ENERGY BUSINESS CYCLES

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Overview

The background to this work is rooted in the literature on business cycle realizations. Like the hurricanes, we like to name these events: the Great Depression in the 1930s, Stagflation in the 1960s, Oil Crises in the 1970s, the Great Moderation commencing in the 1980s, Japan's lost decade for the 1990s, and the Great Recession of the late 2000s. Each of these experiences have tended to provoke intensified research efforts trying to explain what has happened, and, sometimes, to offer policy instruments for resolving the problem(s). The current paper is related to such studies, seeking to explain the causes and consequences of an adverse shock and paths to recovery. It is, however, different in one important dimension: it is a study not reacting per se to a particular oil price shock but mainly adding to the ever-growing body of work on energy economics.

In particular, two points for further debate re-emerges. First, is that one of the important questions that have been circulating in the economics profession since the Great Moderation is, "Is the reduced influence of energy price shocks on output volatility observed in the data since the mid-1980s the new norm?" This is a legitimate concern if we consider, for instance, that the positive percentage energy price change reached a high of 145% in 2008 having been climbing from 2002 and yet the Great Recession was attributed to the demand shock of housing default and the supply shock of financial credit constraint. To answer this question, among others, a significant strand of theoretical and empirical literature has been built around a dividing line, with many continuing to lend support to the seminal contribution of Hamilton (1983), who showed that variations in the price of oil are an important correlate to observed variations in many indicators of aggregate and sectoral economic activities. It is not surprising, however, that, with the benefits of additional time series data that is now available, and with economic characteristics that are distinct to those that Hamilton studied, the economic effects of energy price changes on macroeconomic variables such as output, consumption, and investment appear to have been reversed in studies that spanned beyond Hamilton's sample period to, say, the late 1980s or early 1990s [see, for example, Hooker (1997)].

The second point of debate is like the first: there seems to be no agreement in outcome because of the linear structure between oil (prices) and output originally assumed in Hamilton's empirical work, which technical interpretation and specification has been carried over into theoretical modelling [see, for example, Kim and Loungani (1992), Rotemberg and Woodford (1996), and Finn (2000)]. This is a problem arising from treating energy price shocks symmetrically. Indeed, researchers of oil-macroeconomic relationships in the late 1970s and early 1980s did not face this problem because the evidence before them was that energy shocks were mainly price rises. This led Mork (1989) to advocate the need to correct for the true effects of energy price shocks by assuming asymmetry. While this adaptation of the oil price series may have appeared unnecessary pre-1970, it clearly seems like a convincing experiment to carry out post-1970 as the decades of true oil volatilities were ushered in. The benchmark approach adopted here, therefore, is to treat energy price shocks symmetrically. Hooker's finding that data does not support nonlinear and asymmetric representation of the oil-macroeconomic variable interaction permits this launch pad, plus we are mainly interested in how energy price shocks impact aggregate macroeconomic variables. Moreover, on theoretical grounds, this is the right place to start given that our model may not capture the asymmetric response of macroeconomic variables.

A brief summary of the model used, estimation technique and results are provided next.

Model and Methodology

The model is based on Long and Plosser (1983) as augmented by the model of Kim and Loungani (1992). We set this up as a two-sector open economy model, which is essential to characterising the data properties of a two-sector U.S. open economy. We suppose that the finished goods of the two sectors are imperfect substitutes for identical products being produced abroad; that is, trade is assumed to be necessary and made possible by representative households in different countries who are willing to buy goods from other countries similar to those being produced in their own countries, mainly because they attribute different qualities to products based on production origin. On the supply side, there are two production sectors consisting of firms producing two types of goods with different levels of energy intensities. The firms requiring greater amounts of energy for production make up the energy intensive, e, sector producing energy intensive goods, $Y(e)$, and the remaining firms are the non-energy intensive, n, sector producing non-energy intensive goods, $Y(n)$. In each sector, firms are supposed to employ three factors of production, namely: labor hours, capital services, and primary energy. Labor hours and capital services are assumed to be internationally immobile, but the domestic firms import their primary energy requirements. On the demand side, there are households who demand composite consumption goods, C, and who make decisions on investment, I, pay taxes to or receive benefits from the government, T, and supply aggregate labor hours, H. Households can invest in two types of physical capital, K(*e*) and K(*n*), assumed to be subject to capital adjustment cost, and have access to domestic bonds, B. Lastly, we assume that households carry out all trades in goods and services with the rest of the world (RoW), while the firms only trade in crude oil. To simplify matters, the model economy has been described in terms of the domestic country, where all prices have been expressed relative to the general price level in the RoW, which has been chosen to be the numeraire, P(*m*)=1, where *m* denotes imports.

Having obtained the solution to the model, we went on to use the method of indirect inference developed in Le et al. (2011). This is a classical statistical inferential approach to assessing an applied model, whether calibrated or already estimated, in which we maintain the basic concepts well-known in the evaluation of RBC models of comparing the moments generated by data simulated from the model with the observed data. Indeed, we know that using moments for the comparison gives a framework that is free of distribution. Instead, we posit a general but simple formal model (an auxiliary model, which we choose to be a VAR(1) in this case) -- in effect the conditional mean of the distribution of the data -- and base our comparison on features of this model estimated from simulated and actual data. When we use the method for evaluation purposes, we take as given the structural model parameters. The assumption behind this is that if the given model is correct, then it will give predictions about the features of the model, as depicted by impulse response functions and moments, that match those observed in the actual data. On the other hand, when we use indirect inference for estimation purposes, the task is to choose values for the structural model parameters such that when simulated, the model generates coefficients of the auxiliary model that replicates the findings in the actual data. In our experiment, we make attempts at both evaluating and estimating the model under indirect inference.

Results and Conclusions

We find that, when estimated, a two sector computable dynamic stochastic general equilibrium open economy model of the U.S. that formally admits energy into the production process can generate plausible parameter values that can be applied to deal with a broad range of economic issues. As a benchmark, we require that the model fits the data for output, real exchange rate, energy use, and consumption: output because it serves as a measure of a country's total income; real exchange rate because it serves as a determinant of a country's relative competitiveness; energy use because it serves as an indicator of special inputs into a country's production process; and consumption because it serves as a yardstick for evaluating a country's standard of living. Finally, we argue that this model, with appropriate extensions, some of which we also propose, can help future modelers to tackle other research questions.

References

Hamilton, J. D. (1983). Oil and the macroeconomy since World War II. The Journal of Political Economy, 228-248.

Hooker, M. A. (1997). Exploring the robustness of the oil price-macroeconomy relationship. Division of Research and Statistics, Division of Monetary Affairs, Federal Reserve Board.

Kim, I. M., & Loungani, P. (1992). The role of energy in real business cycle models. Journal of Monetary Economics, 29(2), 173-189.

Le, V. P. M., Meenagh, D., Minford, P., & Wickens, M. (2011). How much nominal rigidity is there in the US economy? Testing a New Keynesian DSGE Model using indirect inference. Journal of Economic Dynamics and Control, 35(12), 2078-2104.

Long Jr, J. B., & Plosser, C. I. (1983). Real business cycles. The Journal of Political Economy, 39-69.

Mork, K. A. (1989). Oil and the macroeconomy when prices go up and down: an extension of Hamilton's results. Journal of Political Economy, 740-744.

Rotemberg, J. J., & Woodford, M. (1996). Imperfect competition and the effects of energy price increases on economic activity. Journal of Money, Credit and Banking, 28(4), 549-577.