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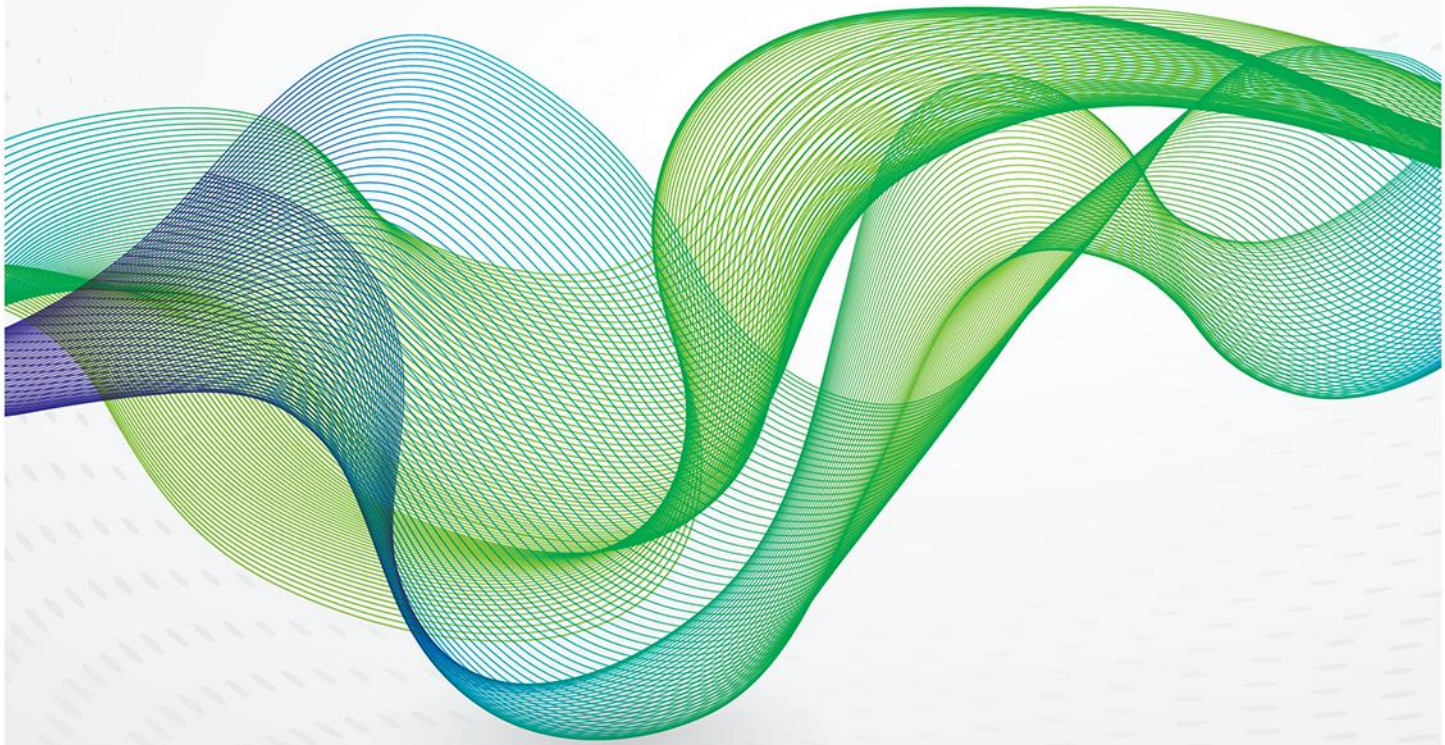
Not all oil supply shocks are alike either: Disentangling the supply determinant



OXFORD ENERGY COMMENT

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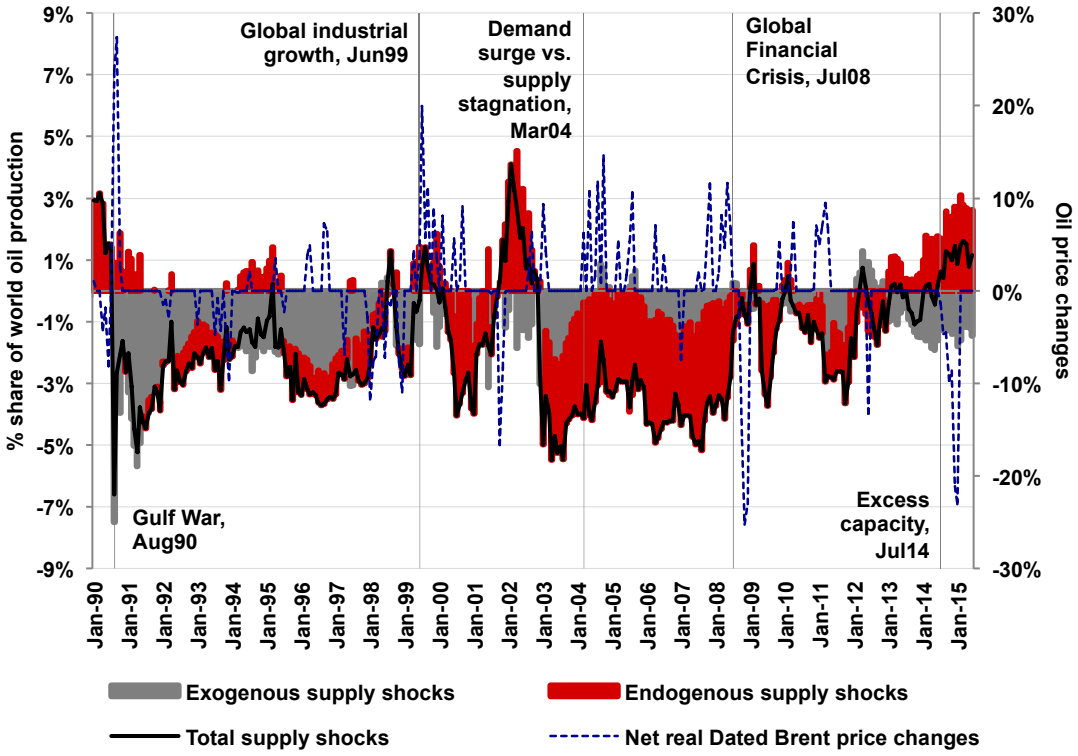
In recent years, a consensus has emerged about the basic building blocks of modelling the global oil market thanks to important advances on the empirical framework for analysing oil price shocks. On the supply side, the oil price is primarily influenced by exogenous shocks to the physical availability of crude oil (*flow supply*). On the demand side, the oil price is largely driven by fluctuations in the global business cycle (*flow demand*) and to a lesser extent by shocks to the stock demand for crude oil associated with the forward-looking behaviour of market participants (*speculative demand*), as well as by other idiosyncratic demand-specific shocks. It follows that *"not all oil price shocks are alike"* (Kilian, 2009); as in this work and related references it is observed that there are important differences in the historical contribution of these structural shocks to the real price of oil. Most notably, recent empirical findings point to a decrease in the explanatory ability of the supply side of the market, as most of the oil price changes in historical episodes can be largely attributed to demand-specific shocks. Although there is little disagreement regarding the robustness of this evidence, there is no doubt that the conventional notion of modelling oil supply shocks explicitly from an exogenous perspective seems to become elusive.

Traditionally, flow supply shocks were thought to reflect disruptions to the volume of crude oil coming out of the ground caused mainly by exogenous political events in oil-producing countries. Whereas such exogenous shortfalls in oil production were initially thought to have played a significant role during historical oil price shocks in 1973-74, 1980-81, 1990-91 and 2002-03, recent studies argue that oil supply shocks are not as important as originally thought. One explanation is that oil supply shocks conditional on information contained in past data of changes in global oil production have little systematic predictive power for changes in the real price of oil (see Kilian, 2008, p. 1062). An alternative and complementary explanation is that supply shocks may also be determined endogenously with respect to the cumulative amount that could eventually be extracted and the projected time path for the demand function (Adelman, 2003; Smith, 2012). On this basis, recent studies highlight the important role of capacity constraints in crude oil production amid large increases in oil demand as a key factor affecting the price of oil, but stress the need to identify observables other than oil production data that can be used in the context of the empirical analysis of oil price shocks.

In a recent OIES Paper (Economou, 2016), we undertake this task and develop a new measure that jointly identifies and disentangles the supply shocks of crude oil into exogenous and endogenous, by quantifying the positive and negative shocks of oil production caused by events outside the oil market (exogenous) or as a consequence of the normal functioning of the oil market (endogenous). The study argues that exogenous supply shocks originate mainly from geopolitical and political episodes in oil-producing countries that lead to the actual disruption of drilling and extracting operations at oil facilities. On the other hand, endogenous supply shocks are associated directly with substantial positive or negative changes in operable capacity, relative to demand, as a result of geological, economic and technological stimulus or limitation.

Figure 1 plots the combined total of the constructed measure for the period 1990.1-2015.6, stacked with each discrete category of supply shocks, i.e. exogenous and endogenous, and the net oil price changes for the same period. For most of the 1990s shortfalls in oil production caused by geopolitical episodes in OPEC countries accounted for about 7% of the variability in global oil production. However, this pattern reverses after 2000, as fluctuations in crude oil production were mostly associated with endogenous innovations in oil supply that were brought about largely by market-specific events, i.e. large shifts in demand hitting capacity constraints or capacity expansions running ahead of demand. That said, it is worth mentioning that oil price developments after 2012 are reflected explicitly in the cumulative effect of the aggregate supply shock series (total supply shocks), as the two categories coexist and lead to the build-up of the 2014 oil price collapse.

Figure 1. Aggregate measure of total supply shocks of crude oil



The study then turns to the related issue of how the new measures affect the assessment of the dynamic effects of supply shocks on the real price of oil since 1990. Analysis builds on four formal econometric models of the global oil market in the tradition of Kilian and Murphy (2014) that incorporate past data on oil prices, on the global business cycle as developed in Kilian (2009) and on global oil supply conditional on the model's specification of the related structural shocks: (1) *flow supply shocks* conditional on past global oil production data; (2) *exogenous supply shocks* conditional on the constructed proxy of exogenous shortfalls in crude oil production; (3) *endogenous supply shocks* conditional on the constructed proxy of market-specific capacity shifts in crude oil production; and (4) *total supply shocks* conditional on the constructed proxy of aggregate changes in total available operable capacity.

Results suggest that the supply determinant may have very different effects on the real price of oil, depending on the specific characteristics of the supply shock. In particular, the measures that capture market-driven shifts in available operable capacity are found to be more plausible than the rest in explaining the variability of the real price of oil. Estimates show that flow supply shocks have a negligible impact on the variation in the real price of oil with a mere 2%. The explanatory power of exogenous supply shocks somewhat increases to 16%, while endogenous supply shocks have a much larger role in explaining changes in the real price of oil with 30%. Finally, total supply shocks that combine both measures, i.e. exogenous and endogenous, account for 32% of the variation in the real price of oil.

Figure 2 compares the respective cumulative effect of flow supply shocks and total supply shocks to the real price of oil, based on a historical decomposition of the data for 1990.1–2015.6. Evidently, after 2000 there is a tenuous link between the two series according to which the former underestimate the historical contribution of oil supply shocks to changes in the real price of oil. For example, during the great price surge of 2003-08 the dashed line shows that flow supply shocks made comparatively small contributions to the real price of oil. This contrasts with a much larger role of total supply shocks that appear to have exerted significant upward pressure on the real price of oil over the same period (solid line). Thereafter, notwithstanding some differences in magnitudes, the two historical

decompositions largely agree with each other with respect to the timing of the sharp swings in the real price of oil that preceded and followed the 2014 oil price collapse. With this in mind, it is instructive to examine in more detail the underlying nature and timing of the supply shocks after 2004.

Figure 2. Historical decomposition of the real price of oil for 1990.1–2015.6

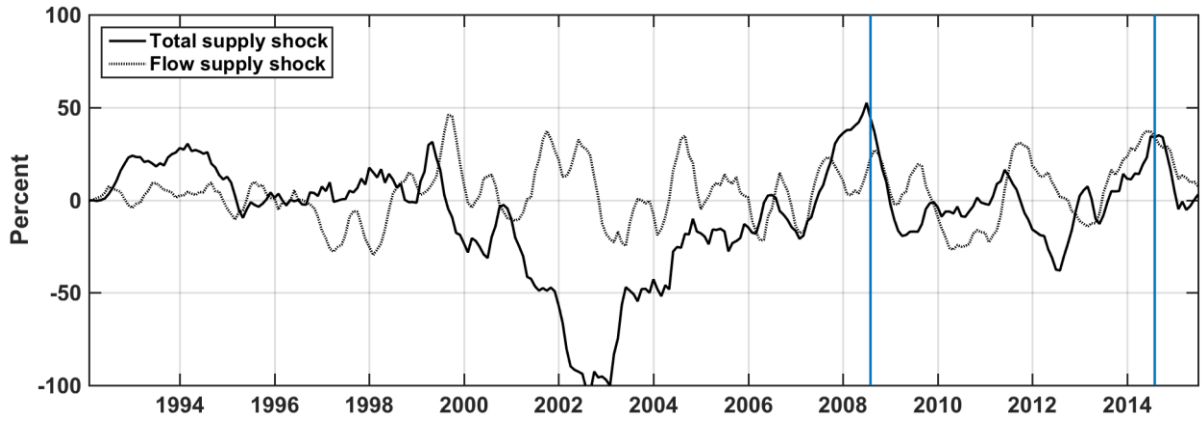
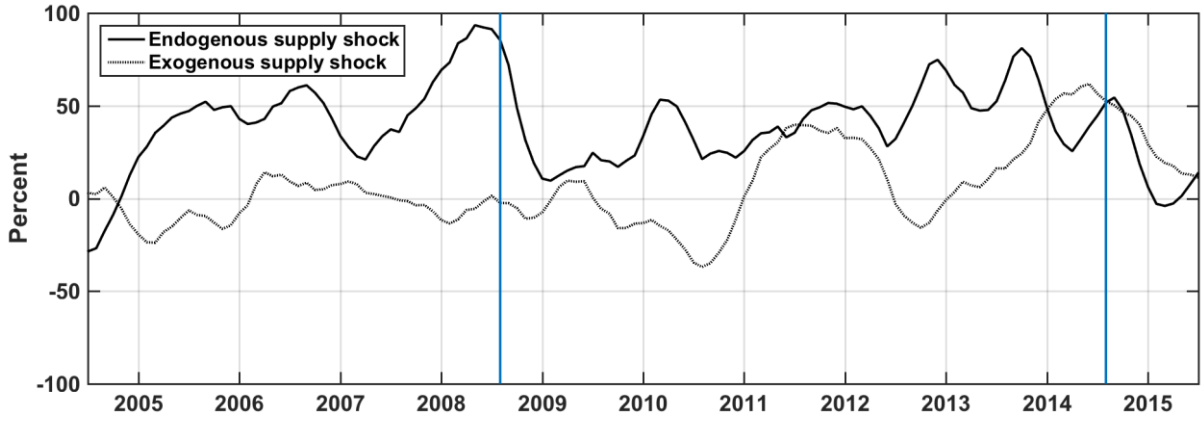


Figure 3 decomposes the cumulative effect of supply shocks to the real price of oil into exogenous and endogenous for the period 2004.6–2015.6. From the figure it can be seen that the bulk of the continued supply-related increase in the real price of oil starting in 2004 can be attributed explicitly to endogenous supply shocks. This evidence is consistent with the unexpected halt of the growth of global oil production amid booming demand as a result of the structural underinvestment in the upstream sector of the 1990s, the maturity of legacy oil fields and the long lead-times associated with the development and production of new capacity. The persistent positive effect of endogenous supply shocks on the real price of oil spikes in 2008 but declines sharply from 2013.

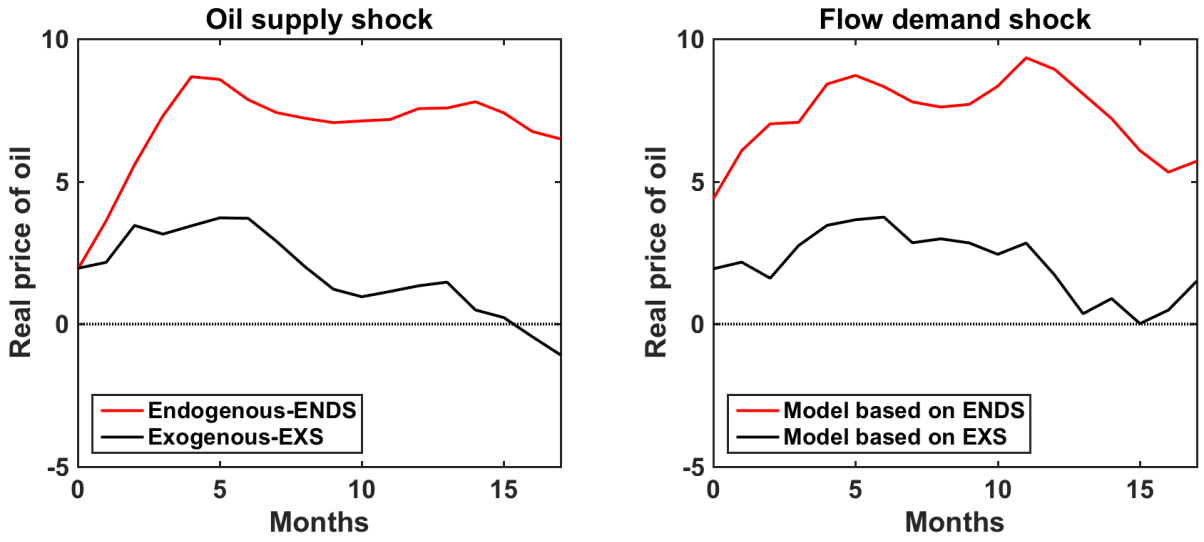
Figure 3. Historical decomposition of the real price of oil for 2004.6–2015.6



To the extent that unexpected positive oil supply shocks mattered for the real price of oil after 2010, these were largely driven by exogenous shocks in crude oil production that were explicitly associated with sharp swings in Libyan output staring in 2011. There is no evidence throughout that any other geopolitical episode exerted any sort of upward pressure on the real price of oil, despite the fact that the loss in output may have been greater. It follows that the quantitative importance of exogenous disruptions in crude oil production to the real price of oil appears to be highly sensitive to the ability of other producers to find alternatives of similar quality to the grade of the missing crude oil and not to the magnitude of the shock *per se*. Accordingly, the timing of the oil price collapse in July 2014 is compatible with the sharp recovery of Libyan oil production by 700,000 bpd starting in June 2014, in conjunction with the presence of endogenous downward pressures on the real price of oil.

Taken together, it is important to emphasize that the specification of supply shocks greatly affects the qualitative and quantitative features of the responses of the real price of oil to both supply and demand shocks. First, as follows from Figure 4, an exogenous supply disruption causes a temporary increase in the price of oil that persists only for twelve months, as oil production shortfalls in one region tend to trigger production increases elsewhere in the world. A negative endogenous supply shock, on the contrary, is associated with a steep and very persistent increase in the real price of oil, consistent with the view that unless oil demand deteriorates, the shock treatment for capacity contractions is associated with significant lags that reflect the long lead times from investment decisions to first oil.

Figure 4. Responses of the real price of oil to supply and demand shocks



Second, in the explicit presence of an unanticipated exogenous disruption of oil production, an unanticipated expansion of flow demand causes a relative increase on the real price of oil that is only temporary and expires within twelve months. By contrast, in the explicit presence of an unanticipated contraction of operable capacity the effect of an unanticipated positive shock of flow demand on the real price of oil is immediate, highly significant and very persistent. The robustness of these results confirms the widely documented view in the literature that the conjunction of capacity constraints amid large increases in oil demand generates large oil price increases. This finding confirms that neither of the market fundamentals can be an important determinant *per se*, but it is rather the catalytic interaction of both supply and demand that has historically driven the real price of oil.

In conclusion, these results suggest that the supply side of the market has been an important determinant of the price of oil after all. It is thus central to allow for endogenous innovations in modelling the effects of oil supply shocks within a framework that is both theoretically and empirically sound. The importance is that researchers and policymakers should keep advancing the understanding of the transmission of oil supply shocks to market price, as well as the channels through which the fundamental determinants interact and produce large contemporaneous effects on the price of oil.

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