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The global crude oil market and biofuel agricultural commodity prices

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A B S T R A C T

In this paper we use quarterly data, over the period from 1975:2 to 2016:1, and a joint structural VAR model of the global crude oil market and the U.S. corn market, to disentangle demand and supply shocks in the global crude oil market and the U.S. corn market and investigate their effects on corn prices in the United States. We identify the model by assuming that innovations to the real price of crude oil are predetermined with respect to the corn market in the United States and show that close to 36% of the variation in the real price of corn can be attributed to structural supply and demand shocks in the global crude oil market.

1. Introduction

After the United States authorities enacted in 2005 the Renewable Fuel Standard, also known as the ethanol mandate, there have been significant changes in the dynamics between fossil fuel and agricultural commodity prices. The ethanol mandate specifies that gasoline and diesel contain a certain amount of biofuel (mostly ethanol), derived from feedstocks (mostly corn). As recently put by Avalos and Lombardi (2015, p. 1), "some studies have then argued that ethanol and biodiesel subsidies in advanced economies may have strengthen the link between the prices of oil and those of some food commodities." In this regard, Serletis and Xu (2018), in their investigation of mean and volatility spillovers between the crude oil market and the main biofuel feedstock markets, also find that the ethanol mandate has strengthened the linkages between the oil market and the biofuel feedstock markets in terms of volatility spillovers. In fact, as can be seen in Fig. 1, before the ethanol mandate, crude oil and corn prices move together and decouple episodically in response to economic growth, technological change, and weather conditions. However, after the ethanol mandate, the price of corn in the United States has increased significantly and moves more closely with the price of crude oil. See also Coronado, Rojas, Romero-Meza, Serletis, and Chiu (2018) for a more detailed discussion regarding the relationship between crude oil prices and biofuel agricultural commodity prices.

Our approach in this paper complements Avalos and Lombardi (2015), who investigate the impact of oil market structural shocks on the prices of corn, soybean, and sugar, using the Kilian (2009) structural VAR with monthly data. However, our study differs from Avalos and Lombardi, as we follow Kilian (2010) and investigate the effects of demand and supply shocks in the global crude oil market and the U.S. corn market on corn prices in the United States. In particular, we estimate the structural VAR model of Kilian (2010), augmented with the real price of corn and corn consumption, in order to investigate the relationship between crude oil and corn prices. We treat the price of crude oil as endogenous and disentangle the causes underlying oil price shocks. In particular, we model changes in the real price

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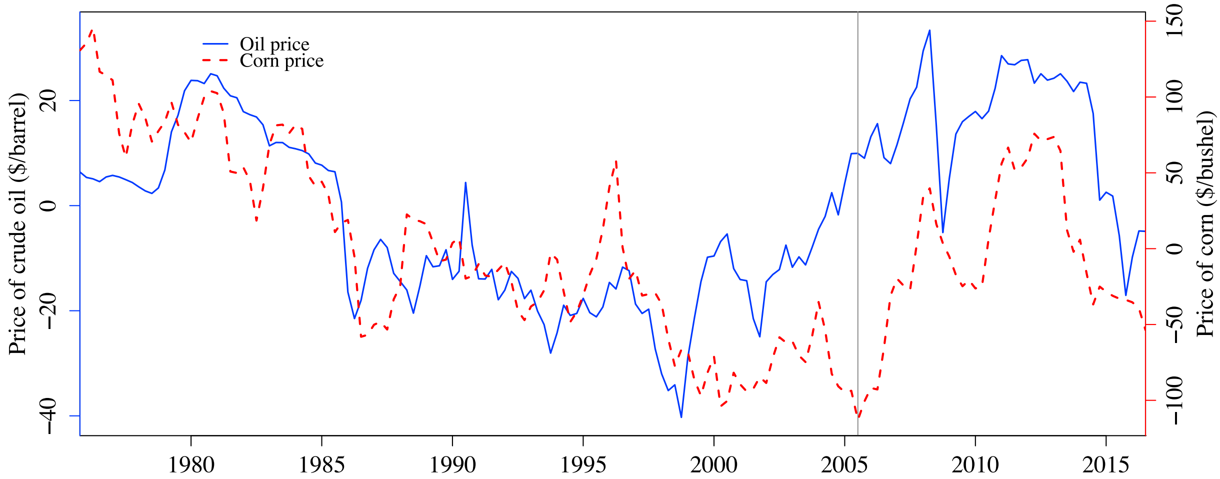

Fig. 1. Crude oil and corn prices, 1975:Q2–2016:Q1.

of crude oil as arising from three different sources: shocks to the global supply of crude oil, shocks to the global demand for all industrial commodities (including crude oil) that are driven by the global business cycle, and oil-market specific demand shocks (also referred to as precautionary demand shocks). We use quarterly data, over the period from 1975:2 to 2016:1, and find that close to 36% of the variation in the real price of corn in the United States can be attributed to structural supply and demand shocks in the global crude oil market.

The paper is organized as follows. Section 2 discusses the data. Sections 3 and 4 describe the empirical method and present the results. Section 5 investigates the robustness of the results, and the final section briefly concludes the paper.

2. Data

We consider a structural VAR model based on quarterly time series data for the United States, from 1975:2 to 2016:1, for $\mathbf{z}_t = (\Delta prod_t, rea_t, rpo_t, rpcorn_t, \Delta CornUse_t)'$, where $\Delta prod_t$ is the percent change in global crude oil production, rea_t is a measure of real economic activity, rpo_t is the real price of oil, $rpcorn_t$ is the real price of corn, and $\Delta CornUse_t$ is the percent change in U.S. total corn consumption.

Regarding the percent change in global crude oil production, $\Delta prod_t$, we use the oil production data from the U.S. Department of Energy to compute the log differences of world crude oil production in millions of barrels pumped per day (and averaged by month). We use Kilian's (2009) detrended real freight rate index to measure the component of real economic activity (rea_t) that drives demand for industrial commodities in global markets. As noted by Kilian (2009), this index is constructed from dry cargo single voyage ocean freight rates and is deflated by the U.S. Consumer Price Index (CPI) to express it in real terms. The real freight rate index is linearly detrended to remove long-term trends and thus represent the global business cycle; whether the detrended freight rate index is an adequate reflection of the overall economic climate is an issue beyond the scope of this paper. See Kilian (2009) for more details regarding the construction of this measure of global real economic activity. Finally, we divide the U.S. composite refiners' acquisition cost of crude oil (RAC), as compiled by the U.S. Department of Energy, by the U.S. Consumer Price Index (CPI) to obtain the real price of crude oil, rpo_t.

We seasonally adjust the price received by U.S. corn producers (dollars per bushel), as compiled by the U.S. Department of Agriculture, and divide it by the U.S. CPI to obtain the real price of corn, $rpcorn_t$. Corn total disappearance (million bushels) from the U.S. Department of Agriculture is employed to calculate the percent change in seasonally adjusted U.S. total corn consumption, $\Delta CornUse_t$. The corn consumption data is only available quarterly on a marketing-year basis; based on the U.S. Department of Agriculture, the marketing year for corn supply-use statistics begins September 1 and is comprised of four quarters, September–November, December–February, March–May, and June–August. In order to match the frequency of the corn consumption series, we convert all the monthly data to quarterly data based on the corn marketing year. Finally, the fact that global oil production enters the VAR model in percent changes, $\Delta prod_t$, and the measure of real economic activity, rea_t, is expressed as percent deviations from trend, suggests that we should be using the demeaned forms (deviations from mean) of the natural logs of the real oil price and corn prices in order to have consistent variables in the VAR system of equations.

Fig. 2 shows the historical evolution of our series (the percent change in global crude oil production, $\Delta prod_t$, real economic activity, rea_t, log real oil price, rpo_t, log real corn price, $rpcorn_t$, and the percent change in U.S. total corn consumption, $\Delta CornUse_t$) over the sample period.

3. The structural VAR model

The structural VAR representation is based on Kilian (2009) and Kilian and Park (2009) and is