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Demand effects and speculation in oil markets: Theory and evidence

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A B S T R A C T

We present evidence showing the existence of stable cointegrating vectors connecting four important variables in the U.S. and global oil markets: oil production, stocks of crude oil, the real price of oil, and broad measures of income. Our data are monthly, and go back to the 1930s, split into sub-samples which correspond to periods before and after the 1973 crisis. We further show that the cointegrating vectors found in the data accord well with an extended commodity storage model which allows for demand growth dynamics and for supply regimes. Specifically, inventories and price move in opposite directions when supply is flexible, but the relationship reverses so that they comove when supply is inflexible.

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1. Introduction

The role of speculation in driving the price of crude oil has been the object of renewed interest recently. The decades-old debate, between those who argue that market developments can be directly attributed to changes in fundamentals and those who believe that speculators are creating price volatility, is showing no signs of abating.[1] In this paper we put forward the argument that a simple model with four variables – inventories, production, income, and price – can be useful in capturing

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[1] See Singleton (2013) for a recent review. Recent theoretical contributions include Pavlova and Basak (2012), where institutional investors can cause commodity prices to rise and become more volatile, and Sockin and Xiong (2012), where feedback effects from futures prices affect commodity spot prices through an information channel. However, in a survey of recent empirical work Fattouh et al. (2012) find scant evidence for the effect of speculation on prices. See also Hamilton (2009).

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important long-run features of the market for crude oil, and in particular elucidating the seemingly unstable relationship between inventories and price. We estimate the long-run equilibrium relationships predicted by the model separately for the periods 1931–1972 and 1975–2011and show that our model's long-run predictions are borne out by the data. We show evidence in support of our model's prediction that a stable equilibrium relationship exists among these four variables, that these equilibrium relationships are stable before and after the 1973 crisis, and that they broadly comport in sign to the model's predictions. Specifically, we find, as predicted by the model, that post – 1973 there is a stable **positive** long-run relationship between inventories of crude oil and the real price of crude, whereas before 1973 that relationship was **negative**.

In a previous paper, Dvir and Rogoff (2009), we argue that the real price of oil has gone through three distinct periods. First, from 1861 to about 1878 (a period not covered in the current paper), the price of oil was generally high (in real terms), and was moreover highly persistent and volatile. Then came a much less volatile period, between 1878 and 1973, in which prices were also generally lower and not at all persistent. This long period can be further divided into two sub-periods: before and after 1933, where price volatility is significantly lower after 1933 compared with the years 1878–1933. Finally, from 1973 onwards, there is a recurrence of high persistence and volatility accompanied again by higher prices. In that paper, we offered a narrative, based on our reading of the historical events, for the recurrence of high price persistence in the two end-periods mentioned, 1861–1878 and 1973–2010. We argued that in these periods two forces coincided: first, demand (governed by income) was high and very persistent, i.e. it was governed by growth shocks. Second, access to supply was restricted by agents who had the capability and incentive to do so. In particular, whereas before the crisis oil supply was easily accessible, and indeed was actively managed by regulators, after the crisis there was no easy way of increasing oil production. Post 1973, all excess capacity existed in the Middle East, where producers were more interested in maintaining high prices than in accommodating demand increases.

In that paper we also presented our model, which is an extension of the canonical commodity storage model à la Deaton and Laroque (1992, 1996). Our model introduces income growth dynamics to that framework, and in particular, can accommodate both $I(0)$ and $I(1)$ income processes. In that paper we focused on predictions of the model with regards to demand and supply shocks. In the current paper we emphasize the related but distinct **long-run** relationships which are also predicted by the model. This focus is important when attempting to account for actual market behavior. Perhaps due to the existence of unit roots in the various series – inventories, production, and price – identifying long-run relationships among them has not been a priority in the literature on the market for crude oil. However predictable long-run relationships between these variables are a hallmark of the commodity storage model. Therefore our contribution here is two-fold: first, we show that these long-run relationships do exist in the data, as predicted by the model. Second, we show that the relationships we identify in the data are (mostly) sign – consistent with our version of the commodity storage model.

Introducing income growth dynamics to the classical model adds considerably to its predictive capacity, partly by changing some of the classical model's predictions. The model can now predict how inventories and price behave when income rises or falls, conditioning on production behavior. The relationship between inventories and price is therefore no longer simple, becoming a function of production behavior. In particular, inventories may rise or fall with income. Specifically, in periods when production is flexible, i.e. when a rise in income, which raises demand, is predicted to result in a commensurate rise in production, inventories should fall, since the effects of high demand should dissipate quickly. This should help mitigate any rise in price associated with the surge in demand so that inventories and price should exhibit a negative relationship. Conversely, in periods when production is inflexible, i.e. when a rise in income is not predicted to raise production significantly, inventories should rise. This would actually enhance any rise in prices associated with high demand, so that inventories and price should exhibit a positive long run relationship. Note importantly that causality runs in both directions in a commodity storage model: in the flexible supply case a rise in prices will cause inventories to drop, thereby releasing more oil to the market and exerting a downward effect on prices. In the restricted supply case a rise in price leads to a surge in inventories, pulling oil off the market and leading to further price rises. The relationships we identify should therefore be understood as long-run equilibrium conditions, and not given a causality interpretation. It is therefore important to specify the long-run relationship among all four variables – inventories, production, income, and price – at the same time.

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