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Monetary policy, the tax code, and the real effects of energy shocks ☆

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ABSTRACT

This paper develops a monetary model with taxes to account for the time-varying effects of energy shocks on output and hours worked in post-World War II U.S. data. In our model, the real effects of an energy shock are amplified when the monetary authority responds to that shock by changing its inflation objective. Specifically, higher inflation raises households' nominal capital gains taxes since those taxes are not indexed to inflation. The increase in taxes behaves as a negative wealth effect and generates an immediate decline in output, investment, and hours worked. The large drop in investment then causes a gradual but very persistent decline in the capital stock. That protracted decline in the capital stock is associated with an extended period of low labor productivity and high inflation. The real effects from the increase in nominal capital gains taxes are magnified by the tax on nominal interest income, which is also not indexed to inflation. A prolonged period of higher inflation and lower labor productivity following a negative energy shock is consistent with the stagflation of the 1970s. The negative effects, however, subsided greatly after 1980 due to the Volcker disinflation policy which prevented the Fed from accommodating negative energy shocks with higher inflation.

1. Introduction

Research economists over the past 35 years have worked to understand the effects of energy shocks on aggregate fluctuations. One problem is to justify theoretically how an energy shock could have such a large impact on output and hours worked when energy is such a small factor in production. Another problem is to explain why the negative impact of higher energy prices moderated so much after 1983.

In this paper, we develop a monetary model with taxes to account for the time-varying effects of energy shocks on output and hours worked. The model includes energy as a consumption good and as a third factor in a CES production function with capital and labor. It also incorporates taxes on income from labor, capital, bonds, and realized capital gains. All of the real income from capital is taxed as capital income paid out on an accrual basis. In our model, all capital gains are due to increases in the nominal price of capital. Shifts in the monetary policy regime change the way in which inflation

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expectations respond to energy shocks. Monetary policy has real effects because shifts in inflation expectations change the expected tax on bond interest income and capital gains.

This paper replicates the observed dynamics between energy shocks and real economic activity from the 1970s in a real business cycle (RBC) model with energy shocks, accommodative monetary policy, and the taxation of nominal capital gains and bond interest income. Our model captures the nuance that capital gains are taxed only when they are realized. In our framework, energy shocks directly affect output and hours worked by altering the relative price of energy. Those direct effects are amplified by indirect effects which operate through the interaction between monetary policy and the tax code and can be larger in size than the direct effects.

The model is used to compute the effects of energy shocks under alternative policy regimes, which are calibrated to post-World War II U.S. data. We find that energy shocks had a large impact on the real economy before 1980 because the Fed allowed the implicit inflation target to change in response to those shocks. Medium- to long-run inflation expectations rose with adverse shocks to the energy supply. Higher expected inflation increased the expected taxes on capital gains, which caused an immediate decline in output and hours worked. That effect was amplified by the tax on bond interest income. Beginning in October 1979, Fed Chairman Paul Volcker announced a shift toward an aggressive anti-inflation policy. Under that regime, the Fed no longer adjusted its inflation rate target in response to energy shocks, which may explain the substantially diminished effect of energy shocks on the real economy, as documented in Hooker (1996).

The next section briefly reviews the literature on the macroeconomic consequences of energy shocks. Following that, we describe the model used in this study with an emphasis on the tax code and the role of energy. We calibrate the model based on long-run relationships and microeconomic studies. Our results show that a monetary policy which accommodates energy price hikes can have large effects on the real economy, both in the short run on output and hours worked and in the long run on capital and productivity.

2. Energy shocks in the U.S. postwar economy

In this paper, energy shocks represent supply shocks to all forms of energy with the understanding that, historically, the largest shocks to the U.S. energy supply have been to the supply of crude oil. Because of the quality and availability of data, our model is calibrated to data on energy consumed by U.S. households despite the fact that the model has energy in consumption and production. We model the energy shock as an exogenous innovation to supply. Overall, our paper contributes to a large literature on the empirical regularities of oil prices, output, and inflation by examining the interaction between taxation and monetary policy.

Hamilton (1983, 2009) documents that all but one of the post-World War II recessions were preceded by a significant increase in the price of crude oil. The tripling of oil prices prior to the deep recession of 1974 had a profound impact on the conventional wisdom about the effects of energy shocks. Following a sharp rise in oil prices, initial estimates from January 1976 indicate that GDP declined 7.7 percent from the business cycle peak in 1973:Q4 to the trough in 1975:Q1. In comparison, initial estimates in January 2010 of the "Great Recession" indicate that GDP fell only 3.7 percent from its 2007:Q4 peak to the 2009:Q2 trough.[1] That large GDP decline in 1974 motivated economists to examine the effects of energy shocks on the real economy.

Baily (1981) argues that the capital stock in place prior to 1973 was dependent on low-price energy and that the sharp rise in the relative price of oil caused a substantial share of the capital stock to become obsolete. Wei (2003) develops a general equilibrium model with putty-clay investment and shows that this feature cannot account for either the magnitude of the declines in output and hours worked or the large drop in equity prices that occurred in 1973–1974. Alpanda and Peralta-Alva (2010) show that Wei's results for equity prices depend on the particular method in which she defines investment. Using a standard definition of investment and the putty-clay model of capital, Alpanda and Peralta-Alva (2010) find that the oil shock could explain about half of the decline in equity prices; but, like Wei (2003), they cannot explain the large drop in output and hours worked.

The failure of the U.S. economy to respond positively to the oil price declines of 1986 and the mild recession following the oil price hikes of 1990 led researchers to ask whether changes in the oil market could explain the moderation in aggregate volatility that occurred around 1983 (the "Great Moderation"). Part of the decrease in volatility is attributable to a decline in the size of shocks and part is due to an increase in the efficiency of energy use, as the ratio of energy consumption to GDP fell by about half from 1974 to 2008. Although most studies assume a break in the early 1980s, with distinct periods of high and low efficiency, the actual change in the ratio of energy use to GDP occurs around 1973–1974. Energy use prior to 1973 grew at about the same rate as real GDP. After 1973, per capita energy use remained relatively constant, while per capita real GDP continued to grow.

Rotemberg and Woodford (1996) argue that monopolistic competition is needed to capture the large effects of oil prices on the economy. Finn (2000) shows that making capacity utilization and the depreciation rate dependent on energy use has the same relative effect as introducing monopolistic competition. Leduc and Sill (2004) determine that the monetary policy rule matters in a general equilibrium model with oil prices. Specifically, they find that the Fed negatively affected output

[1] The vintage data sets can be found at the Federal Reserve Bank of Philadelphia's website: http://www.philadelphiafed.org/research-and-data/real-time-center/real-time-data/data-files/ROUTPUT/.