Energy Economics 34 (2012) 1896–1909

Contents lists available at SciVerse ScienceDirect

Energy Economics

journal homepage: www.elsevier.com/locate/eneco

On the volatility–volume relationship in energy futures markets using intraday data ☆

Julien Chevallier [a,*], Benoît Sévi [b]

[a] Université Paris 8 (LED), 2 rue de la Liberté 93526 Saint-Denis Cedex, France
[b] Aix-Marseille University (Aix-Marseille School of Economics), CNRS & EHESS. Château La Farge, Route des Milles, 13290 Les Milles Aix-en-Provence, France

ARTICLE INFO

Article history:
Received 31 May 2011
Received in revised form 22 April 2012
Accepted 24 August 2012
Available online 1 September 2012

JEL classification:
C15
C32
C53
G1
Q4

Keywords:
Trading volume
Price volatility
Crude oil futures
Natural gas futures
Realized volatility
Realized semivariance

ABSTRACT

This paper investigates the relationship between trading volume and price volatility in the crude oil and natural gas futures markets when using high-frequency data. By regressing various realized volatility measures (with/without jumps) on trading volume and trading frequency, our results feature a contemporaneous and largely positive relationship. Furthermore, we test whether the volatility–volume relationship is symmetric for energy futures by considering positive and negative realized semivariances. We show that *(i)* an asymm etric volatility–volume relationship indeed exists, *(ii)* trading volume and trading frequency significantly affect negative and positive realized semivariance, and *(iii)* the information content of negative realized semivariance is higher than for positive realized semivariance.

1. Introduction

Trading volume and price volatility are heavily studied because their behaviors matter for traders, speculators, and hedgers who need to extract information from these variables to predict future prices.[1] Markets are assumed to contain noise, whose source is the precision of information contained in prices. Since price alone does not allow traders to observe the information signal, or the true value of the asset, volume may yield sufficient additional information for that signal to be observed. From that perspective, different groups of agents are interested in the volatility–volume relationship in futures markets. Volume may be used to forecast future price movements because traders condition their expectations on volumes exchanged, as well as on the actual price level. On the one hand, hedgers typically engage in trading futures contracts to stabilize their future income flows or costs, with the trading volume being determined by their expectations about future spot (and futures) price movements. On the other hand, speculators take a position in futures contracts based on their expectations of futures price variability (Foster, 1995). Furthermore, policymakers follow closely their evolution to assess market activity, and to identify potential regulatory changes (Wang and Yau, 2000).

According to Karpoff (1987), the price–volume relationship constitutes a central question in finance because it relates to the rate of information flow to the market, how the information is disseminated, the extent to which market prices convey the information, the size of the market and the existence of short sales constraints.[2] Indeed, it is likely that simultaneous large volumes and large price changes (either positive or negative) may be traced to their common ties to information flows, or to a directing process that may be interpreted as the flow of information. Since changes in prices and trading volume are both driven by the same directing variable, namely the information flow, it is expected that they will exhibit a positive correlation. Trading

☆ The authors wish to thank the Editor – Prof. Richard S.J. Tol – as well as an anonymous reviewer for helpful comments which lead to an improved version of the paper.
* Corresponding author.
E-mail addresses: julien.chevallier@dauphine.fr (J. Chevallier), benoit.sevi@univ-amu.fr (B. Sévi).
[1] See the discussion in O'Hara (1995), Section 6.2.

[2] The relatively large cost of taking a short position provides an explanation for the observation that, in equity markets, the volume associated with a price increase generally exceeds that with an equal price decrease, since costly short sales restrict some investors' abilities to trade on new information.

0140-9883/$ – see front matter
http://dx.doi.org/10.1016/j.eneco.2012.08.024

volume may be typically considered along three dimensions (Jones et al., 1994): *trading volume* (i.e. the number of shares traded), *trading frequency* (i.e. the number of trades) and *trade size* (i.e. the number of shares per trade). In theory, the volatility–volume relationship may be driven by either one or several components. Hence, to capture the full dynamics behind the volatility–volume relationship, we need to consider the differential roles of these three components.

Previous empirical research has noted that there is generally a strong contemporaneous positive relationship between volume and price volatility in futures markets (Gallant et al., 1992), despite the coexistence of several theoretical backgrounds (see Huang and Masulis, 2003 for a review). On the one hand, based on the insight that larger-sized trades tend to be executed by better-informed investors, Easley et al. (1997) document a positive relationship between trading volume and price volatility. Chiang et al. (2010) provide strong evidence to support the sequential information hypothesis, and demonstrate that it is useful to use lagged values of trading volume to predict return volatility. On the other hand, assuming that informed investors engage in stealth trading by breaking up large trades into many smaller transactions, Kyle (1985) finds a positive relationship between trading frequency and volatility. These results are confirmed by Jones et al. (1994) and Huang and Masulis (2003), among others. Finally, models relying on the mixture of distributions hypothesis (MDH, Harris, 1987)[3] advocate that trading frequency shall not affect price volatility, and that trading volume is the relevant factor reflecting the arrival of new information. Chen and Daigler (2008) show how these perspectives are complementary rather than competitive in nature, and help in explaining the different aspects of the volatility–volume relationship as information passes from one group of agents to another.

In addition, price–volume relationships have significant implications for futures markets, i.e. how price volatility affects the volume of trades in futures contracts. Knowledge of price volatility is useful for estimating margin requirements and option prices. In general, the price variability of a futures contract indicates the riskiness of holding the commodity. This information may then be used to set the price in many energy futures contracts for the physical commodity. From that perspective, the volume of trades constitutes an important aspect in influencing price volatility: as it increases, the variability of daily price changes is also likely to increase, and hence both margin requirements and option prices are likely to increase. What concerns energy futures markets, Serletis (1992) and Foster (1995) have studied the volume–volatility relationship for crude oil futures contracts. Fujihara and Mougoué (1997) further confirm that the knowledge of current trading volume improves the ability to forecast petroleum futures prices. Herbert (1995) documents that the volume of trades explains the volatility of natural gas futures contracts.

To enrich the understanding of the trading dynamics behind the volatility–volume relationship in the crude oil and natural gas futures markets, we examine in this paper the role of trading volume and trading frequency on high-frequency measures of volatility. Namely, we investigate the presence of an *asymmetric* volatility–volume relationship in oil and gas futures markets by using high-frequency data. The main contribution is to consider the downside vs. upside semivariance (Barndorff-Nielsen et al. (2008)), and to discriminate between them. Broadly speaking, negative (positive) realized semivariance may be defined as measuring the variation of asset price falls (increases). An asymmetric volatility–volume relationship implies that the relation is fundamentally different for positive and negative price changes, i.e. the correlations between volume and positive/negative price changes are expected to vary and to have distinct explanatory powers. This view is supported by the empirical observation that trading tends to be higher in bull markets than in bear markets (Foster, 1995).[4] However, this asymmetry is generally not present in futures markets.

The literature on the volatility–volume relationship using high-frequency data is still very sparse. The main idea behind using high-frequency data consists in re-examining the results of previous literature by using a more precise estimator of the unobserved volatility.[5] By constructing the realized volatility measure from the sum of intraday squared returns, Chan and Fong (2006) establish that the number of trades is the dominant factor behind the volatility–volume relationship and that, beyond the trading volume or the number of trades, trade size adds very little explanatory power for realized volatility. Giot et al. (2010) further decompose realized volatility into two major components: a continuously varying (persistent) component and a discontinuous (temporary) jump component based on bipower variation (Barndorff-Nielsen and Shephard (2004, 2006)). To do so, they distinguish between the *level* of volatility (i.e., low vs. high volatility) and the *nature* of volatility (i.e., continuous vs. discontinuous volatility). While previous literature has been focusing on the former aspect of the positive volatility–volume relationship, their study aims at characterizing the latter aspect by introducing the concept of jumps for the 100 largest stocks traded on the New York Stock Exchange (NYSE) from January 1995 to September 1999. Giot et al. (2010) find that the number of trades remains the dominant factor, whatever the volatility component considered, except for jumps which are not related in most cases to any trading activity variables.

To our best knowledge, this methodology has not been applied yet to energy futures markets. We follow Chan and Fong (2006) by using high-frequency data to investigate the relation between volatility and transaction data, such as trading volume and trading frequency. In addition, we provide new evidence based on filtering jumps from realized volatility measures with bipower variation (BPV, Barndorff-Nielsen and Shephard (2004, 2006), Andersen et al. (2007a, 2007b) and median realized volatility (MedRV, Andersen, Dobrev and Schaumburg (2012) to properly account for the role of volume on the continuous component of volatility, as in Giot et al. (2010).

Our work contributes to the literature in a number of dimensions. First, we study crude oil and natural gas, the two most liquid energy markets in the world, with high-frequency data to obtain a less noisy measure of volatility. Second, we establish that trading volume and trading frequency are significant and positive in explaining various realized volatility measures, which emphasize their central role in shaping the information flow. Overall, we find that the variables for trading volume and trading frequency share the same information content. Thus, they yield to the same qualitative results in the context

[3] The MDH for the joint distribution of price changes and volumes is based on two assumptions. First, the joint distribution of price changes and trading volume is bivariate normal conditional upon the arrival of information. Second, the daily number of information events is random, which implies that price increments are generated by the stochastic rate of information arrival. Since price changes and trading volume are assumed to react to information events, their total daily quantities are the cumulative sum of reactions to each news event. The implication of the MDH is that prices and volume have a joint response to information due to their common distribution (Foster, 1995).

[4] Note that explaining what accounts precisely for this asymmetric price–volume relationship goes beyond the scope of this paper. As mentioned by Karpoff (1987), if the key is short sale constraints, then futures market data would reveal no correlation between volumes and price changes. To the extent that organized option trading reduces the cost of taking net short positions, the asymmetry should also be attenuated in price and volume data from optionable securities.

[5] The interest of using realized measures is well illustrated by Avramov et al. (2006), who use the realized volatility estimator as a robustness check. They show that the explanatory power in their regression of the volatility on the volume is two times greater when using intraday data compared to daily data.