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Supply response, economic diversification and recovery strategy in the oil sector

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ABSTRACT

We argue that country oil supply response to price is affected by structural, market and policy-induced factors and conceptualized their effects. For fifty three major oil-producing countries, we further estimate country price elasticities of oil supply through a random effects model, which allows the estimation of the output effects of factors that can be shaped by public policies. Results obtained from panel data for the 1995-2014 time-period suggest the potential to accelerate recovery from an oil price depression through deliberate policies aimed at making oil supply more price responsive. Such policies include improved business climate, reduced corruption and larger levels of government spending. Greater degrees of diversification from oil, larger oil reserves, higher GDP and a less favorable exchange rate are also found to increase the potential for economic resurgence as oil prices increase. OPEC membership is also found to boost the potential for sectorial and overall economic recovery.

1. Introduction

Global oil prices experienced an unprecedented sharp decline in recent years. For example, between January 2014 and January 2016, the Brent price of crude oil dropped by 65%, from $108 per barrel to $38 (see Fig. 1). Since January of 2016, oil prices have remained low, hovering between $38 and $54 per barrel.

This recent decline has had the effect of shrinking the economies of many oil-producing nations [6], especially those that were not well diversified. For example, in Nigeria, the country that motivated this study, the economy depends largely on oil and oil and gas revenues account for 35% of GDP, 95% of export earnings and 70% of government revenues [14]. The economic effects of the recent decline in oil prices have been devastating, leading to a major economic recession [25]. More specific effects on the Nigerian economy include a more than 50% devaluation of the currency exchange rate, major unemployment, unpaid salaries and the failure of several private sector companies. Recovery in Nigeria has been stymied by the inability to grow other sectors such as agriculture.

In contrast to Nigeria, countries with more diversified economies seem to have performed better. Russia, for example, was hard hit, but due to its relatively more diversified economy, did not experience an economic devastation as severe as Nigeria. The more diversified and advanced economies in Europe and North America (e.g. UK, Denmark, Netherlands, France, Norway, the United States and Canada) have largely avoided this economic downturn and some may, in fact, have benefited from lower oil prices through the reduction of energy, transportation and other costs [30]. While a decline in oil prices, driven by supply shocks, boosts economic activity in advanced economies, it depresses such activities in emerging economies [7]. Advanced economies are typically more economically diverse than emerging economies [7].

The arithmetic that translates sectorial economic shocks into economic downturns is very simple. As illustrated in Appendix 1, holding other factors constant, the smaller the relative size of the crude oil sector, the lower the adverse aggregate economic impact of a sharp decline in oil prices [8,15,22]. Therefore, a country's share of national output attributable to the crude oil sector shapes the effects of a price decline on sectorial output in the overall economy.

Supply elasticity matters. Holding other factors constant, the smaller the own-price elasticity of supply of the crude oil sector, the lower the aggregate economic impact of the price decline. Finally, the economic impacts are also determined by two other factors: (a) the relationship between price in the crude oil sector and the outputs of

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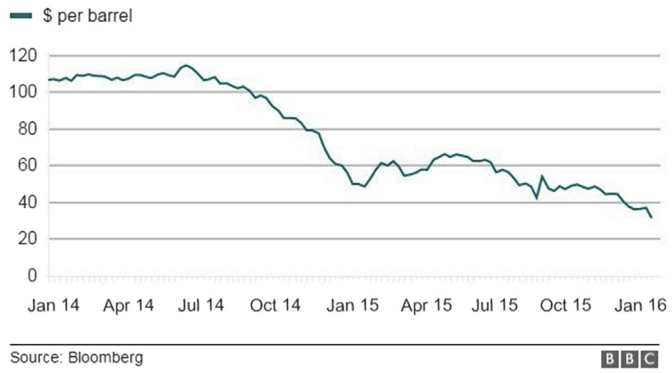

Fig. 1. Brent Crude oil price movement from January 2014 to January 2016.

other sectors, and (b) the relationship between price in the crude oil sector and prices in other sectors. That is, when a crude oil price decline triggers a recession, its adverse economic impacts are larger than when it triggers cross-sectorial economic growth due to lower costs of such things as transportation, industrial production and agriculture. These combined effects shape the overall impact of crude oil prices on the economy.

The role of the price responsiveness of the sector facing a major price shock is noteworthy. Studies have estimated supply elasticities for various oil-producing countries [4,7]. These differences obviously help explain the differentials in economic impacts of oil price decline. However, the literature has not addressed why these elasticities differ. While Peersman and Robays [26] examined inter-country differentials in economic shocks due to diversification, the rationales and implications of differentials in supply response were not examined. Also not well examined are the effects of various policy, structural and market factors on oil supply response. To the extent that oil supply response is affected by such factors, changes can be applied to shape the path to recovery for oil-producing countries after a major price decline.

Based on the arithmetic in Appendix 1, the extent of the debilitating economic effects of a major oil price shock in an oil-producing economy is hypothesized to depend on the price elasticity of oil supply, the degree of economic diversification and cross-sector elasticities of product supply and of prices with respect to oil price. Economies that are more diversified, that have less elastic supply and whose non-oil sectors are positively affected by oil price declines should experience milder adverse general economic impacts than non-diversified economies with more elastic oil supply functions and whose non-oil sectors are negatively affected by oil sector price declines.

The primary objectives of this paper are to (a) explain oil supply responsiveness on the basis of policy, structural and market factors; (b) decompose the standard oil supply elasticity into an independent price effect and effects through policy, structural and market factors and estimate these components; and (c) use these in offering a rational explanation for the patterns of price transmission to the oil sector and the overall economy. In this paper, it is hypothesized that various factors affect oil supply response behavior. By estimating, analyzing and explaining their effects, this paper contributes to the understanding of the role of oil prices in shaping the economic performance of oil-producing economies. In the sections that follow, the determinants of oil supply responsiveness are identified and their effects on oil supply conceptualized; hypotheses about the relationships between these determinants and supply are put forth and empirically tested using a panel data from major oil-producing countries; and policy recommendations are provided.

1.1. Conceptual framework

Price elasticities of supply are frequently estimated, analyzed and discussed in economic literature [7,26,27]. Their estimates help explain the effects of market price and policy changes on production [21]. Major production-oriented policies, including market share strategies, rely on supply elasticity estimates [5]. It is apparent, based on previous elasticity estimates, that oil supply responsiveness varies by country [2,26]. For example, Akaeze [2] estimated oil supply elasticities to be 2.21 for Australia, 0.10 for China, 0.46 for Nigeria, 0.29 for Russia and 0.28 for the US. These differences may reflect deep fundamentals and uniqueness of the structure and performance of oil production in each country.

Askari and Cummings [3] shed some light on factors that may affect supply elasticity, albeit not for the oil sector. However, no study has attempted to empirically explain the roles of these factors in crude oil production. Here, we argue that the lack of full understanding of the influence of policy on producer behavior, price responsiveness and sensitivity to market signals may have limited policy instrument choice in the oil sector. The results of this study could be useful in understanding the dynamics of oil supply response, in designing realistic oil sector policies and in managing supply responsiveness.

The simple framework provided by Mills and Schumann [24] for evaluating differences among producing units is applied here in evaluating cross-country differentials in supply response. Consider the case where various countries employ heterogeneous oil production technologies. For country i, denote C_i as the cost of producing oil, q_i as the quantity of oil produced, and p as the exogenous crude oil price that is assumed to be the same across countries. Inherent in this assumption is the notion that deviation of price from a standard market price, such as Brent price, reflects quality differences. Box 1 shows the derivation of country supply function for crude oil based on a quadratic cost function. It also shows the associated profit function that allows the derivation of the elasticity of supply. In Box 2, we derive the supply elasticity and show its relationships to other structural parameters of production.

The conceptual framework captured in Boxes 1 and 2 suggests the following: (a) supply response should decrease with the size of the crude oil industry in a country; (b) supply response should be higher in countries with low capital intensity (ratio of fixed to variable costs); and (c) supply response should increase with variable costs. Therefore, factors that shape capital intensity, fixed costs and variable costs in a country are good candidates for determinants of supply response.

2. Oil supply changes: policy, structural and market factors

Now we explore the factors that could shape the trajectory and dynamics of country oil supply behavior by affecting country capital intensity, production costs, and other structural and market factors. We illustrated some of these factors in Fig. 2.

2.1. Policy-induced factors

Oil sector policy varies by country [20] and is usually controlled by the government. Examples of relevant policies include property rights in the oil sector; the degrees of business, financial and investment freedoms; the extent of corruption; and the size of government spending.

2.1.1. Oil sector property rights

Property rights do vary by country based on each country's policy. Some countries have heavy entry fees and low revenue sharing, while some have lower entry fees and a higher revenue sharing procedure, with mixtures in-between. For example, entry into the oil sector usually involves the issuance of licenses to oil blocks. These licenses can give oil producers sole rights to explore for crude oil and to exercise other related property rights, or can limit the rights of oil companies. Arrangements can also vary from pure royalty or revenue sharing to joint-ventures with the government. Adequate and readily enforced property rights can foster production flexibility. We hypothesize that strong property rights translate into greater supply response.