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What drives the commodity price beta of oil industry stocks?

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ABSTRACT

We test theoretical drivers of the oil price beta of oil industry stocks. The strongest statistical and economic support comes for market conditions-type variables as the prime drivers: namely, oil price (+), bond rate (+), volatility of oil returns (−) and cost of carry (+). Though statistically significant, exogenous firm characteristics and oil firms' financing decisions have less compelling economic significance. There is weaker support for the prediction that financial risk management reduces the exposure of oil stocks to crude oil price variation. Finally, extended modelling shows that mean reversion in oil prices also helps explain cross-sectional variation in the oil beta.

1. Introduction

This paper theoretically models and tests the determinants of the commodity beta (i.e. *stock price sensitivity with respect to output/commodity price*, in this case oil) of oil industry stocks. Given imperfect capital markets, the risk associated with fluctuations in crude oil prices is fundamentally important to the managers and investors of firms within the oil and gas sector. Moreover, growing demand, geopolitical pressures and challenging resource allocation continue to drive uncertainty across the global energy landscape and this is prominently manifested through oil prices. Thus, by enhancing our understanding of the key drivers underlying the risk exposures of oil stocks, both managers and investors will be better placed to optimally manage/respond to the commodity-price risk facing their respective decision-making contexts. These considerations are the core motivations for our study.

Several studies have examined the exposure of oil stocks to fluctuations in the oil price within the North American, UK and Australian equity markets, however, to date the results do not provide conclusive statistical evidence (see, for example, Boyer and Filion, 2007; Chen et al., 1986; Hamao, 1989; Haushalter et al., 2002; Henriques and Sadorsky, 2008; Kaneko and Lee, 1995; Sadorsky, 2001). In addition, this literature focuses on the estimation of oil price exposure at the market or industry level, with minimal empirical research undertaken at the firm level. Our paper redresses this situation by modelling oil price exposures at the firm level, for a sample of North American oil companies over the period 1999 to 2008.[1]

While the extant finance literature gives good service to the potential role of uncertainty around exchange rates or interest rates as additional sources of risk, the more general question of the theoretical determinants of commodity price exposure has not been totally ignored.[2] Tufano (1998) is the beacon in this regard and his work applies to the gold industry. His modelling predicts that the theoretical drivers of the gold price exposure of gold stocks relate to: (i) market conditions; (ii) exogenous firm characteristics; (iii) a firm's financial policy; and (iv) a firm's risk management policy.[3] Hong and Sarkar (2008) extend the theoretical derivation of the commodity beta to account for the mean-reverting output price process. Despite the importance of the oil industry, to date, the literature is absent a rigorous theoretical framework which models the sensitivity of oil stocks to fluctuations in the output price and the factors driving such oil price exposure. As a

[1] The North American market represents the largest proportion of the world's oil companies in terms of both market capitalization and the number of listed firms, with the US and Canada being the third and seventh largest world oil producers, respectively (U.S. Energy Information Administration, 2010a,b).

[2] Prior studies which have sought to estimate the exposure of firms to fluctuations in the commodity price have concentrated on the gold bullion price, most notably; documenting that for gold mining stocks, changes in the gold bullion price (i.e. output price risk) is an important determinant of returns. See, for example, McDonald and Solnik (1977); Tufano (1998); and Faff and Hillier (2004).

[3] Employing a sample of 48 North American gold stocks over the period 1990 to 1994, Tufano (1998) finds that the exposures of gold stocks are negatively related to select exogenous firm characteristics, as well as market conditions and a firm's risk management strategies, while being positively related to the financing policies of gold firms.

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consequence a robust empirical assessment of the factors driving these "oil betas" does not exist. We re-redress these limitations in the literature.

Given many similarities in the fundamental characteristics of the gold and oil industries, our strategy for modelling oil commodity betas in the oil industry is to begin with Tufano (1998) theoretical framework. However, this base model requires careful re-interpretation and enhancement. For one thing, oil producing companies have unique operating characteristics which make it difficult to accurately predict the effect of market-wide and firm-based factors on their oil price exposure (Quirin et al., 2000, p. 787). With the impact of these factors being dependent on a number of external influences, the challenge therefore is to build a more reliable model to understand the determinants of stock returns. Accordingly, the contribution of our research lies in the innovation associated with the inclusion of fundamental factors specific to the oil industry in a range of valuation models designed to analytically explain the returns of oil stocks. One key element of this relates to accommodating the mean-reverting nature of oil prices in our model.

Our findings can be neatly summarized. We document that there is strong statistical and economic support for market conditions as theoretical determinants of oil price exposure, most notably, oil price (positive role), bond rate (positive), volatility of oil returns (negative) and cost of carry (positive). However, the statistical significance of exogenous firm characteristics and oil firms' financing policy are not convincingly supported by a corresponding level of economic significance. There is also some support for the empirical prediction that financial risk management activities reduce the exposure of oil stocks to fluctuations in the price of crude oil. Finally, extended modelling and tests show that a high degree of mean reversion evidenced in the crude oil price drives systematic cross-sectional differences in stock price sensitivities to oil price returns.

2. Comparison of the fundamental characteristics of the oil and gold industries

The basic elements of the underlying valuation models implemented by Tufano (1998) appear common to all mining and extractive industries in general, with particular similarities in the defining characteristics of the oil and gold industries. Publicly traded oil stocks, like gold mining firms, produce a commodity output which is exhaustible and whose price is highly volatile. However, while the gold industry predominantly comprises 'pure play' firms, the oil industry has both upstream (exploration and production) and downstream (refining and processing of crude oil, their distribution and marketing) elements, with firms either fully integrated across all levels of the value-chain or concentrated within a particular sector of specialization (Sadorsky, 2001, p. 18). Despite the differences in the operating structures, the financial composition of these firms does not materially differ, with both industries typically operating with a high degree of financial leverage to support the capital intensity required to purchase, develop and operate mines/oilfields.

The finite nature of gold and oil resources means that firms within these sectors are subject to significant volatility in commodity prices driven by fluctuations in demand and supply conditions. The cyclical nature of the oil industry suggests that uncertainty driven by oil price volatility is a constant concern. Oil is a globally traded commodity with the price determined by global demand and supply conditions, however, an increasing demand for oil coupled with decreasing global supplies has seen a rise in the oil price from historical averages, driving greater volatility in oil price fluctuations. This enhanced volatility has increased risk and uncertainty within the oil market, subsequently negatively impacting stock prices while reducing wealth and investment opportunities (Henriques and Sadorsky, 2008, p. 999).

While the empirical literature evidences the co-movement of commodity prices (e.g. Pindyck and Rotemberg, 1990), another body of research analyses the unique characteristics of these commodities as underlying drivers of fluctuations in the crude oil and gold bullion price. Inflation, changes in the exchange rate of the US dollar and heightened political and economic uncertainty are major factors contributing to gold price movements, with recurring concerns over the inflationary impact of higher oil prices coupled with investor demand and speculative activity also seen to drive increased fluctuation in the gold bullion price (Reserve Bank of Australia, 2007).

The literature also documents that the long-term evolution of the price of an exhaustible commodity should follow a mean reverting price process and gravitate over time toward the mean reverting price level (Hong and Sarkar, 2008). Mean reversion in energy prices is well supported by empirical studies of energy price behaviour, as well as basic microeconomic theory (Bessembinder et al., 1995; Hong and Sarkar, 2008; Longstaff and Schwartz, 1995). Basic microeconomic theory suggests that in the long-run the price of a commodity will be tied to its long-term marginal production cost or the long-run profit-maximising price sought by cartel managers in the case of cartelised commodities like oil (Laughton and Jacoby, 1995, p. 188). The speed at which prices revert to their long-run level, however, is dependent on a number of factors including the nature, magnitude and direction of the commodity price shock.

Despite these factors, demand and supply pressures and non-constant convenience yields in commodity markets suggest that mean-reversion to long-run equilibrium prices holds. Within commodity-based industries, however, it is difficult to disentangle the structural change in fundamentals of the industry from inherent fluctuations in the mean reverting price process. Estimating the mean reversion parameters of a variety of commodities, Bessembinder et al. (1995) find that there is substantial mean reversion in the crude oil prices but far less reversion in gold bullion prices.[4]

3. Hypothesis development

3.1. Valuation models

Tufano (1998) employs three valuation frameworks: fixed-production model; flexible-production model; and a model of fixed-production with hedging.[5] The flexible-production model recognizes that commodity-based firms have real options in their production schedules (see, for example, Brennan, 1990; Brennan and Schwartz, 1985; Paddock et al., 1988; Schwartz and Moon, 2000). The real options model developed by Brennan and Schwartz (1985) for the evaluation of investment projects treats output prices as stochastic, takes explicit account of managerial control over the output rate (which is assumed to be variable in response to the output price) and incorporates the possibility that a specific project may be closed down or suspended if the output price falls below the firm's marginal cost. Ignoring the optionality embedded in mine operating decisions tends to overstate the mine's sensitivity to price shocks of the underlying commodity (Tufano, 1998, p. 1025). Under the fixed-production model with hedging, firms that sell forward their entire production profile can eliminate their exposure to commodity prices which subsequently drives their commodity beta towards zero. In addition, the price at which gold is sold forward affects the observed beta for those firms that sell forward less than their entire future production.

[4] More specifically, Bessembinder et al. (1995) estimate that 55 percent of crude oil price shocks are reversed in the 8 months following the shock, while only 5.7% of gold bullion price shocks are reversed over a similar period.

[5] In the fixed-production model, firms cannot alter their production profiles and do not engage in financial risk management. Under the assumptions of this model, a company owns a fixed quantity of reserves that it is expected to mine/tap at a given production rate which is specified at time zero and remains unaltered over the life of the mine/oilfield. The model is based on the premise of the DCF technique.