Overview

Since the turn of the millennium, energy markets have experienced a number of shocks, particularly on the supply side. The rise of unconventional methods of production in the United States and the changing role of OPEC have impacted energy commodity markets. The financialization of commodity markets also played a role in the volatility observed in energy markets. The commingling of such events, over the last 15 years, could have impacts on the interconnectedness of energy commodity markets. The hypothesis pertaining to the interconnectedness of energy commodity markets dates to the early work of Adelman (1992), and continues today with the investigation of a ‘global pool’ hypotheses in oil markets [Gulen, 1999; and Wilmot, 2013], typically with a focus on the univariate or bilateral properties of the commodities price series.

Yet, a particularly salient feature of many commodity markets is the unexpectedly rapid changes that result from the arrival of new information. The discontinuous arrival of information necessitates a stochastic process that incorporates this feature, and as such jump processes have become an important tool in the analysis of energy markets. Recent research has established the relevance of discontinuities for modeling oil prices, and recognized that the arrival of new information can lead to “jumps” (Askari and Krichene, 2008; Lee et al., 2010; Mason and Wilmot, 2014; Postali and Picchetti, 2006; Wilmot and Mason, 2013).

In general, the adoption of a stochastic process which incorporates the discontinuous arrival of information has allowed for multiple jumps to occur in a period, however the jump intensity is assumed to be constant over time. This latter feature is of particular importance for energy markets as they are frequently hit with unexpected news. Examples include natural disasters (hurricanes, earthquakes), geopolitical developments (nationalization, strikes) strategic actions (OPEC), and other unforeseen events (spills, pipeline disruptions). These sorts of effects can lead to periods of unexpectedly large changes in energy futures prices, either upwards or downwards. Chan and Maheu (2002) developed a conditional jump model (ARJI), with a time conditional jump intensity, which is modelled as an autoregressive moving average (ARMA) form. Applied to daily stock returns, the jump model is coupled with a generalized autoregressive conditional heteroscedasticity (GARCH) specification of volatility. The results indicate significant evidence of time variation in the conditional jump intensity. Recently, Wilmot and Mason (2019) have applied the model to three energy commodity futures prices (crude oil, natural gas, coal). Based on daily futures price returns, the results demonstrate the importance of incorporating time-varying jump intensities in energy markets.

Herein, the autoregressive conditional jump intensity model (ARJI) is adopted, with an emphasis on the time-varying jump intensity, for use in examining the interconnectedness across tiers of the North American crude oil market. As Fatouh (2011) notes, the pricing formulae used in oil markets centre on key ‘physical’ benchmarks such as West Texas Intermediate (WTI). If jumps are important at the benchmark level, what role have they to play in the secondary (Kern River, Western Canadian Select, California Midway, etc.) markets? According to Fatouh (2011) as the market becomes thinner – lower volume of production – the pricing process becomes more difficult. Furthermore, the author notes that markets with low volumes of production influence the price for markets with higher volumes. Do discontinuities in one crude oil market influence arrival of discontinuities in another? The potential presence of bilateral relationships across an array of crude oil prices, from different regions of North America, is investigated. Finally, the period of study is dissected into sub-periods (pre- and post 2008) due to what would be described as a structural break, with one possible cause due to the rapid increase shale oil production (Brown and Yucel, 2013).
Methods
Using daily data on crude oil (spot) prices, from secondary North American markets and the WTI benchmark series. A series of time-varying jump intensity values, based on the ARJI model of Chan and Maheu (2002) are obtained. The ARJI model should be useful in capturing time series dynamics of the conditional jump intensity. To investigate the existence of Granger causality, vector autoregression (VAR) methods are employed. The model allows for an examination of linkages within and across the spectrum of crude oil series under study.

Results
Prior to estimation of the jump diffusion process, conventional tests were utilized to determine the existence of a unit root. The ADF, Phillips – Perron, as well as the modified ADF test (Elliot et al, 1996) indicate that price (levels) appear to be nonstationarity while (log) returns (calculated as 1st – differences) are stationary over the period of study. The data are generally available starting in 2000, through the end of 2018. The period contains numerous events (Great Recession, Katrina, Shale Revolution) that are likely to produce a structural break. Based on the results of a structural break analysis, sub periods were formulated. Preliminary findings reinforce the role of discontinuities (jumps) for the idiosyncratic (or secondary) crude series, which aligns with previous results for the benchmark series (Wilmot and Mason, 2013).

Conclusions
While the project is ongoing, preliminary analysis suggests evidence of a bi-directional relationship. Such a results could have consequences for producers, traders, and governments. Intuitively, it stands to reason that shocks to the benchmark (WTI) crude oil would ‘affect’ secondary crudes. Yet, a result that suggest that secondary crudes can impact the benchmark could have broad implications, particularly for the dynamics of hedging strategies.

References