Energy Economics 44 (2014) 113–134

Contents lists available at ScienceDirect

Energy Economics

journal homepage: www.elsevier.com/locate/eneco

The differential effects of oil demand and supply shocks on the global economy ☆

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ARTICLE INFO

Article history:
Received 20 July 2013
Received in revised form 18 March 2014
Accepted 20 March 2014
Available online 5 April 2014

JEL classification:
C32
E17
F44
F47
Q41

Keywords:
Global VAR (GVAR)
Interconnectedness
Global macroeconomic modeling
Sign restrictions
Impulse responses
International business cycle
Oil-demand and oil-supply shocks

ABSTRACT

We employ a set of sign restrictions on the impulse responses of a Global VAR model, estimated for 38 countries/regions over the period 1979Q2–2011Q2, as well as bounds on impact price elasticities of oil supply and oil demand to discriminate between supply-driven and demand-driven oil-price shocks, and to study the time profile of their macroeconomic effects across a wide range of countries and real/financial variables. We show that the above identification scheme can greatly benefit from the cross-sectional dimension of the GVAR—by providing a large number of additional cross-country sign restrictions and hence reducing the set of admissible models. The results indicate that the economic consequences of a supply-driven oil-price shock are very different from those of an oil-demand shock driven by global economic activity, and vary for oil-importing countries compared to energy exporters. While oil importers typically face a long-lived fall in economic activity in response to a supply-driven surge in oil prices, the impact is positive for energy-exporting countries that possess large proven oil/gas reserves. However, in response to an oil-demand disturbance, almost all countries in our sample experience long-run inflationary pressures, an increase in real output, a rise in interest rates, and a fall in equity prices.

1. Introduction

How do oil-price shocks affect real output, inflation, the real effective exchange rates, interest rates, and equity prices in different countries, including major oil exporters? Drawing on insights from Baumeister and Peersman (2013) and Kilian and Murphy (2014), we identify two groups of explanatory factors as the main drivers of the evolution of crude oil prices: (i) fast-growing demand due to high global economic growth; and (ii) declining supply or expected production shortfalls in the future. We employ a set of dynamic sign restrictions on the impulse responses of a Global VAR (GVAR) model as well as bounds on impact price elasticities of oil supply and oil demand to identify the underlying demand and supply shocks in the world crude oil market, and to study the macroeconomic consequences of oil-price fluctuations across different countries (including both commodity importers and exporters). We show that these sign/quantity restrictions can greatly benefit from the cross-sectional dimension of the GVAR—which provides a large number of additional cross-country identifying restrictions and reduces the set of admissible structural impulse responses.

Our GVAR approach employs a dynamic multi-country framework for the analysis of the international transmission of shocks, and comprises 38 country/region-specific models, among which is a single Euro Area region (including 8 of the 11 countries that joined Euro in 1999) as well as the countries of the Gulf Cooperation Council (GCC). These individual models are solved in a global setting where core macroeconomic variables of each economy are related to corresponding foreign variables, which have been constructed to match the international

☆ We are grateful to Alberto Behar, John Christopher Bluedorn, Samir Ghazouani, Joong Shik Kang, Lutz Kilian, Michael Kumhof, and Adrian Pagan as well as seminar participants at the IMF, the European Bank for Reconstruction and Development, the University of St Andrews, Kuwait Institute for Scientific Research, the Economic Research Forum 19th Annual Conference, and the University of Gothenburg for constructive comments and suggestions. We would also like to thank the Editors (Richard S.J. Tol and John P. Weyant) and two anonymous referees for most helpful suggestions. Kamiar Mohaddes acknowledges financial support from the Economic Research Forum (ERF). The views expressed in this paper are those of the authors and do not necessarily represent those of the International Monetary Fund, IMF policy, or the ERF.
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http://dx.doi.org/10.1016/j.eneco.2014.03.014
0140-9883/

trade pattern of the country under consideration and serve as a proxy for common unobserved factors. The model has both real and financial variables: real GDP, inflation, real equity prices, real effective exchange rate, short and long-term interest rates, global oil production, and the price of oil. We treat the latter endogenously as the question of whether oil prices are demand-driven or supply-driven often reignites debate about their exogenous or endogenous treatment in macroeconomic models. Our framework is able to account for various transmission channels, including not only trade relationships but also financial linkages through interest rates, equity prices, and exchange rates; see Dees et al. (2007a,b) and Pesaran et al. (2007). We estimate the 38 individual VARX* models over the period 1979Q2–2011Q2. Having solved the GVAR model, we examine the effect of oil-demand and oil-supply shocks on the macroeconomic variables of different countries.

Consistent with the findings of earlier studies[1]—but at a more disaggregated country level and for a wider range of macroeconomic aggregates—the results of our "set-identified" GVAR model of the world economy indicate that the economic consequences of a supply-driven oil-price shock are very different from those of an oil-demand shock driven by changes in global economic activity; and very different for oil-importing countries when compared with energy exporters. We find that while oil importers typically face a long-lived fall in economic activity in response to a supply-driven surge in oil prices, the impact is positive for energy-exporting countries that possess large proven oil/gas reserves. However, in response to an oil-demand disturbance, almost all countries in our sample experience long-run inflationary pressures, and an increase in real output. Furthermore, following an oil-demand shock interest rates increase while equity prices fall in all major oil-importing countries.

Compared to Dees et al. (2007a,b), the current paper advances the work on GVAR modeling in the following directions: (i) we extend the geographical coverage of the GVAR model to major oil exporters as well as other countries in the Middle East and North Africa region; (ii) we extend the sample period until the second quarter of 2011, thus including both the recent oil price boom (2002–2008) as well as the initial oil-supply disruptions which accompanied the Arab Spring (see Fig. 1 for the evolution of oil prices and a history of oil production disruptions since 1970); (iii) we allow for the simultaneous determination of oil prices, oil production, and several key macroeconomic variables in a global setting; and (iv) we demonstrate how a GVAR model, covering over 90% of world GDP, 85% of world oil consumption, and 80% of world proven oil reserves, can be used for "set-identified" impulse response analysis and to obtain a better understanding of structural shocks.

Furthermore, we contribute to the literature that assesses the macroeconomic effects of oil price shocks along the following dimensions. To study the oil–macroeconomy relationship, we provide a compact model of the world economy that takes into account the economic interlinkages and spillovers that exist between different regions (which may also shape the responses of different macroeconomic variables to oil price shocks), rather than undertaking a country-by-country structural VAR analysis of the oil market. By directly controlling for macroeconomic determinants of oil demand in a large-scale macroeconometric model of the world economy, rather than relying on proxies for global real economic activity, we try to achieve a better understanding of structural oil-supply and oil-demand shocks.

Moreover, while there is a growing literature that employs sign restrictions on impulse responses as a way of identifying shocks in structural VARs—for example, Faust (1998), Uhlig (2005), and Canova and Nicoló (2002)—we extend this approach to a GVAR framework in which the cross-sectional dimension of the model is utilized to identify shocks that are global in nature, i.e. shocks that affect many countries simultaneously. Fry and Pagan (2011) argue that sign restrictions solve the parametric identification problem present in structural VARs but leave the model identification problem unresolved. The latter refers to the fact that there are many models with identified parameters that provide the same fit to the data. To narrow the set of admissible structural models, we follow Kilian and Murphy (2014) and augment the above sign restrictions with bounds on impact price elasticities of oil demand and oil supply (to rule out those models that imply economically implausible responses). We also show that the global dimension of the GVAR—by offering a large number of additional cross-country sign restrictions—can significantly narrow the number of plausible models that satisfy our a priori sign/quantity restrictions, and therefore can move us one step closer to calculating those impulse responses that are qualitatively and sometimes quantitatively similar. However, we acknowledge that even after imposing sign restrictions, bounds on oil-price elasticities, and cross-country identifying restrictions, there are still a large number of structural models that satisfy these restrictions and therefore it is necessary to find a way to summarize the available information. For this purpose, we follow Fry and Pagan (2011) and report the "Medium Target" of our impulse responses (a single model whose impulse responses are as close as possible to the median values).

The rest of the paper is organized as follows. Section 2 gives a brief review of the relevant literature. Section 3 describes the GVAR methodology while Section 4 outlines our modeling approach. Section 5 explains the identification procedure used in this paper and investigates the macroeconomic effects of oil-supply and oil-demand shocks. Finally, Section 6 concludes and offers some policy recommendations.

2. Literature review

We are certainly not the first ones to emphasize the importance of identifying the underlying sources of oil-price shocks for studying their macroeconomic consequences. Using a structural VAR framework for the case of the United States, Kilian (2009) decomposes oil-price shocks into three types—an oil-supply shock, an oil-demand shock driven by economic activity, and an oil-specific demand shock driven by expectations about future changes in oil conditions—and concludes that the macroeconomic effect of the most recent oil price surge (2003–08) was generally moderate. This observation could be interpreted as evidence of the key role played by the demand side in explaining the recent boom in oil prices. Had the shock been triggered by supply-side factors, global aggregate demand would have fallen, because a negative supply shock is perceived to be a tax on oil consumers (with a high propensity to consume) in favor of oil producers (with a lower propensity to consume). Following a supply-driven oil price shock and in the presence of nonlinearities in the product and labor markets (for example price and wage rigidities), production costs increase and as a result inflation rises; often prompting central banks to raise their policy rates, and placing additional downward pressure on growth.[2] However, in response to a demand-driven oil price shock, combined with a near vertical oil supply curve, output and inflation move in the same direction (both increase). Hamilton (2009) argues that while historical oil price shocks were primarily associated with physical supply disruptions, the price run-up of 2007–08 was caused by strong global demand and stagnating world oil production. He then concludes that in spite of different causes, the consequences for the economy of higher oil prices have been very similar to those observed in earlier episodes.

Most papers in the literature that investigate the effects of oil shocks on macroeconomic variables have focused on a handful of industrialized/OECD countries, and in most cases they have looked at the impact of oil shocks exclusively on the United States (and in isolation from the rest of the world). Moreover, the focus of those analyses has predominantly been on net oil importers—see, for example, Blanchard and Gali (2007), Hamilton (2009), Kilian (2009), and Peersman and Van Robays (2012). An exception is the work of Esfahani et al. (2014),

[1] See, for instance, Kilian (2009), Kilian and Murphy (2014) and Peersman and Van Robays (2012).

[2] See Raissi (2011) for a discussion of optimal monetary policy in the presence of labor market inefficiencies.