data using a modified version of the vector autoregression model (VAR) introduced in Kilian (2009). The modified model can identify exogenous oil supply shocks, demand shocks driven by global economic activity, and a demand shock driven by unexpected strong economic activity in the United States. Data from the post-1986 era is used to estimate the model.

Impulse response functions from the VAR show minimal movements in core inflation in response to both the exogenous oil supply shock and the shock to U.S. real GDP. An oil supply shock causes a rise in core inflation of about 10 basis points in the first month. In response to the demand shock, core inflation initially falls by a trivial amount. But, the initial responses and the ones following are not statistically different from 0 for either shock.

The federal funds rate adjusts differently in response to the two shocks. The month to month changes are small, but the cumulative impacts show the federal funds rate falling in response to the exogenous supply shock but increasing in response to the demand shock. These results are similar to the findings in Kilian and Lewis (2011), which showed that the federal funds rate had a tendency to fall in response to oil supply shocks but increase in response to demand shocks in the oil market driven by global economic activity or other sources of demand.

Interestingly, the movement in the funds rate is qualitatively similar to the response the theoretical model predicts should occur when the central bank stabilizes core inflation. This leads me to conclude that the Federal Reserve has been distinguishing between different shocks that increase the price of oil and responding to them in a manner which keeps core inflation stable. While this may not be the optimal policy response to both shocks, the losses predicted by the theoretical model under this policy are relatively small in nature.

The rest of the paper is organized as follows. Section 2 outlines the model. Section 3 presents the results about the optimal policy and the policy rules. Empirical results are presented in Section 4. Section 5 concludes.

2. The model

The model used is a New Keynesian model modified to incorporate firm and household demands for oil, capital accumulation, and an exogenous oil supply. The following exposition introduces those equations necessary for understanding the special features of the model or the results presented in later sections. All other equations and derivations are relegated to the technical appendix.

2.1. Production

There is a continuum of firms of measure 1 in the intermediate goods sector, with firms being indexed by i. Each firm produces a specific good, denoted by y_{it}, which is sold at price p_{it}. The final good, Y_t, is produced using the intermediate

[2] See Woodford (2003) and references therein for more discussion on the Wicksellian nature of the model.