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Monetary effects on nominal oil prices

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ABSTRACT

The paper presents a theory of nominal asset prices for competitively owned oil. Focusing on monetary effects, with flexible oil prices the US dollar oil price should follow the aggregate US price level. But with rigid nominal oil prices, the nominal oil price jumps proportionally to nominal interest rate increases. We find evidence for structural breaks in the nominal oil price that are used to illustrate the theory of oil price jumps. The evidence also indicates strong Granger causality of the oil price by US inflation as is consistent with the theory.

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1. Introduction

An extensive literature has studied the effects of exogenous oil price shocks on macroeconomic outcomes, such as inflation, interest rates, and output (Bernanke, Gertler, & Watson, 2004; Hamilton, 1983; Kim & Loungani, 1992; Leduc & Sill, 2004). Much less has been said, however, about the factors that determine the international oil price itself.[1] While it is not impossible in principle that the *real* oil price is driven predominantly by oil sector-specific (e.g. technological) factors, largely unrelated to

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[1] A few recent exceptions include Barsky and Kilian (2001, 2004); Kilian (2009), and Nakov and Pescatori (in press-a,b).

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the broader macroeconomy, it seems much more plausible that the world oil price should be affected by global macroeconomic conditions as well. The latter appears even more likely when considering the *nominal* US dollar price of oil.

In this paper we focus on changes in the nominal oil price that must occur in equilibrium just to offset persistent shifts in US inflation. We view such inflation shifts as rooted in persistent changes in the growth rate of the money supply. The oil price changes take place in a competitive setting in which it is costly to renegotiate oil contracts. The latter gives rise to a pricing condition for the nominally rigid oil price whereby the newly set nominal oil price builds in the expected future inflation.

The model is in the minimalist setting that can illustrate the theory. It is a representative agent, deterministic, cash-in-advance economy that incorporates oil as an input to the production process of the final consumption good. In Section 2 we present evidence of nominally rigid oil prices prior to the mid 1980s. When the nominal oil price is stable within inflation regimes as during this period, our model implies that, from one inflation regime to the next, the oil price must jump in line with the change in the nominal interest rate net of output growth. This adjustment is necessary to restore equilibrium so that the oil firm's owners earn a competitive return on their fixed factor of production, the oil field (Section 3). The driving forces in our setup are infrequent persistent changes in the rate of inflation rooted in exogenous money supply changes. We test for and date such breaks in inflation regimes using a test for multiple structural breaks due to Bai and Perron (1998) (Section 4). We find evidence for four such breaks in the postwar period: two upward shifts in 1967 and 1973, and two downward shifts in 1982 and 1992 (see the top panel of Fig. 2); we identify three related breaks in the nominal oil price: two upward jumps in 1973, 1979, and a crash in 1985. Using the estimated break dates, we compute the oil price changes implied by the model and contrast them with the actual oil price changes, showing that the theory is consistent with the data for the period of rigid oil prices. In addition, we revisit Hamilton's (1983) Granger causality tests. At first we replicate Hamilton's result that inflation did not Granger-cause the oil price prior to 1973. However, we find robust evidence that the oil price is Granger caused by US inflation since 1973. Qualifications and possible extensions are discussed in Sections 5 and 6, and an extension considering nominal gold prices is made in a similar fashion in Appendix A.

2. Stylized facts of nominal oil price change

Fig. 1 graphs the annual percentage change in the nominal oil price versus the annual percentage change in the *rate* of inflation (the annual *acceleration* of the price level) for the period from 1957 to 2009. Inflation is defined in the usual way as the annual percentage change in the consumer price index (with the energy component removed). The figure shows that nominal oil prices were relatively unchanging before 1985, except for big spikes around 1974 and 1979, while the inflation rate moved around throughout the period. The spikes represent movements to new oil price levels that for a while remain relatively unchanged. With the oil price stable up to the first spike, between the first two spikes, and between the second spike and around 1985, these periods may characterize different "regimes" of oil price levels. Starting around 1985, oil price changes begin following inflation rate changes rather closely.

Alternatively, looking directly at the monthly series for the US dollar West Texas Intermediate oil price (in the middle panel of Fig. 2) it is clear that, at least up until 1979, the nominal oil price was changed rather infrequently. A closer look at the data reveals that the average price spell for the period from 1957 to 1979 was more than a year (and close to a year-and-a-half if we exclude the couple of occasions with two or three consecutive price changes of a few cents); the longest price spell is around 2 years; other nominal oil price series, such as the series compiled by the IMF, show even more rigid behavior.

The above pattern has to do with the fact that prior to the 1979 Iranian revolution, much of the oil market was dominated by long-term contracts with oil companies (Biolsi, 1995). In particular, Hamilton (1983) documents the practice of "posted" oil prices during the "pre-OPEC" period, and the regulatory defense of posted prices by the Texas Railroad Commission and other US state regulatory agencies. The commissions tended to keep the nominal price of oil constant, allowing the quantity produced to fluctuate to meet demand, unless a large disturbance occurred. This policy of keeping the