IMPACTS OF OIL PRICE SHOCKS ON THE U.S. ECONOMY: A META-ANALYSIS OF OIL PRICE ELASTICITY OF GDP FOR NET OIL-IMPORTING ECONOMIES

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Overview

Policy makers are interested in estimates of the potential damage to the economy from oil price shocks, particularly during periods of rapid and large increases in oil prices that accompany severe supply shocks. Such estimates are needed to quantify the economic costs of oil price shocks, and to evaluate the potential benefits of alternative policy responses. Research on the macroeconomic effects of oil market fluctuations is extensive (Hamilton, 1983; Brown and Yucel, 2002; Jones et al., 2004; Barsky and Kilian, 2004; Huntington, 2005; Hamilton, 2005; Barsky and Kilian, 2004; Blanchard and Gali, 2010; Hamilton, 2009; Blanchard and Riggi, 2013; Kilian, 2014). However, estimates of the oil price elasticity of the GDP in the oil-economy literature span a wide range. For example, Huntington (2005) suggests that the mean US GDP elasticity is "~-5%" to "~0%". Estimates of the mean US GDP elasticity from more recent studies (Cashin et al., 2013; Cologni and Manera, 2008; Peersman and Robays, 2009) tend to fall in the middle of this range.

Methods

The wide range of estimates for the oil price elasticity of GDP in the literature can be attributed to a multitude of fundamental and methodological factors, implying that reliance on a single study, or on simple averages and ranges from a few studies, to choose values of the GDP elasticity for policy analysis would be inadequate. In this study we seek to identify and account for the sensitivity of these GDP-elasticity estimates to some of the relevant sources of variation, combining insights from multiple studies, while seeking to exclude uncertainties that are due to artifacts of the individual studies. The current study employs a meta-analysis approach to summarize available estimates of the GDP elasticity from the recent oil-economy literature. This approach enables a systematic evaluation of the mean and sensitivity of the oil price elasticity of the GDP to key driving factors. Specifically, within the limits of the data that can be distilled from the literature we evaluate the role of the following factors in determining the oil price elasticity of the GDP in net oil-importing economies, with a focus on the US: (i) Modeling/specification approaches; (ii) Period of data coverage; (iii) Size and duration of the oil price shock; (iv) Oil and other characteristics of the economy. We focus on estimates for the U.S. but include some recent non-U.S. studies to better understand the influence of these factors. We provide an overview of the data and an evaluation of the potential role of these factors. We estimate regression models using ordinary least squares (OLS), weighted least squares (WLS) and Fixed-Effect/Mixed-Effect (FE/ME) models. Our final model is a Mixed-Effect model estimated using the partial robust M-regression (PRM) approach to help correct for well-known issues with meta-analysis data, such as collinearity and heteroscedasticity.

Results

Coefficient estimates from the meta-regression model provide quantitative insights into the role of many of the factors highlighted above. The estimated coefficients were used to perform a Monte Carlo simulation of the meta-regression model with 250,000 replications. The simulations focus on the US by setting all regional dummy variables, except for the US, to zero. All period dummy variables were set to 1 to represent an analysis based on the entire period covered by the data in our analysis. For model agnosticism, the model class dummies were randomized using the uniform distribution (that is, the alternative values were equally-weighted). The following additional variables were also randomized using the uniform distribution: 1) Shock sizes from 1% to 100% at 10% intervals; 2) Number of quarters after the shock between 1 and 20; 3) Linear price variable dummy set to 1 or 0. US real GDP per capita, petroleum-energy use ratio and net petroleum import-energy use ratio were set to $44.5x103, 0.51 and 0.15, the approximate 2014 values, respectively. Model parameters were also randomized using the multivariate normal distribution based on the heteroscedastic-consistent covariance matrix of the coefficients. Summary values of the simulated estimates including the mean, one- and two-standard deviation confidence intervals (i.e. 68% CI and 95% CI) for 20 quarters following a shock were produced.

The mean estimate for the U.S. is negative over the entire period with the magnitude increasing from 0.01 to slightly larger than 0.02 over the 20 quarters. The mean estimate reaches -0.02 by the 3rd quarter, and plateaus at about the same value by the 9th quarter. The 68% CI over the period is -0.035 to 0.005, but is entirely negative after the 3rd quarter, and the 95% CI is -0.052 to +0.011

Conclusions

The meta-regression coefficients provide a basis for estimating the oil price elasticity of the U.S. GDP for policy analysis because this approach relies on multiple observations from recent studies and uses both US and non-U.S. studies to broaden perspective and help account for a number of key factors. The direct mean estimate of the US GDP elasticity from the data is about -0.02. Using 2014 energy and economic conditions for the U.S., including all data time-periods, and agnosticism (equal-weighting) of the five modelling approaches, simulations with our meta-regression model finds a mean value that is slightly larger in magnitude. For policy analysis the estimated meta-regression model can be used in two ways. First, the simulated values of US oil price elasticity of the GDP represent a readily available overall summary of the mean and variation of the oil price elasticity of the GDP based on the data in this study. Second, when values of the explanatory variables are expected to change significantly the coefficients estimates of the meta-regression model can be used to recalculate the elasticities or generate a distribution of estimates using the Monte Carlo simulation approach demonstrated above. The first approach has been used for previous energy security policy-related analysis within the ORNL BenEStock model (Leiby et. al. 2016), which adopted a mean value of about -0.02. Alternatively, coefficients of the meta-regression model could be incorporated in a policy model directly, allowing the GDP elasticity to be updated as the explanatory variables change during the simulations or to explore the range of uncertainties and sources in the GDP impacts of oil price shocks.

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