Original Article

Implications of futures trading volume: Hedgers versus speculators

Received (in revised form): 10th June 2009

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ABSTRACT The high trading volume in securities markets has puzzled researchers for years. Recently, overconfidence models have offered testable implications to address the puzzle. In this study, we proved empirically that investors have different degrees of overconfidence in trading securities. Using information in the Commitments of Traders reports of the Commodity Futures Trading Commission to differentiate between hedgers and speculators, we find relatively strong and consistent evidence of overconfident trading among futures speculators only. There are four major findings in our results. First, speculators trade more (less) aggressively following gains (losses) in futures markets. Second, speculators trade more (less) aggressively following gains (losses) of related stocks in the stock market. Third, gains (losses) of less-related stocks, however, do not affect the trading of futures speculators. Finally, it is found that overconfident futures speculators assume more (less) risk following market gains (losses). Given that overconfident investors tend to overestimate investment returns, our findings may have important implications for investors in zero-sum financial markets.
Journal of Asset Management (2009) **10,** 318–337. doi:10.1057/jam.2009.31

Keywords: overconfidence; trading volume; futures; speculators; hedgers

INTRODUCTION

In 2006, 2.04 billion exchange-traded futures contracts were transacted in the United States. This number represents a phenomenal growth of 27 per cent per annum since the year 2000.[1] Over the same period, the trading volume of all the securities on the New York Stock Exchange (NYSE) increased from 262.47 billion to 588.13 billion shares, yielding a growth rate of 14.4 per cent per year.[2] The annual growth rate of futures volume was almost twice that of the NYSE securities between 2000 and 2006. The volume of futures is astonishingly high when we consider the fact that the most heavily traded futures contract (3-month Eurodollars) on the Chicago Mercantile Exchange in 2006 involved only 270 traders and had a volume of 9.3 million.[3] Official statistics reveal that most futures contracts involve fewer than 100 traders. Researchers have generally considered the trading volume in speculative markets too large to be justified on rational grounds. De Bondt and Thaler (1995, p. 392) note that the high trading volume observed in financial markets 'is perhaps the single most embarrassing fact to the standard finance paradigm.'

Extant literature on trading volume analysis typically focuses on common equity; there is no published study that specifically explains the high trading volume in futures markets. We intend to fill the void in the literature through this study, and hope to extract information that may be useful to investors. We examine futures volume because information in the Commitments of Traders reports of the Commodity Futures Trading Commission (CFTC) allows us to separate hedgers from speculators. This enables us to determine whether hedgers and speculators behave differently in the context of volume analysis. Ederington and Lee (2002) show that there are substantial differences between hedgers and speculators in their propensity to take up a position. Wang (2003) and Sanders *et al* (2004) also provide evidence that the net trading positions of speculators and hedgers react differently to market returns and information. We add to the literature by investigating overconfidence as a possible explanation for the high volume of futures. Jonsson and Allwood (2003) and Glaser and Weber (2007) find that people often show different levels of overconfidence depending on the task or domain. This implies that investors may have different degrees of overconfidence when trading securities. Our study is the first to investigate the overconfidence effect among different types of traders in the same market.

A variety of explanations have been offered for the extraordinarily high volume of equity trading that takes place on stock exchanges. A common thesis is that heterogeneous information causes rational trading to take place. However, Milgrom and Stokey (1982) show that rational trade might not occur even when traders have heterogeneous information. Other no-trade theorems have also argued that heterogeneous information alone cannot justify the high trading volume in securities (Brunnermeier, 2001). Despite the fact that the models of noise trading or liquidity trading appear able to justify trading (Shleifer and Summers, 1990; Pagano and Roell, 1992), many have suggested that noise or liquidity trading is unsatisfactory in accounting for the high trading volume in financial markets (Wang, 1998; Hirshleifer, 2001). With the failure of traditional models in explaining trading volume, a growing number of researchers have in recent years tried to account for the anomaly by developing theoretical models that are built on the assumption of investor overconfidence (for example, Odean, 1998, 1999; Barber and Odean, 2001; Daniel *et al*, 2001; Gervais and Odean, 2001; Wang, 2001). The presence of overconfidence in the business world is well known. Many studies find that corporate managers are prone to the wishful thinking that projects under their command are bound to succeed (for example, Russo and Schoemaker, 1992; Malmendier and Tate, 2005). In addition, it has been well documented in the cognitive psychology and behavior science literature that overconfidence is rather persistent and does not wane over time. The impact of persistent overconfidence in financial markets has been overwhelming. Empirical studies find that investors persistently overestimate the average rate of return to their assets and underestimate the risk associated with the return.

More importantly, many researchers find that overconfidence is associated with high levels of trading volume in financial assets (Grinblatt and Keloharju, 2006; Statman *et al*, 2006; Glaser and Weber, 2007).

Futures volume has been examined frequently in the studies on the relationship between volume and price (for example, Cornell, 1981; Tauchen and Pitts, 1983, Grammatikos and Saunders, 1986; Foster, 1995; Nguyen and Daigler, 2007). Some examined the determinants of futures volume in terms of macroeconomic and financial variables (Martell and Wolf, 1987; Foster, 1995; Kocagil and Shachmurove, 1998). Some researchers have related futures volume to information theories such as the sequential information model and the mixture of distributions hypothesis; however, such attempts appear inadequate given the inability of heterogeneous information in accounting for the high level of trading volume. Most of the existing studies on futures volume mainly examine the relationship between the time series of volume and price so as to yield a prediction regarding the price-volume relationship. None have explored the underlying force driving futures volume.

This study is motivated by the lack of an explanation for the high trading volume in futures markets. The ability to separate hedgers from speculators also motivates our desire to investigate the empirical implication in the literature that investors may have different degrees of overconfidence when trading securities. This investigation adds to the literature that shows that futures trading might be affected by behavioral factors such as investor sentiment (Simon and Wiggins III, 2001; Wang, 2001, 2003). In addition, it is important to study volume, as pointed out by Karpoff (1987), because it can provide insights about market structure and information flows. This study is also related to the literature on the volume-return relationship in futures markets. A better understanding of how trader behavior affects trading activity may help make better predictions of the volume-return relationship of futures. This study also contributes to the line of research that examines trading behavior by trader type (Hartzmark, 1991; Ederington and Lee, 2002; Wang, 2003).

In this study, we investigate the presence of overconfident trading in futures markets by examining the trading volumes of six commodity futures. Four testable hypotheses are developed based on the implications of overconfidence models. When no differentiation is made between hedgers and speculators, only limited evidence of overconfident trading in futures markets is found in the aggregate volume. When we separate the volume data of hedgers and speculators by using the information in the Commitments of Traders reports of the CFTC, we find relatively strong and consistent evidence of overconfident trading among the speculators in three of the six examined futures markets. For hedgers, we do not find any evidence of overconfident trading. There are four major findings in our results. First, we find that speculators trade more (less) aggressively following gains (losses) in futures markets. Second, we find that speculators trade more (less) aggressively following gains (losses) of related stocks in the stock market. Third, gains (losses) of less-related stocks, do not affect the trading of futures speculators. Finally, we find evidence that overconfident futures speculators assume more (less) risk following market gains (losses). Given that overconfident traders tend to overestimate investment returns, our findings may have important implications for investors in zero-sum financial markets.

The remainder of this paper is organized as follows. We first provide a brief review of the related literature. Next, we develop four testable hypotheses based on the implications of overconfidence models and describe the methodology. Data and results are then presented. The final section presents the summary and conclusions.

OVERCONFIDENCE IN FINANCIAL MARKETS

Researchers attribute overconfidence to two cognitive traits: biased self-attribution and confirmatory bias (Odean, 1998; Daniel *et al*, 2001; Gervais and Odean, 2001; Hirshleifer, 2001). Biased self-attribution causes investors to attribute success to their own abilities and failure to bad luck or external factors. Confirmatory bias causes investors to interpret evidence as consistent with their prior beliefs. Accordingly, overconfidence models have three major predictions regarding the behavior of overconfident investors in speculative markets.

The first prediction of overconfidence models is that overconfident investors are likely to mistakenly attribute market gains to their ability to pick winners in stock markets, and as a result the investors tend to trade more aggressively following market gains. Similar arguments that overconfident investors trade excessively have been made by De Long *et al* (1991), Kyle and Wang (1997), Benos (1998), Wang (1998, 2001), Daniel *et al* (2001) and Hirshleifer and Luo (2001), among others. There has been empirical evidence showing that overconfident investors are associated with high levels of trading volume. In a study of 78 000 individual investors, Barber and Odean (2000) find substantial persistence of investor overconfidence, which results in high levels of trading volume and high turnover rates. Statman *et al* (2006) point out that with the biased self-attribution of overconfident investors, trading volume is related to lagged returns because investment success increases the degree of overconfidence. They examined both market-wide and individual security turnover and found evidence showing that share turnover is positively related to lagged returns for many months. Based on a monthly survey of financial market specialists, Deaves, Luders and Schroder (2005) find that even professional market analysts are persistently overconfident.

The second postulation of overconfidence models is that high total market returns make some investors overconfident about the precision of their information (Odean, 1998; Gervais and Odean, 2001). According to Daniel *et al* (2001), overconfident investors tend to overemphasize their own private information and to believe the information is more accurate and precise than other sources of information. Glaser and Weber (2007) examine whether overconfidence is a manifestation of miscalibration of uncertainty; they conclude that measures of miscalibration are unrelated to overconfident trading volume. Grinblatt and Keloharju (2006) find evidence that trading volume is more related to overconfidence than to sensation-seeking.

There is consensus in the finance literature that stock price movements are more volatile than warranted by an efficient capital market (Shiller, 1981). The third general supposition of overconfidence models suggests that overconfident traders might be responsible for the excessive volatility in stock markets. According to Benos (1998), it is possible that overconfident traders aggressively exploit their information and cause share prices to move too much in one or the other direction. The prediction that overconfident traders are associated with higher levels of asset price volatility is also found in studies by Odean (1998), Daniel *et al* (1998), Wang (1998) and Gervais and Odean (2001). The observable outcome in speculative markets is that overconfident investors hold riskier positions than if the investors were rational, as overconfident investors persistently overestimate the average rate of return to their assets and underestimate the risk.

HYPOTHESES AND METHODOLOGY

Our first testable hypothesis is that overconfident futures traders trade more (less) aggressively after gains (losses) in futures markets. We develop this hypothesis based on the first general prediction of overconfidence models that overconfident traders attribute market gains to their own ability in investing and are likely to trade more (less) aggressively after market gains (losses). The empirical procedure used for testing Hypothesis 1 is a vector error correction model (VECM) with the following specification:

$$\begin{bmatrix} \Delta fret_t \\ \Delta fturnover_t \end{bmatrix} = \begin{bmatrix} \alpha_{\Delta fret} \\ \alpha_{\Delta fturnover} \end{bmatrix} + \sum_{i=1}^{N} A_i \begin{bmatrix} \Delta fret_{t-i} \\ \Delta fturnover_{t-i} \end{bmatrix} + B_j F\sigma_t + C_k \Phi_t - 1 + \begin{bmatrix} \varepsilon_{\Delta fret,t} \\ \varepsilon_{\Delta fturnover,t} \end{bmatrix} \quad (1)$$

where $\Delta fret$ is the first-differenced futures return, $\Delta fturnover$ is the first-differenced futures turnover, $F\sigma$ is futures return volatility and Φ is an error correction term.

The model is chosen in order to study the interaction between the volume and return time-series of the futures selected for investigation. We follow Statman *et al* (2006) in using returns and turnover for testing the implications of overconfidence trading. According to Statman *et al* (2006), if investors are overconfident, trading volume will be positively related to lagged returns because investment success increases the degree of overconfidence. A VECM specification is chosen based on the results of a number of unit root and cointegration tests. The VECM methodology allows for a covariance structure to exist in the residual vector, ε_t, that captures the contemporaneous correlation between endogenous variables. The VECM methodology also allows for the coexistence of a long-run equilibrium and short-term dynamics among the investigated variables.

In the model in equation (1), there are two endogenous variables, first-differenced futures turnover ($\Delta fturnover$) and first-differenced futures return ($\Delta fret$), and one exogenous variable, futures return volatility ($F\sigma$). Formal overconfidence models do not specify a time frame for the relationship between returns and turnover, and thus we let the data determine the number of lags to include based on the Akaike's Information Criterion (AIC). Changes in the residual, $\varepsilon\Delta_{fret,t}$, will affect the current value of $\Delta fret$, but will also affect future values of $\Delta fret$ and $\Delta fturnover$ because lagged values of $\Delta fret$ appear in both equations through the coefficient matrix. Therefore, we can track how futures volume ($\Delta fturnover$) responds over time to shocks of $\varepsilon\Delta_{fret,t}$. The exogenous variable futures volatility ($F\sigma$) is added to control for a possible contemporaneous volume-volatility relationship of financial assets (Karpoff, 1987). The error correction term, $\Phi(t-1)$, accounts for the long-run equilibrium among the time series.

Hypothesis 1: Overconfident futures traders trade more (less) aggressively following gains (losses) in futures markets.

Our second hypothesis integrates the above-mentioned second prediction of overconfidence models and the literature on information transmission. There is ample evidence that information can transmit between speculative markets. For example, Tse *et al* (1996), Tse (1998) and Fung *et al* (2002) have examined the information transmissions and price linkages across markets with similar futures contracts. Prior studies such as those by Ghosh (1993) and Fung and Lo (1995) have investigated the cross-market relationship between futures and spot prices. Despite there being a debate regarding the lead-lag relationship between futures and stock markets, some have observed that stock market information could result in bi-directional movements between the two markets (Abhyankar, 1998; Silvapulle and Moosa, 1999). Thus, given the information transmission between stock and futures markets and the second prediction of overconfidence models, we postulate that overconfident futures investors overestimate the precision of their private information following gains in related stocks. This could happen as overconfident futures investors attempt to assess the precision of their private information by making inferences from price changes in related stocks. For example, overconfident gold futures traders, in evaluating their private information, may weigh information from stock price movements of gold stocks in the stock market. In other words, gains (losses) in gold stocks may cause overconfident gold futures traders to invest more (less) in gold futures. This postulation is consistent with the results of studies on the price discovery function of futures that there is information flow between futures and stock markets (Tse, 1999; So and Tse, 2004). The following VECM specification is used to test the second hypothesis:

$$\begin{bmatrix} \Delta fret_t \\ \Delta fturnover_t \end{bmatrix} = \begin{bmatrix} \alpha_{\Delta fret} \\ \alpha_{\Delta fturnover} \end{bmatrix} + \sum_{i=1}^{N} A_i \begin{bmatrix} \Delta fret_{t-i} \\ \Delta fturnover_{t-i} \end{bmatrix} + B_j F\sigma_t + \sum_{k=0}^{1} C_k \begin{bmatrix} \Delta Sret_{t-k} \\ \Delta Sturnover_{t-k} \end{bmatrix} + D_l \Phi_{t-1} + \begin{bmatrix} \varepsilon_{\Delta fret,t} \\ \varepsilon_{\Delta fturnover,t} \end{bmatrix} \tag{2}$$

where $\Delta Sret$ is the value-weighted average return of related stocks after first differencing and $\Delta Sturnover$ is the value-weighted average of the first-differenced turnover of related stocks. The selection of related stocks is explained later in the section describing the data. $F\sigma$ is volatility of the futures return. The number of lags of each variable is determined by using the AIC.

Hypothesis 2: Overconfident futures traders trade more (less) aggressively following gains (losses) in related stocks.

The third hypothesis is an extension of Hypothesis 2. That is, overconfident investors trade more (less) aggressively following market gains (losses) in less-related stocks. For example, overconfident gold futures traders, in evaluating their private information, may weigh information from stock price movements of platinum stocks in the stock market. We believe this conjecture is reasonable because there is ample evidence that futures traders glean information from a large variety of sources (Han *et al*, 1999; Han and Ozocak, 2002; Simpson and Ramchander, 2004). The VECM for testing this hypothesis is as follows:

$$\begin{bmatrix} \Delta fret_t \\ \Delta fturnover_t \end{bmatrix} = \begin{bmatrix} \alpha_{\Delta fret} \\ \alpha_{\Delta fturnover} \end{bmatrix} + \sum_{i=1}^{N} A_i \begin{bmatrix} \Delta fret_{t-i} \\ \Delta fturnover_{t-i} \end{bmatrix} + B_j F\sigma_t + \sum_{k=0}^{1} C_k \begin{bmatrix} \Delta L\_Sret_{t-k} \\ \Delta L\_Sturnover_{t-k} \end{bmatrix} + D_l \Phi_{t-1} + \begin{bmatrix} \varepsilon_{\Delta fret,t} \\ \varepsilon_{\Delta fturnover,t} \end{bmatrix} \tag{3}$$

where ΔL_Sret is the value-weighted average return of less-related stocks after first differencing and $L\_\Delta Sturnover$ is the value-weighted average of the turnover of less-related stocks after first differencing. The selection of less-related stocks is explained in the section on data description.

Hypothesis 3: Overconfident futures traders trade more (less) aggressively following gains (losses) in less-related stocks.

The last hypothesis is related to the prediction of overconfidence models that overconfident investors are responsible for the excessive volatility in investment markets. As investors become overconfident, they are likely to underestimate risk and trade more in riskier securities. Thus, in futures markets, overconfident futures traders may underestimate the size of the risk premium and trade overly aggressive. However, given the documented contemporaneous volume-volatility relationship of speculative assets (Karpoff, 1987), it is difficult to make meaningful inferences about the presence of overconfident futures trading by directly examining the correlation between futures volatility and futures turnover. Thus, we devise an indirect test for the last hypothesis using the following VECM specification:

$$\begin{aligned}\begin{bmatrix}\Delta fret_t \\ \Delta fturnover_t\end{bmatrix} &= \begin{bmatrix}\alpha_{\Delta fret} \\ \alpha_{\Delta fturnover}\end{bmatrix} \\ &+ \sum_{i=1}^{N} A_i \begin{bmatrix}\Delta fret_{t-i} \\ \Delta fturnover_{t-i}\end{bmatrix} + B_j F\sigma_t \\ &+ \sum_{k=0}^{1} C_k \begin{bmatrix}\Delta Sret_{t-k} \\ \Delta Sturnover_{t-k}\end{bmatrix} + D_l \Phi_{t-1} \\ &+ EmF\sigma \times \Delta Sret + \begin{bmatrix}\varepsilon_{\Delta fret,t} \\ \varepsilon_{\Delta fturnover,t}\end{bmatrix} \qquad (4)\end{aligned}$$

In this model, we introduce the interaction term $F\sigma \times \Delta Sret$ to represent the futures volatility that is associated with the price movements of related stocks. In the $\Delta fturnover$ dependent variable regression of the model, a positive coefficient on the interaction term indicates that a higher (lower) futures turnover is associated with a higher (lower) futures volatility that is related to the price movements of related stocks. A positive coefficient is consistent with the implication that futures traders assume more (less) risk following gains (losses) in related stocks.

Hypothesis 4: Overconfident futures traders hold more (less) riskier positions following market gains (losses).

DATA

We test the four hypotheses using six commodity futures: copper, gold, silver, crude oil, natural gas and unleaded gas. Daily return and turnover data for the period between 1 January 1995 and 31 December 2006 are used. Futures return is measured by the log of price change; turnover is computed as volume divided by open interest. Futures return volatility is computed using the Garman and Klass (1980) equation. To examine the information transmission from related and less-related stocks to overconfident futures traders, we use daily stock return data of the Center for Research in Security Prices database. Four-digit sic codes are used to identify the related and less-related stocks of each commodity futures. For example, for gold futures, daily returns of gold stocks (sic code 1041) are used to compute a value-weighted average return time series of related stocks. For silver futures, daily returns of silver stocks (sic code 1044) are used. For the three metal futures, we select iron ore mining stocks (sic code 1011) to proxy for the less-related stocks. For the three energy futures, coal stocks (sic codes 1221 and 1222) are used to proxy for the less-related stocks.

In the second part of the analyses, we test our hypotheses using information in the Commitments of Traders Reports of the CFTC. The data set allows us to differentiate between the activities of hedgers and speculators. To match with the data frequency of the Commitment of Traders Reports, we convert all the variables to weekly data. The weekly data start from 1 January 1997.

RESULTS

Regression analysis using non-stationary variables may lead to spurious regressions, and therefore it is necessary to examine the stationarity of the concerned variables. Thus, we begin by examining the time series properties of the variables. Table 1 reports the results of the unit root tests. The Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) and Kwaitowski-Phillips-Schmidt-Shin (KPSS) tests are used. The KPSS test is used because of its ability to distinguish between unit roots and near unit root stationary processes. For the ADF and PP tests, the null hypothesis is

Table 1: Unit root tests results

	Returns			*Turnover*		
	ADF	*PP*	*KKPS*	*ADF*	*PP*	*KKPS*
(A) Levels						
Futures						
Copper	−57.8*	−57.8*	0.71**	−20.4*	−37.3*	2.17*
Gold	−55.6*	−55.6*	0.56	−24.0*	−33.2*	0.71**
Silver	−56.2*	−56.3*	0.28	−24.6*	−33.1*	0.58**
Crude oil	−54.4*	−54.4*	0.10	−4.5*	−37.9*	3.03*
Natural gas	−54.9*	−54.9*	0.45***	−3.6*	−39.3*	3.86*
Unleaded gas	−38.7*	−70.2*	0.04	−5.2*	−43.5*	0.44**
Stocks						
Copper	−52.1*	−52.2*	0.82*	−5.1*	−27.7*	1.75*
Gold	−41.3*	−55.6*	0.18	−6.9*	−32.8*	4.63*
Silver	−36.6*	−70.8*	0.02	−7.0*	−44.8*	3.83*
Crude oil	−38.7*	−48.1*	0.07	−4.6*	−21.4*	5.11*
Natural gas	−38.5*	−48.0*	0.08	−4.6*	−21.2*	5.12*
Unleaded gas	−41.5*	−57.1*	0.09	−3.4*	−18.5*	4.43*
(B) First-differences						
Futures						
Copper	−23.2*	−974.5*	0.03	−20.9*	−501.9*	0.06
Gold	−23.5*	−1242.3*	0.02	−24.4*	−1015.3*	0.14
Silver	−23.6*	−796.2*	0.06	−20.9*	−539.2*	0.08
Crude oil	−21.6*	−380.3*	0.03	−27.3*	−407.3*	0.11
Natural gas	−23.0*	−865.2*	0.04	−25.8*	−406.4*	0.05
Unleaded gas	−21.7*	−196.8*	0.19	−22.7*	−243.4*	0.18
Stocks						
Copper	−23.2*	−578.9*	0.02	−26.6*	−497.6*	0.34
Gold	−24.0*	−680.9*	0.06	−23.4*	−288.7*	0.58
Silver	−22.0*	−943.5*	0.03	−21.4*	−377.3*	0.02
Crude oil	−21.4*	−576.6*	0.05	−29.9*	−285.1*	0.05
Natural gas	−21.3*	− 760.1*	0.05	−28.9*	−282.3*	0.05
Unleaded gas	−21.9*	−1111.6*	0.12	−23.5*	−273.1*	0.04

*, ** and *** denote statistical significance at the 0.01, 0.05 and 0.1 levels, respectively.

that there is non-stationarity in the time series. For the KPSS test, the time series is stationary under the null hypothesis. Before first-differencing, the KPSS test sometimes disagrees with the ADF and PP tests about the stationarity of the series in their levels. The results indicate that the futures and stock time series might have non-stationary in their levels. After taking first-differencing of the time series, there is no disagreement among the ADF, PP and KPSS tests that the series have achieved stationarity. That is, all the concerned series are integrated of order one.

Given the evidence of I(1) in the variables, we perform cointegration tests to test for the existence of a long-run equilibrium relationship among the series. The results are reported in Table 2. According to the Johansen's trace test and maximum eigenvalue test statistics, the null hypothesis that no cointegrating vector exists among the series is rejected at the 1 per cent level. The results are qualitatively the same regardless of whether or not a linear trend term is included. Researchers have documented the presence of long-run relationships between stock and futures markets in studies of price discovery (for example, Tse, 1999; So and Tse, 2004). In these studies, cointegration among closely linked securities exists because the markets share at least one common driving force. The presence of cointegration among our series is consistent with the results of the price

Table 2: Cointegration test results

Number of cointegrating equations	*Eigenvalue*	*Trace test statistic*	*Maximum eigenvalue test statistic*
Copper			
0	0.18	1706.8*	605.3*
1	0.16	1101.1*	522.7*
2	0.09	578.8*	306.1*
3	0.07	272.6*	206.3*
Gold			
0	0.22	1964.5*	743.9*
1	0.17	1220.6*	573.6*
2	0.11	646.9*	341.7*
3	0.08	305.2*	219.6*
Silver			
0	0.18	1758.2*	388.9*
1	0.15	1169.2*	500.6*
2	0.49	668.5*	312.1*
3	0.09	356.6*	287.1*
Crude oil			
0	0.19	1737.2*	829.3*
1	0.18	1107.9*	579.6*
2	0.09	528.3*	279.9*
3	0.06	230.3*	179.9*
Natural gas			
0	0.18	179.29*	604.4*
1	0.18	1134.7*	584.9*
2	0.10	549.9*	320.4*
3	0.07	229.4*	190.2*
Unleaded gas			
0	0.21	1548.9*	686.1*
1	0.19	862.9*	635.1*
2	0.06	327.8*	280.8*
3	0.04	27.2*	21.4*

* denotes statistical significance at the 0.01 level.

discovery studies. The finding of cointegration is also consistent with the notion of market efficiency, as it implies that information in stock markets is impounded in the value of futures.

Results in Table 2 confirm that it is appropriate to use VECM models to test the four developed hypotheses. In Tables 3–6, the test results of the four hypotheses using daily time series of futures and stocks are presented. Note that in these tables, the futures turnover is an aggregate measure without a differentiation between hedgers and speculators.

Panel A of Table 3 reports the test result of Hypothesis 1 using copper futures. The result shows that the lagged error correction term ($\Phi(t-1)$) is significant at the 1 per cent level in the system with a t-value of -32.77 in the $\Delta fret$ dependent variable regression and 6.65 in the $\Delta fturnover$ dependent variable regression. The significant error correction term confirms the presence of a long-run equilibrium among the variables, as suggested by the cointegration test result earlier. Both regressions have relatively high adjusted R^2 values of 0.54 and 0.25, respectively. The coefficient on futures volatility ($F\sigma$) is significant in both regressions, confirming the existence of a contemporaneous return-volume-volatility relationship in futures markets (Nguyen and Daigler, 2007). The large and positive coefficient on futures volatility is consistent

Table 3: Test results of Hypothesis 1 (Overconfident futures traders trade more (less) aggressively following gains (losses) in futures markets)

	Δfret	*Δfturnover*
Panel A: Copper futures		
c	0.01	−0.02
	(6.32)*	(−11.46)*
Δfret(*t*−1)	−0.01	−0.63
	(−0.10)	(−6.11)*
Δfret(*t*−2)	−0.02	−0.33
	(−1.26)	(−4.74)*
Δfturnover(*t*−1)	−0.02	−0.42
	(−5.56)*	(−24.31)*
Δfturnover(*t*−2)	−0.01	−0.21
	(−0.31)	(−12.60)*
Fσ	−14.03	100.88
	(−9.81)*	(17.71)*
Φ(*t*−1)	−1.05	0.85
	(−32.77)*	(6.65)*
Adjusted R^2	0.54	0.25

	Gold	*Silver*	*Crude oil*	*Natural gas*	*Unleaded gas*
Panel B: Other futures (only the Δfturnover dependent variable equation is reported)					
c	−0.01	−0.01	−0.03	−0.01	−0.01
	(−5.54)*	(−5.25)*	(−13.30)*	(−1.53)	(−0.24)
Δfret(*t*−1)	−0.47	−1.68	−1.06	−0.43	−0.01
	(−1.28)	(−8.58)*	(−6.87)*	(−2.13)**	(−0.02)
Δfret(*t*−2)	−0.51	−0.76	−0.54	−0.16	0.01
	(−1.96)**	(−5.45)*	(−4.99)*	(−1.12)	(0.52)
Δfturnover(*t*−1)	−0.38	−0.33	−0.40	−0.36	−0.23
	(−21.96)*	(−19.38)*	(−23.74)*	(−20.36)*	(−21.87)*
Δfturnover(*t*−2)	−1.99	−1.42	−0.26	−0.23	−0.22
	(−11.89)	(−8.10)*	(−15.17)*	(−13.19)*	(−12.60)*
Fσ	368.90	115.31	276.86	46.24	10.11
	(15.03)*	(11.97)*	(18.15)*	(3.39)*	(1.91)***
Φ(*t*−1)	1.34	2.49	1.18	0.95	1.13
	(2.96)**	(10.64)*	(6.18)*	(3.86)*	(3.88)*
Adjusted R^2	0.19	0.20	0.24	0.15	0.15

*, ** and *** denote statistical significance at the 0.01, 0.05 and 0.1 levels, respectively.

with previous trading volume studies (Karpoff, 1987). Regarding the Δ*fret* dependent variable regression, first-differenced copper futures returns is negatively related to lagged returns but insignificant. The coefficient on the first lagged Δ*fturnover* is highly significant with a *t*-value of −5.56. The Δ*fret* dependent variable regression, however, does not provide information on overconfident

Table 4: Test results of Hypothesis 2 (Overconfident futures traders trade more (less) aggressively following gains (losses) in related stocks)

	Copper	*Gold*	*Silver*	*Crude oil*	*Natural gas*	*Unleaded gas*
Panel A: Contemporaneous and first lagged returns on related stocks are included in the model (only the Δfturnover dependent variable equation is reported)						
c	−0.02	−0.01	−0.01	−0.02	0.01	0.01
	(−7.34)*	(−0.82)	(−1.65)***	(−5.16)*	(0.53)	(0.09)
Δ*fret*(*t*−1)	−0.56	−0.04	−1.10	−0.93	−0.31	0.01
	(−5.42)*	(−0.13)	(−5.39)*	(−6.15)*	(−1.56)	(0.08)
Δ*fret*(*t*−2)	−0.29	−0.16	−0.55	−0.49	−0.09	0.01
	(−4.16)*	(−0.66)	(−3.83)*	(−4.63)*	(−0.70)	(0.56)
Δ*fturnover*(*t*−1)	−0.43	−0.33	−0.57	−0.48	−0.36	−0.39
	(−24.81)*	(−19.91)*	(−21.01)*	(−23.45)*	(−20.41)*	(−22.11)*
Δ*fturnover*(*t*−2)	−0.22	−0.16	−0.36	−0.44	−0.23	−0.23
	(−12.74)*	(−9.74)*	(−9.30)*	(−14.45)*	(−13.43)*	(−12.82)*
$F\sigma$	101.92	314.42	139.12	263.31	52.65	10.09
	(17.52)*	(10.40)*	(13.09)*	(17.44)*	(3.49)*	(1.68)***
Δ*Sret*	−0.11	0.01	0.07	0.06	−0.01	−0.16
	(−1.25)	(0.16)	(1.68)***	(0.72)	(−0.07)	(−1.15)
Δ*Sret*(*t*−1)	−0.04	0.23	−0.01	−0.20	−0.15	−0.03
	(−0.48)	(2.61)**	(−0.21)	(−1.96)**	(−1.53)	(−0.25)
Δ*Sturnover*	2.44	12.49	2.56	11.12	5.86	13.00
	(2.15)**	(16.59)*	(5.88)*	(9.92)*	(5.07)*	(9.34)*
Δ*Sturnover*(*t*−1)	−4.64	−13.64	−4.65	−12.37	−6.75	−23.32
	(−4.12)*	(−18.90)*	(−10.57)*	(−11.12)*	(−5.92)*	(−9.43)*
Φ(*t*−1)	0.76	0.30	1.62	1.14	0.86	1.02
	(5.77)*	(6.58)*	(6.33)*	(5.68)*	(3.43)*	(4.82)*
Adjusted R^2	0.26	0.28	0.21	0.27	0.16	0.17
Panel B: Only the first lagged return on related stocks is included in the model (only the Δfturnover dependent variable equation is reported)						
c	−0.01	0.01	0.01	−0.01	0.01	0.01
	(−7.17)*	(4.64)*	(0.09)	(−3.59)*	(2.16)**	(2.28)**
Δ*fret*(*t*−1)	−0.59	−0.44	−1.63	−1.06	−0.38	−0.01
	(−5.67)*	(−1.19)	(−8.19)*	(−6.97)*	(−1.91)**	(−0.04)
Δ*fret*(*t*−2)	−0.31	−0.46	−0.76	−0.54	−0.15	0.01
	(−4.37)*	(−1.8)***	(−5.37)*	(−5.00)*	(−1.03)	(0.53)
Δ*fturnover*(*t*−1)	−0.42	−0.35	−0.54	−0.49	−0.36	−0.39
	(−24.55)*	(−20.41)*	(−19.51)*	(−23.26)*	(−20.33)*	(−21.74)*
Δ*fturnover*(*t*−2)	−0.22	−0.18	−0.34	−0.25	−0.23	−0.22
	(−12.66)*	(−10.65)*	(−8.15)*	(−14.82)*	(−13.40)*	(−12.52)*
$F\sigma$	103.81	317.80	151.23	282.44	165.16	10.09
	(17.91)*	(15.70)*	(14.54)*	(18.99)*	(4.42)*	(1.63)
Δ*Sret*	—	—	—	—	—	—
Δ*Sret*(*t*−1)	−0.06	0.16	−0.04	−0.28	−0.19	0.10
	(−0.65)	(1.67)***	(−0.90)	(−2.78)**	(−2.10)**	(−0.20)
Δ*Sturnover*	—	—	—	—	—	—

Table 4 *continued*

	Copper	*Gold*	*Silver*	*Crude oil*	*Natural gas*	*Unleaded gas*
$\Delta Sturnover(t-1)$	−2.73 (−2.92)**	−5.07 (−9.70)*	−3.21 (−8.94)*	−3.17 (−5.00)*	−2.12 (−3.10)*	−3.42 (−2.68)**
$\Phi(t-1)$	0.79 (6.09)*	0.94 (1.97)**	2.42 (10.01)*	1.34 (6.69)*	0.96 (3.81)*	1.10 (3.24)*
Adjusted R^2	0.26	0.21	0.21	0.25	0.15	0.15

*, ** and *** denote statistical significance at the 0.01, 0.05 and 0.1 levels, respectively.

trading. The salient equation in the VECM model is the Δ*fturnover* dependent variable regression. According to Statman *et al* (2006), if investors are overconfident, trading volume will be positively related to lagged returns because investment success increases the degree of overconfidence. In the Δ*fturnover* dependent variable regression in Panel A, the coefficient on the first lagged $\Delta fret(t-1)$ is negative and significant at the 5 per cent level. The coefficient on $\Delta fret(t-2)$ is also negative and significant at the 5 per cent level. That is, there is no evidence of overconfident futures trading in copper futures during the sample period. On the contrary, the turnover of copper futures is significantly lower following higher futures returns.

Given that our focus is on the Δ*fturnover* dependent variable regression and for ease of making comparisons, we present only the regression results of the Δ*fturnover* dependent variable regression for the remaining five futures contracts in Panel B of Table 3 (also in the remaining tables). In general, the results are consistent with those of the copper futures in Panel A. All the lagged error correction terms ($\Phi(t-1)$) are significant at 5 per cent or higher. The regressions have a reasonable explanatory power with an adjusted R^2 value of at least 15 per cent. Our salient variables, the lagged values of Δ*fret*, have either insignificant or significantly negative regression coefficients. That is, futures turnover is not positively related to lagged futures returns. In other words, there is no evidence of overconfident trading in these futures markets over the sample period.

In Table 4, the test results of Hypothesis 2 are reported. Here, the objective is to see whether the information on related stocks in the equity market is associated with overconfident trading in futures markets. In Panel A, both the contemporaneous (Δ*Sret*) and first lagged stock returns ($\Delta Sret(t-1)$) are added to capture the information of the related stocks because the literature has reported either a lead-lag relationship or a bi-directional contemporaneous information transmission between futures and stock markets. In general, the inclusion of related stock returns in the regressions improves the explanatory power of the model, as indicated by the moderately higher adjusted R^2 values across all the futures. The coefficients on lagged futures returns ($\Delta fret(t-1)$ and $\Delta fret(t-2)$) are still significantly negative across all the futures markets, confirming the result in Table 3. However, we have some important results regarding the coefficient on stock returns. For silver futures, the coefficient on Δ*Sret* is positive and significant at the 10 per cent level. For gold futures, the coefficient on $\Delta Sret(t-1)$) is positive and significant at the 5 per cent level. That is, gold and silver futures traders trade more (less) actively subsequent to gains (losses) in gold and silver stocks. The result shows the presence of overconfident trading in gold and silver futures markets, and supports Hypothesis 2 that overconfident trading is associated with gains (losses) in related stocks

Table 5: Test results of Hypothesis 3 (Overconfident futures traders trade more (less) aggressively following gains (losses) in less-related stocks)

	Copper	*Gold*	*Silver*	*Crude oil*	*Natural gas*	*Unleaded gas*
Panel A: Contemporaneous and first lagged returns on less-related stocks are included (only the Δfturnover dependent variable equation is reported)						
c	−0.02	−0.01	−0.01	−0.02	0.01	0.01
	(−8.03)*	(−2.82)**	(−2.13)**	(−9.92)*	(0.47)	(0.02)
Δ*fret*(*t*−1)	−0.61	−0.38	−1.57	−0.98	−0.33	−0.01
	(−5.85)*	(−1.04)	(−8.28)*	(−6.37)*	(−1.62)	(−0.18)
Δ*fret*(*t*−2)	−0.32	−0.45	−0.72	−0.52	−0.11	0.01
	(−4.45)*	(−1.76)***	(−5.04)*	(−4.72)*	(−0.79)	(0.45)
Δ*fturnover*(*t*−1)	−0.42	−0.38	−0.35	−0.40	−0.36	−0.39
	(−24.31)*	(−21.82)*	(−19.62)*	(−23.92)*	(−20.5)*	(−21.97)*
Δ*fturnover*(*t*−2)	−0.22	−1.98	−0.14	−0.25	−0.24	−0.22
	(−12.73)*	(−11.44)*	(−8.23)*	(−15.22)*	(−13.6)*	(−12.49)*
$F\sigma$	101.38	377.24	122.69	273.84	61.54	10.11
	(17.50)*	(12.97)*	(12.11)*	(18.11)*	(4.16)*	(1.93)***
Δ*L_Sret*	0.04	−0.09	−0.05	−0.01	−0.08	−0.25
	(0.63)	(−1.07)	(−0.63)	(−0.03)	(−1.09)	(−2.33)**
ΔL_Sret(*t*−1)	−0.09	−0.02	−0.15	0.07	0.01	−0.26
	(−1.44)	(−0.31)	(−1.70)***	(0.89)	(0.03)	(−2.46)**
Δ*L_Sturnover*	0.49	0.98	0.79	0.31	0.71	1.76
	(1.54)	(2.24)**	(1.89)***	(0.84)	(1.84)***	(3.26)*
Δ*L_Sturnover*(*t*−1)	−0.90	−1.54	−1.72	−0.89	−1.38	−1.77
	(−2.81)**	(−3.55)*	(−4.12)*	(−2.37)**	(−3.63)*	(−3.88)*
Φ(*t*−1)	0.83	1.27	2.39	1.06	0.82	1.01
	(6.34)*	(2.78)*	(10.10)*	(5.49)*	(3.27)*	(2.15)**
Adjusted R^2	0.25	0.19	0.20	0.24	0.15	0.16
Panel B: Only the first lagged return on less-related stocks is included in the model (only the Δfturnover dependent variable equation is reported)						
c	−0.02	−0.01	−0.01	−0.02	0.01	0.02
	(−7.89)*	(−2.35)**	(−7.47)*	(−9.94)*	(0.90)	(0.87)
Δ*fret*(*t*−1)	−0.67	−0.44	−1.63	−0.99	−0.26	−0.01
	(−6.51)*	(−1.18)	(−8.28)*	(−6.47)*	(−1.30)	(−0.21)
Δ*fret*(*t*−2)	−0.35	−0.59	−0.73	−0.52	−0.08	0.01
	(−4.93)*	(−1.89)***	(−5.21)*	(−4.98)*	(−0.62)	(0.45)
Δ*fturnover*(*t*−1)	−0.42	−0.38	−0.32	−0.40	−0.36	−0.39
	(−23.96)*	(−21.89)*	(−19.51)*	(−23.87)*	(−20.60)*	(−21.92)*
Δ*fturnover*(*t*−2)	−0.21	−0.19	−0.14	−0.25	−0.24	−0.23
	(−12.50)*	(−11.49)*	(−8.17)*	(−15.23)*	(−13.36)*	(−12.57)*
$F\sigma$	102.61	355.21	126.61	274.72	66.23	0.01
	(17.91)*	(13.33)*	(12.60)*	(18.26)*	(4.54)*	(1.82)***
Δ*L_Sret*	—	—	—	—	—	—
Δ*L_Sret*(*t*−1)	−0.11	−0.05	−0.16	0.07	−0.01	−0.29
	(−1.64)	(−0.55)	(−1.91)***	(0.87)	(−0.02)	(−2.70)**
Δ*L_Sturnover*	—	—	—	—	—	—

Table 5 *continued*

	Copper	*Gold*	*Silver*	*Crude oil*	*Natural gas*	*Unleaded gas*
$\Delta L\_Sturnover(t-1)$	−0.55 (−2.50)**	−0.84 (−2.78)**	−1.15 (−3.95)*	−0.54 (−2.72)**	−0.87 (−3.41)*	−0.42 (−1.23)
$\Phi(t-1)$	0.98 (7.22)*	1.33 (2.91)**	2.47 (10.49)*	1.08 (5.60)*	0.71 (2.84)**	1.44 (2.72)**
Adjusted R^2	0.26	0.19	0.20	0.24	0.15	0.15

*, ** and *** denote statistical significance at the 0.01, 0.05 and 0.1 levels, respectively.

Table 6: Test results of Hypothesis 4 (Overconfident futures traders hold more (less) riskier positions following market gains (losses))

	Copper	*Gold*	*Silver*	*Crude oil*	*Natural gas*	*Unleaded gas*
c	−0.02 (−7.57)*	−0.01 (−2.35)**	−0.01 (−1.64)	−0.02 (−5.67)*	0.01 (0.58)	0.07 (0.11)
$\Delta fret(t-1)$	−0.55 (−5.35)*	−0.19 (−0.56)	−1.08 (−5.30)*	−0.95 (−6.28)*	−0.37 (−1.85)***	0.01 (0.11)
$\Delta fret(t-2)$	−2.96 (−4.15)*	−0.24 (−0.98)	−0.53 (−3.74)*	−0.51 (−4.74)*	−0.13 (−0.39)	0.01 (0.50)
$\Delta fturnover(t-1)$	−0.43 (−24.86)*	−0.33 (−19.57)*	−0.37 (−1.64)	−0.38 (−23.47)*	−0.53 (−20.41)*	−0.39 (−22.11)*
$\Delta fturnover(t-2)$	−0.22 (−12.75)*	−0.16 (−9.52)*	−0.16 (−9.19)*	−0.24 (−14.45)*	−0.23 (−13.52)*	−0.23 (−12.82)*
$F\sigma$	106.47 (17.12)*	497.07 (12.19)*	140.41 (13.31)*	246.77 (17.49)*	55.08 (3.59)*	10.89 (1.59)
$\Delta Sret$	−0.12 (−1.30)	0.05 (0.73)	0.08 (1.77)***	0.07 (0.74)	−0.01 (−0.09)	−0.16 (−1.13)
$\Delta Sret(t-1)$	−0.19 (−1.56)	0.36 (3.84)*	0.04 (0.71)	−0.06 (−0.48)	−0.11 (−1.01)	−0.06 (−0.39)
$\Delta Sturnover$	2.39 (2.11)**	11.51 (15.11)*	2.63 (6.02)*	11.04 (9.85)*	5.83 (5.05)*	23.01 (9.34)*
$\Delta Sturnover(t-1)$	−4.59 (−4.08)*	−13.81 (−19.26)*	4.75 (−10.75)*	−12.35 (−11.10)*	−6.77 (−5.94)*	−23.25 (−9.44)*
$F\sigma \times \Delta Sret$	−817.41 (−2.07)**	−1654.23 (−6.65)*	−428.21 (−2.25)**	−1208.28 (−1.65)	−840.3 (−1.01)	301.6 (0.82)
Φ	0.74 (5.58)*	0.51 (2.13)**	1.66 (6.47)*	1.97 (6.22)*	0.98 (3.84)*	0.21 (6.39)*
Adjusted R^2	0.25	0.29	0.21	0.27	0.16	0.17

*, ** and *** denote statistical significance at the 0.01, 0.05 and 0.1 levels, respectively.

in the equity market. It is unlikely that the result is associated with the disposition effect of Shefrin and Statman (1985) because, according to Statman *et al* (2006), disposition effects would have caused the traders to trade selected contracts rather than engage in higher (lower) levels of trading in general. For crude oil futures, the coefficient on

$\Delta Sret(t-1)$ is significantly negative at 5 per cent. That is, gains in crude oil stocks result in lower levels of turnover in crude oil futures. Contemporaneous stock turnover ($\Delta Sturnover$) has a significant positive effect on futures turnover across all the chosen futures, but first lagged stock turnover ($\Delta Sturnover(t-1)$) has a negative effect. In Panel B of Table 4, only the first lagged stock return ($\Delta Sret(t-1)$) is added in the regressions. The results are generally similar to those in Panel A. Turnover of gold futures again shows a positive relationship with the performance of gold stocks, but the turnover of silver futures is unaffected by the return on silver stocks.

The test results of Hypothesis 3 are presented in Table 5. Here, the objective is to examine whether the information transmitted from less-related stocks in the equity market would encourage futures traders to become overconfident. To recapitulate, we use coal stocks to represent the less-related stocks for the three energy futures; iron ore mining stocks serve as the less-related stocks for the three metal futures. In Panel A (using both contemporary (ΔL_Sret) and lagged returns of less-related stocks ($\Delta L\_Sret(t-1)$)) and Panel B (using only ($\Delta L\_Sret(t-1)$)), there is no evidence that the return on less-related stocks is positively related to futures turnover. The results show that the return on less-related stocks actually has a significant negative impact on the turnover of silver and unleaded gas futures. Thus, there is no evidence of overconfident trading associated with the information transmission from less-related stocks. The coefficients on lagged futures returns ($\Delta fret(t-1)$ and $\Delta fret(t-2)$) are also significantly negative for copper, silver and crude oil futures. In short, the information of less-related stocks does not encourage futures traders to become overconfident.

The test results for Hypothesis 4 are reported in Table 6. In this test, we want to see whether gains (losses) on related stocks encourage futures traders to take on more (less) risk. The salient variable in this test is the coefficient on the interaction term ($F\sigma \times \Delta Sret$). A positive coefficient on the interaction term indicates that a higher (lower) futures turnover is associated with a higher (lower) futures volatility that is associated with the price movements of related stocks. A positive coefficient is consistent with implications that futures traders assume more (less) risk following gains (losses) in related stocks. As shown in Table 6, the coefficient on $F\sigma \times \Delta Sret$ is either significantly negative or insignificant in the six regressions. In other words, there is no evidence that futures turnover is positively related to the futures volatility that is associated with stock market gains (losses). In untabulated results, $F\sigma \times \Delta Sret(t-1)$ is used and no significant result is obtained.

Thus far, the results in Tables 3–6, using aggregate volume data, show either no or very limited evidence that futures traders are overconfident. Given that hedgers and speculators may behave differently, the four hypotheses are tested again using the trading information of speculators and hedgers that is found in the Commitments of Traders reports of the CFTC. For brevity and the convenience of making comparisons, we summarize the results and report only the coefficients of the salient variables ($\Delta fret(t-1)$ and $\Delta fret(t-2)$) of the $\Delta fturnover$ dependent variable regression in Table 7. The complete results are available from the authors.

The test results of Hypotheses 1 through 4 are reported in Panels A through D of Table 7, respectively. In Panel A, the result shows that there is more evidence of overconfident trading in futures markets. For speculators, $\Delta fturnover$ is positively related to lagged $\Delta fret(t-2)$ for copper, gold and crude oil futures, though only significant at the 10 per cent level. The result moderately supports Hypothesis 1. However, the finding represents a marked difference from the results reported earlier in Tables 3–6 where

Table 7: Test results of Hypotheses 1 through 4 using weekly volume data in Commitments of Traders Reports (Hedgers vs Speculators)

	Hedgers		*Speculators*	
	Δfret(t−1)	*Δfret(t−2)*	*Δfret(t−1)*	*Δfret(t−2)*
A: Hypothesis 1				
Copper	1.11	1.46	0.71	1.76***
Gold	−1.87***	−0.12	0.82	1.69***
Silver	−1.21	−1.53	0.02	0.21
Crude oil	−1.46	0.76	−0.16	1.82***
Natural gas	0.62	−0.32	1.29	0.55
Unleaded gas	−2.52**	−1.98**	−0.03	0.96

	Hedgers				*Speculators*			
	Δfret(t−1)	*Δfret(t−2)*	*ΔSret*	*ΔSret(t−1)*	*Δfret(t−1)*	*Δfret(t−2)*	*ΔSret*	*ΔSret(t−1)*
B1: Hypothesis 2 (With both the contemporaneous and first lagged returns of related stocks included in the model)								
Copper	1.01	1.41	0.54	0.38	0.74	1.80***	1.70***	−0.56
Gold	−1.83***	−0.10	0.24	−0.44	0.55	1.72***	1.97**	−1.07
Silver	−1.02	−1.48	−0.20	−0.24	0.52	0.47	0.69	0.03
Crude oil	−1.37	0.73	−2.01**	−1.23	−0.33	1.67***	1.77***	−1.02
Natural gas	0.31	−0.44	−0.48	2.32**	1.23	1.52	1.22	0.04
Unleaded gas	−2.60	−1.93***	0.62	1.24	0.10	0.61	0.50	0.04

	Hedgers				*Speculators*			
	Δfret(t−1)	*Δfret(t−1)*	*ΔSret*	*ΔSret(t−1)*	*Δfret(t−1)*	*Δfret(t−1)*	*ΔSret*	*ΔSret(t−1)*
B2: Hypothesis 2 (only the first lagged return of related stocks is included in the model)								
Copper	0.89	1.31	0.40	0.02	0.71	1.78***	—	−0.57
Gold	−1.88***	−0.15	−0.38	0.02	0.53	1.82***	—	−0.29
Silver	−1.21	−1.57	−0.28	0.05	0.51	0.13	—	0.05
Crude oil	−1.43	0.77	−1.08	0.25	−0.27	1.74***	—	−1.08
Natural gas	0.39	−0.38	0.06	2.27**	1.27	0.54	—	−0.07
Unleaded gas	−2.65**	−2.18**	1.16	0.60	−0.12	0.65	—	0.02

	Hedgers				*Speculators*			
	Δfret(t−1)	*Δfret(t−1)*	*ΔLSret*	*ΔLSret(t−1)*	*Δfret(t−1)*	*Δfret(t−1)*	*ΔLSret*	*ΔLSret(t−1)*
C1: Hypothesis 3 (With both the contemporaneous and first lagged returns of less-related stocks included in the model)								
Copper	1.14	1.50	−0.60	0.77	0.98	2.20**	−1.30	−0.96
Gold	−1.94***	−0.25	−1.12	0.37	0.69	1.71***	−1.48	0.38
Silver	−1.08	−1.51	−0.89	−0.30	−0.01	0.19	0.29	0.80
Crude oil	−1.36	0.76	−2.39**	−1.52	−0.10	1.79***	−1.46	−1.63
Natural gas	0.61	−0.15	0.32	1.55	1.36	0.62	0.66	0.19
Unleaded gas	−2.04**	−2.02**	0.92	−0.28	−0.22	0.64	−0.75	−0.42

	Hedgers				*Speculators*			
	Δfret(t−1)	*Δfret(t−1)*	*ΔLSret*	*ΔLSret(t−1)*	*Δfret(t−1)*	*Δfret(t−1)*	*ΔLSret*	*ΔLSret(t−1)*
C2: Hypothesis 3 (Only the first lagged return of less-related stocks is included in the model)								
Copper	0.89	1.32	—	0.40	0.62	1.74***	–	−1.03
Gold	−2.05**	−0.29	—	1.27	0.56	1.70***	–	0.50
Silver	−1.34	−1.60	—	−0.15	−0.10	0.11	–	0.84
Crude oil	−1.41	0.79	—	−1.58	0.11	1.86***	–	−1.08
Natural gas	0.54	−0.38	—	1.47	1.37	0.56	–	0.18
Unleaded gas	−2.13**	−1.99**	—	−0.55	−0.01	0.55	–	0.30

Table 7 *continued*

	Hedgers			*Speculators*		
	Δfret(t−1)	*Δfret(t−2)*	*Fσ*ΔSret*	*Δfret(t−1)*	*Δfret(t−1)*	*Fσ*ΔSret*
D: Hypothesis 4						
Copper	0.97	1.38	−0.02	0.60	1.68***	2.11**
Gold	−1.84***	−0.09	−0.73	0.71	1.37	0.51
Silver	−1.14	−1.44	1.56	0.62	0.56	−0.77
Crude oil	−1.38	0.69	1.65	−0.38	1.98**	1.04
Natural gas	0.30	−0.42	0.25	1.24	0.52	−0.04
Unleaded gas	−2.64**	−1.84***	−0.50	−0.04	0.55	0.46

*, ** and *** denote statistical significance at the 0.01, 0.05 and 0.1 levels, respectively.
Only the coefficients on the salient variables of the Δ*fturnover* dependent variable regression are reported.

the aggregate turnover is used. For hedgers, the effect of lagged futures returns, Δ*fret*(*t*−1) and Δ*fret*(*t*−2), on futures turnover is either insignificant or significantly negative. In Panel B1, with both the contemporaneous and first lagged returns of related stocks included in the model, supportive evidence for Hypothesis 2 that gains (losses) in related stocks encourage futures traders to become overconfident is obtained. This observation is found, again, among speculators instead of hedgers. For speculators, the coefficient on the contemporaneous stock return (Δ*Sret*) is positively significant at either 10 or 5 per cent for copper, gold and crude oil futures. For these three futures markets, the coefficient on lagged futures returns (Δ*fret*(*t*−2)) is also positively significant. Thus, the results show relatively strong and consistent evidence that gains (losses) in related stock markets are associated with overconfident trading in the corresponding futures markets. In Panel B2, keeping the first lagged return but omitting the contemporaneous return of related stocks in the model, there is no evidence that the return on related stocks is associated with overconfident trading in the selected futures. In Panels C1 and C2, the results do not provide any support for Hypothesis 3, as the coefficient on the return on less-related stocks (Δ*L_Sret* or Δ*L_Sret*(*t*−1)) is not positively related to futures turnover in a significant manner. That is, gains (losses) in less-related stocks in the equity market do not lead to overconfident trading in futures markets. In Panel D, for speculators, the coefficient on $F\sigma \times \Delta Sret$ is positive and significant at the 5 per cent level for copper futures. This is consistent with the prediction of Hypothesis 4 that overconfident futures traders assume more (less) risk following market gains (losses). However, no similar evidence is found for the other five futures.

In sum, when futures traders are divided into speculators and hedgers, relatively strong and consistent evidence of overconfident trading is found among speculators in some futures markets. We consider it likely that the evidence of overconfident trading is biased downward, given the current system of classifying all the commercial positions as hedgers. Some researchers have questioned the appropriateness of treating all commercial positions as hedgers (Ederington and Lee (2002); Sanders *et al*, 2004). It is likely that some commercial positions belong to speculators.

Finally, results of variance decomposition and Granger causality tests are reported in Table 8 to help confirm our findings that speculators are more likely to experience overconfident trading in futures markets. In Panel A of Table 8, it can be seen that for speculators' futures turnover, futures return innovations have a much higher impact in copper, gold and crude oil futures than the remaining futures. For example, for gold futures, gold futures return innovations

Table 8: Other supportive evidence of overconfident trading

Period	*Copper*	*Gold*	*Silver*	*Crude oil*	*Natural gas*	*Unlead gas*
Panel A: Variance decomposition (%) of speculators' futures turnover (effects of futures return innovations on futures turnover)						
1	9.25	11.45	2.01	8.03	0.33	2.61
2	10.22	13.30	2.23	12.78	0.24	3.14
3	11.09	14.01	2.71	15.64	0.52	3.78
4	11.27	13.82	2.68	15.55	0.79	4.01
5	12.06	13.21	2.77	16.23	0.95	4.11

	Copper	*Gold*	*Crude oil*
Panel B: Granger Causality (lagged Δfret positively → Δfturnover) test using turnover of speculators. Only those futures with evidence of overconfident trading are evaluated.			
Hypo 1.	5.36 (0.07)	4.66 (0.10)	7.92 (0.04)
Hypo 2.	4.93 (0.08)	4.62 (0.10)	7.79 (0.04)
	5.48 (0.06)	4.71 (0.10)	7.64 (0.05)
Hypo 3.	4.60 (0.10)	4.69 (0.10)	7.39 (0.05)
	4.64 (0.10)	4.72 (0.10)	7.43 (0.05)
Hypo 4.	4.79 (0.09)	4.12 (0.11)	7.56 (0.05)
	4.09 (0.13)	4.14 (0.11)	8.10 (0.04)

Average value across all the VECM specifications used for testing hypotheses 1 through 4.
The reported numbers are chi-square values with the *p*-value in brackets.

account for 11.45 per cent of the forecast variance in gold futures turnover in the first period, whereas the number is only 0.33 per cent for natural gas futures. Thus, variance decomposition analysis indicates that the futures turnover rate of speculators is strongly affected by futures returns in copper, gold and crude oil futures markets. This finding supports the results in Table 7 that there is evidence of overconfident trading among the speculators of copper, gold and crude oil futures. In Panel B of Table 8, we evaluate the presence of Granger causality among the futures that have shown evidence of overconfidence trading. The result shows that lagged futures returns (Δ*fret*) indeed Granger-cause futures turnover (Δ*fturnover*) for copper, gold and crude oil futures. The results in Table 8 confirm that overconfident trading has likely occurred in copper, gold and crude oil futures markets.

SUMMARY AND CONCLUSIONS

Investors' enthusiasm for active trading in securities markets has puzzled researchers for years. Conventional asset pricing models suggest that investors should buy the market portfolio and hold it in perpetuity; rebalancing activities would generate only negligible trading on average. After numerous unsuccessful attempts to explain why trading volume in securities markets is so large, researchers have begun to study and document how behavioral factors might offer an explanation. It is postulated that investors trade so aggressively because they are overconfident. Some studies have found evidence of overconfident trading in stock markets. In this study, we add to the literature by investigating the presence of overconfident trading in futures markets. When we use daily aggregate volume data without making a differentiation between hedgers and speculators, we find very limited evidence of overconfident trading in futures markets. Upon differentiating the volume data of hedgers and speculators using the information in the Commitments of Traders reports of the CFTC, we find relatively strong and consistent evidence of overconfident trading among the speculators in three of the six examined futures markets. For hedgers, we do not find any evidence of overconfident trading. Our results show that speculators trade more (less) aggressively following gains (losses) in futures markets. It is also found that speculators trade more (less) aggressively following gains (losses) of related stocks in the stock market. This finding is consistent with implications that there is information transmission between futures and stock markets, and that the information transmitted from related stocks encourage overconfident trading among futures speculators. Gains (losses) of less-related stocks, however, do not affect the trading of futures speculators. The results also show that overconfident futures speculators assume more (less) risk following market gains (losses). It is likely that our results represent an underestimation of the overconfident trading in futures markets under the current system of classifying all commercial positions as hedgers. Given that confident traders tend to overestimate investment returns, our findings may have important implications for investors in zero-sum financial markets.

NOTES

1. Futures Industry Association Annual Volume Surveys.
2. New York Stock Exchange Annual Statistics.
3. Commodity Futures Trading Commission Commitments of Traders Reports.

REFERENCES

Abhyankar, A. (1998) Linear and nonlinear Granger causality: Evidence from the UK stock index futures markets. *The Journal of Futures Markets* 18: 519–540.

Barber, B.M. and Odean, T. (2000) Trading is hazardous to your wealth: The common stock investment performance of individual investors. *Journal of Finance* 55: 773–806.

Barber, B.M. and Odean, T. (2001) Boys will be boys: Gender, overconfidence, and common stock investment. *Quarterly Journal of Economics* 116: 261–292.

Benos, A.V. (1998) Aggressiveness and survival of overconfident traders. *Journal of Financial Markets* 1: 353–383.

Brunnermeier, M.K. (2001) *Asset Pricing Under Asymmetric Information: Bubbles, Crashes, Technical Analysis, and Herding*. Oxford, UK: Oxford University Press.

Cornell, B. (1981) The relationship between volume and price variability in futures markets. *The Journal of Futures Markets* 1: 303–316.

Daniel, K., Hirshleifer, D. and Subrahmanyam, A. (1998) Investor psychology and security market under- and overreactions. *Journal of Finance* 53: 1839–1886.

Daniel, K., Hirshleifer, D. and Subrahmanyam, A. (2001) Overconfidence, arbitrage, and equilibrium asset pricing. *Journal of Finance* 56: 921–965.

Deaves, R., Luders, E. and Luo, R. (2005) The Dynamics of Overconfidence: Evidence from Stock Market Forecasters. Working paper, Social Science Research Network.

De Bondt, W.F. and Thaler, R.H. (1995) Financial decision making in markets and firms: A behavioral perspective. In: R.A. Jarrow, V. Maksimovic and W.T. Ziemba (eds.) *Handbooks in Operations Research and Management Science*, Vol. 9, Finance. Amsterdam, the Netherlands: Elsevier, pp. 385–410.

De Long, J.B., Shleifer, A., Summers, L. and Waldmann, R.J. (1991) The survival of noise traders in financial markets. *Journal of Business* 64: 1–20.

Ederington, L. and Lee, J.H. (2002) Who trades futures and bow: Evidence from the heating oil futures markets. *Journal of Business* 75: 353–373.

Foster, A.J. (1995) Volume-volatility relationships for crude oil futures markets. *Journal of Futures Markets* 15: 929–951.

Fung, H.G., Leung, W.K. and Xu, X.E. (2002) Information role of U.S. futures trading in a global financial market. *Journal of Futures Markets* 21: 1071–1090.

Fung, H.G. and Lo, W.C. (1995) An empirical examination of the *ex ante* international interest rate transmission. *Financial Review* 30: 175–192.

Garman, M. and Klass, M. (1980) On the estimation of security price volatilities from historical data. *Journal of Business* 53: 67–78.

Gervais, S. and Odean, T. (2001) Learning to be overconfident. *Review of Financial Studies* 14: 1–27.

Ghosh, A. (1993) Cointegration and error correction models: Causality between index and futures prices. *Journal of Futures Markets* 13: 193–206.

Glaser, M. and Weber, M. 2007 Overconfidence and trading volume. *Geneva Risk Insurance Review* 32: 1–36.

Grammatikos, T. and Saunders, A. (1986) Futures price variability: A test of maturity and volume effects. *Journal of Business* 59: 319–330.

Grinblatt, M. and Keloharju, M. (2006) Sensation Seeking, Overconfidence, and Trading Activity. NBER Working Paper #12223.

Han, L., Kling, J. and Sell, C. (1999) Foreign exchange futures volatility: Day of the week, intra-day, and maturity patterns in the presence of macroeconomic announcements. *Journal of Futures Markets* 19: 665–693.

Han, L. and Ozocak, O. (2002) Risk-return relationships in foreign-currency futures following macroeconomics announcements. *Journal of Futures Markets* 22: 729–764.

Hartzmark, M.L. (1991) Luck versus forecast ability: Determinants of trader performance in futures markets. *Journal of Business* 64: 49–74.

Hirshleifer, D. (2001) Investor psychology and asset pricing. *Journal of Finance* 56: 1533–1597.

Hirshleifer, D. and Luo, G.Y. (2001) On the survival of overconfident traders in a competitive securities market. *Journal of Financial Markets* 4: 73–84.

Jonsson, A.C. and Allwood, C.M. (2003) Stability and variability in the realism of confidence judgments over time, content domain, and gender. *Personality and Individual Differences* 34: 559–574.

Karpoff, J.M. (1987) The relation between price changes and trading volume: A survey. *Journal of Financial and Quantitative Analysis* 22: 109–126.

Kocagil, A.E. and Shachmurove, Y. (1998) Return-volume dynamics in futures markets. *Journal of Futures Markets* 18: 399–426.

Kyle, A.S. and Wang, F.A. (1997) Speculation duopoly with agreement to disagree: Can overconfidence survive the market test? *Journal of Finance* 52: 2073–2090.

Malmendier, U. and Tate, G. (2005) CEO overconfidence and corporate investment. *Journal of Finance* 60: 2661–2700.

Martell, T.F. and Wolf, A. (1987) Determinants of trading volume in future markets. *Journal of Futures Markets* 7: 233–244.

Milgrom, P. and Stokey, N. (1982) Information, trade and common knowledge. *Journal of Economic Theory* 26: 17–27.

Nguyen, D. and Daigler, R. (2007) A return-volume-volatility analysis of futures contracts. *Review of Futures Markets* 15: 265–293.

Odean, T. (1998) Volume, volatility, price, and profit when all traders are above average. *Journal of Finance* 53: 1887–1934.

Odean, T. (1999) Do investors trade too much? *American Economic Review* 89: 1279–1298.

Pagano, M. and Roell, A. (1992) Trading volume. In: P. Newman, J. Eatwell and M. Milgate (eds.) *The New Palgrave Dictionary of Money and Finance.* London: Macmillan, pp. 679–683.

Russo, J.E. and Schoemaker, P. (1992) Managing overconfidence. *Sloan Management Review* 33: 7–17.

Sanders, D.R., Boris, K. and Manfredo, M. (2004) Hedgers, funds, and small speculators in the energy futures markets: An analysis of the CFTC's Commitments of Traders reports. *Energy Economics* 26: 425–445.

Shefrin, H. and Statman, M. (1985) The disposition to sell winners too early and ride losers too long: Theory and evidence. *Journal of Finance* 40: 777–791.

Shiller, R.J. (1981) Do stock prices move too much to be justified by subsequent changes in dividends? *American Economic Review* 71: 421–436.

Shleifer, A. and Summers, L.H. (1990) The noise trader approach to finance. *Journal of Economic Perspectives* 4: 19–33.

Silvapulle, P. and Moosa, I.A. (1999) The relationship between spot and futures prices: Evidence from the crude oil market. *The Journal of Futures Markets* 19: 175–193.

Simon, D.P. and Wiggins III, R. (2001) S&P futures, returns and contrary sentiment indicators. *Journal of Futures Markets* 21: 447–462.

Simpson, M.W. and Ramchander, S. (2004) An examination of the impact of macroeconomic news on the spot and futures treasuries markets. *The Journal of Futures markets* 24: 453–478.

So, R.W. and Tse, Y. (2004) Price discovery in the Hang Seng Index markets: Index, futures, and the Tracker Fund. *Journal of Futures Markets* 24: 887–907.

Statman, M., Thorley, S. and Vorkink, K. (2006) Investor overconfidence and trading volume. *Review of Financial Studies* 19: 1531–1565.

Tauchen, G.E. and Pitts, M. (1983) The price variability volume relationship on speculative markets. *Econometrica* 51: 485–505.

Tse, Y. (1998) International linkages in Euromark futures markets: Information transmission and market integration. *Journal of Futures Markets* 18: 129–149.

Tse, Y. (1999) Price discovery and volatility spillovers in the DJIA index and futures markets. *Journal of Futures Markets* 19: 911–930.

Tse, Y., Lee, T. and Booth, G. (1996) The international transmission of information in Eurodollar futures markets: A continuously trading market hypothesis. *Journal of International Money and Finance* 15: 447–465.

Wang, F.A. (1998) Strategic trading, asymmetric information and heterogeneous prior beliefs. *Journal of Financial Markets* 1: 321–352.

Wang, F.A. (2001) Overconfidence, investor sentiment, and evolution. *Journal of Financial Intermediation* 10: 138–170.

Wang, C. (2003) The behavior and performance of major types of futures traders. *Journal of Futures Markets* 23: 1–31.