# VOLATILITY, VOLUME, AND THE NOTION OF BALANCE IN THE S&P 500 CASH AND FUTURES MARKETS

**SHARON BROWN-HRUSKA**
**GREGORY KUSERK**

## INTRODUCTION

Regulatory authorities and market critics have suggested that an imbalance between the level of futures trading and cash trading leads to increased volatility and instability in the cash market. For example, the International Organization of Securities Commissioners (IOSCO), an organization of government regulators from throughout the world, proposed a work project be undertaken that "would focus upon the need to maintain balance between the stock and derivative markets in order to avoid adverse effects on the stability of the stock market."[1] The Tokyo Stock Exchange (TSE) proposed that limits be imposed on stock index futures trading when there is a large mismatch in the trading volumes of cash and futures markets, suggesting that volume

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[1] *Strategic Assessment* (1990), p. 25.

■ *Sharon Brown-Hruska is an Assistant Professor of Finance, Tulane University.*

■ *Gregory Kuserk is a Senior Economist in the Division of Economic Analysis, Commodity Futures Trading Commission.*

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imbalance is a precursor to the market becoming "overheated."[2] It is unclear in these proposals and in other references what differential constitutes an imbalance. The term imbalance is defined in this study to mean an excess of futures trading volume over cash market volume.

Following the stock price declines of 1987 and 1989, the relationship between stock index futures trading and the stock market was scrutinized in numerous government, academic, and exchange-sponsored studies. Those studies found no conclusive empirical evidence to support the notion that high levels of futures trading, either alone or relative to trading in the cash market, result in elevated volatility. On the contrary, Bessembinder and Seguin (1992) present evidence that high trading volume in the futures market is associated with decreased stock price volatility. Despite the lack of evidence, futures activity has been targeted disproportionately by regulatory measures following periods of elevated stock price volatility. Following the 1987 crash, circuit breakers were implemented in the futures market that limit stock index futures trading following a 12 point price change. No similar limitation has been imposed on the trading of the component stocks. With the intent of reducing trading volume in futures, the TSE raised margins and recommended circuit breakers for shutting down index futures and options trading. No such restrictions were applied to the cash market.[3] Although high futures trading volume has not been shown to cause cash market volatility, those regulatory initiatives effectively lower futures market trading volume relative to cash, implying that regulators believe that reducing futures trading volume restores some balance to the markets and therefore, stabilizes prices.

This article reviews the theoretical models on the relationship between trading volume in the cash and futures markets to determine if there is support for a theoretically optimal relationship between the volume of trade in the two markets and empirically examines whether cash markets exhibit higher price volatility than usual when futures trading volume is high relative to the cash market. This investigation is conducted using data on the Chicago Mercantile Exchange's S&P 500 futures contract and stocks traded on the New York Stock Exchange (NYSE). It is found that the ratio of the daily trading value of S&P 500

[2] *Economist,* April 24, 1993.

[3] See *International Securities Regulation Report,* August 10, 1993, p. 9, and *Financial Times,* July 23, 1993, p. 23.

futures[4] to the traded value of NYSE stocks generally hovers around 1. In addition, a higher expected ratio of futures trading to cash market trading is associated with lower price volatility in the cash equity market. Finally, higher levels of contemporaneous expected and unexpected cash trading and unexpected futures trading are associated with higher cash price volatility.

## THEORETICAL AND EMPIRICAL CONSIDERATIONS

Although the notion of balance has not been examined explicitly in theoretical terms in financial economics, two general classes of models, portfolio choice models and asymmetric information models, provide insight. In portfolio choice models, investors are symmetrically informed about the future values of tradable assets suggesting that trading is related to differences in investors' risk and return profiles.[5] Investors use futures contracts for their general effect on return distributions. For example, by cross-hedging, an investor can use a stock index futures contract to hedge the risk inherent in any equity portfolio with which the price of the stock index futures contract is correlated. Because the price of a particular futures contract will be correlated with a number of assets, trading volume in a futures contract over an interval of time need not be less than the traded value of the cash commodity or asset(s) underlying it.

Asymmetric information models employ a rational expectations framework in which traders formulate their demands using all available information.[6] To the extent that different trading mechanisms cause differences in the way prices incorporate information, such mechanisms will affect the actions of informed traders and, hence, trading volume. Futures markets are generally set up as continuous auction markets, whereas cash markets vary widely from dealer markets (bid and ask prices posted by a specialist who takes the opposing side of all orders) to batch markets (prices set at specific times during the day, with all trades

[4]Consistent with others who have examined the impact of futures trading [see SEC (1988), chapter 3], this study defines trading value as the daily volume of trading times the daily settlement price times 500. Although this measure is referred to as the value of futures trading, it should be noted that the theoretical value of a futures contract at any point in time tends toward zero.

[5]Telser (1986) provides a unique discussion of futures volume and its relationship to cash volume, likening the relationship to that between fractional reserves and the money supply. See also Karpoff (1986, 1987) and Carlton (1983). In addition to asymmetric information, portfolio choice models abstract from the effect of market imperfections on trading volume.

[6]See Black (1990) for a review of research in this area.

executed at the posted price). Trading volume will vary depending on how market conditions affect the rewards to information trading under different trading mechanisms. Further, different trading mechanisms in futures and cash markets can result in different equilibrium bid–ask spreads, with which trading volume is thought to vary inversely. Thus, while these models cannot predict the relative volume of trading in cash and futures markets, they suggest that the underlying microstructure of the markets will affect the balance.

Portfolio choice models and asymmetric information models suggest no predictable empirical relationship between futures volume and volume in the cash market or between the relative levels of trading in the two markets and price volatility in either market. Several empirical studies, however, consider the relationship between trading volume and volatility within a market. Karpoff (1987) reviews a number of studies that deal with intramarket volume and volatility and finds that volume is positively related to the absolute value of price changes in a market. He also finds that volume and the price change per se are positively related. While these findings appear incongruous, Karpoff argues that the models used to estimate the relationship between volume and volatility are misspecified. In actuality, an asymmetric price–volume relationship may exist, resulting in limited support for both theories.

Another body of literature considers the relationship between trading volume in the derived market and price volatility in the underlying instrument. Conflicting arguments exist as to why futures trading may increase or decrease volatility in the cash market. Figlewski (1981) notes that the ability of cash market participants to hedge with futures lowers volatility and improves the functioning of the cash market by reducing the risk premia embedded in cash prices. Danthine (1978) asserts that the information reflected through futures trading exerts a stabilizing influence on cash prices. Conversely, if futures prices are distorted by manipulation or technical factors, this may lead to increased volatility. Stein (1987) notes that futures markets attract uninformed speculative order flow, reducing the informativeness of prices, leading to price instability and a decrease in welfare. Moreover, uninformed speculation is thought to be greater in the futures markets due to the lower transactions costs associated with it. Figlewski (1981) also contends that if increased hedging demand is not offset by enough speculation, or if futures traders are less informed than cash market participants, volatility in the cash markets in increased. Summers and Summers (1989) argued that transactions taxes, increased margins, and other measures to reduce futures trading volume "have the beneficial effects of curbing instability introduced by speculation."

Bessembinder and Seguin (1992) considered the interrelationship between spot trading volume, futures trading activity, and cash price volatility. They found that unexpected cash market trading volume has a much larger effect on volatility than expected cash market trading volume. In addition, they found a significant decline in the coefficients relating cash price volatility to spot trading volume when futures trading was introduced. They found also that stock market volatility is negatively associated with the level of open interest in stock index futures.

In summary, existing theories regarding trading volume do not imply that an optimal level of futures trading volume to cash market volume need exist. To the extent that the relative level of futures trading volume to cash market trading volume affects cash price volatility, an empirical investigation is necessary.

## EMPIRICAL METHODS AND DATA

To investigate the notion of market balance, a series is constructed of the relative trading volume in the two markets that controls for nominal differences in the values of the instruments traded. The balance series is defined as the ratio of the daily volume of the S&P 500 futures times the daily settlement price times 500 to the daily dollar value of NYSE share volume.

The nature of the relationship between the balance series and average five-minute returns during what might be termed crisis times in the market is considered. Days of large absolute returns are examined to determine whether a disproportionate number of these days also exhibit balance ratios that differ substantially from normal. Using a methodology introduced by Schwert (1990) that allows for unbiased estimation of daily standard deviations conditional on observable variables, the relationship between balance and price volatility in the markets is also analyzed. Controlling for other factors that may influence cash price volatility, this method involves iterating between a return and a standard deviation equation of the following forms:

$$R_t = \alpha_1 + \sum_{j=1}^{n} \gamma_j R_{t-j} + \sum_{i=1}^{4} \rho_i d_i + \sum_{j=1}^{n} \psi_j \hat{\sigma}_{t-j} + U_t \tag{1}$$

$$\hat{\sigma}_t = \alpha_2 + \sum_{t=1}^{4} \eta_i d_i + \sum_{j=1}^{n} \beta_j \hat{\sigma}_{t-j} + \sum_{j=1}^{n} \omega_j \hat{U}_{t-j} + \varepsilon_t \tag{2}$$

where $R_t = \ln(P_t/P_{t-1})$ is the return on day $t$; $P_t$ is the closing price on day $t$; $\hat{U}_t$ is the residual from eq. (1); and $\hat{\sigma}_t = |U_t|\sqrt{\pi/2}$ is the estimated conditional return standard deviation on day $t$. A day of the week dummy variable is used as a control for day of the week volatility effects as identified by various authors.[7] The procedure for estimating these equations is to first estimate eq. (1), without the conditional return standard deviations, using ordinary least squares (OLS). The residuals from eq. (1) are then used to estimate the conditional return standard deviation as noted above, and these estimates are used to estimate eq. (2) with OLS. The predicted values of eq. (2) are then used to reestimate eq. (1).[8] This procedure is iterated three times, as suggested by Davidian and Carroll (1987).

Of primary interest in this study is eq. (2), which models the conditional standard deviation of prices. To evaluate the relationship between volatility, individual trading volumes, and the balance ratio, eq. (2) is modified to include these variables as follows:

$$\hat{\sigma}_t = \alpha_2 + \sum_{t=1}^{4} \eta_i d_i + \sum_{j=1}^{n} \beta_j \hat{\sigma}_{t-j} + \sum_{j=1}^{n} \omega_j \hat{U}_{t-j} + \phi_1 CV_t + \phi_2 FV_t + \phi_3 \frac{FV_t}{CV_t} + \varepsilon_t \tag{2a}$$

where $CV_t$ and $FV_t$ are the dollar values of NYSE stocks and S&P 500 futures, respectively, traded on day $t$. The value of futures trading is measured as the settlement price of the nearby futures contract times 500 times the number of contracts traded. Equation (2a) gives the general model for the empirical analysis of the association between balance and volatility.

Bessembinder and Seguin (1992) suggest that the competing predictions regarding the information content of futures and cash market trading can be tested by segregating the trading volume series and balance series into unexpected and expected components by modeling each series as ARIMA processes.[9] Such a partitioning provides a means

[7] $F$-tests confirm the existence of a day of the week effect, but are not reported here. The results of the tests are available from the authors upon request. Also, see French (1980) and Jain and Joh (1988).

[8] Davidian and Carroll (1987) suggest that a weighted least squares procedure with fitted values from eq. (2) should be used for the estimation of eq. (1). Use of the weighted least squares procedure, however, does not significantly alter the results using OLS. Results reported herein are those using the OLS procedure.

[9] The results reported in this article are based on raw volume levels and using an ARIMA(0, 0, 10) specification to partition the data series. Results are not qualitatively different using a log series or an ARIMA(0, 1, 10) specification for partitioning purposes.

to sort out information shocks that enter the markets, since, as noted by Epps and Epps (1976), the extent to which traders disagree about valuation effects of information causes greater volume and volatility simultaneously. Information arrival that positively impacts the value of equities leads to an increase in volatility and volume in both equities and stock index futures and results in a positive correlation between cash volatility and unexpected futures and cash volume. Alternatively, those who assert that futures volume is destabilizing tend to focus on order flow generated by speculators, and other uninformed traders such as liquidity or noise traders. Partitioning each of the volume and the balance series into unexpected and expected variables provides a means to examine the effects of information shocks while isolating the uniformed speculative trading that is alleged to destabilize the cash market.

Partitioning the futures volume, cash volume, and balance data series into expected and unexpected components results in six variables. A model specification that contains all six variables would exhibit collinearity since the balance series, the ratio of the futures volume to cash volume, contains the other explanatory variables in the regression. To avoid this problem, three specifications of eq. (2a) are estimated. Specification (I) contains the expected and unexpected components of the balance series:

$$\hat{\sigma}_t = \alpha_2 + \sum_{t=1}^{4} \eta_i d_i + \sum_{j=1}^{10} \beta_j \hat{\sigma}_{t-j} + \sum_{j=1}^{10} \omega_j \hat{U}_{t-j} + \phi_1 \left(\frac{FV_t}{CV_t}\right)^E + \phi_2 \left(\frac{FV_t}{CV_t}\right)^U + \varepsilon_t \tag{I}$$

where $(FV_t/CV_t)^E$ represents the expected balance series and $(FV_t/CV_t)^U$ denotes the unexpected balance series. Specification (II) contains the expected component of the balance series, the unexpected component of the futures volume series, and the unexpected component of the cash volume series:

$$\hat{\sigma}_t = \alpha_2 + \sum_{t=1}^{4} \eta_i d_i + \sum_{j=1}^{10} \beta_j \hat{\sigma}_{t-j} + \sum_{j=1}^{10} \omega_j \hat{U}_{t-j} + \phi_1 CV_t^U + \phi_2 FV_t^U + \phi_3 \left(\frac{FV_t}{CV_t}\right)^E + \varepsilon_t \tag{II}$$

Specification (III) contains the unexpected component of the balance series, the expected component of the futures volume series, and the expected component of the cash volume series:

$$\hat{\sigma}_t = \alpha_2 + \sum_{t=1}^{4} \eta_i d_i + \sum_{j=1}^{10} \beta_j \hat{\sigma}_{t-j} + \sum_{j=1}^{10} \omega_j \hat{U}_{t-j} + \phi_1 CV_t^E + \phi_2 FV_t^E + \phi_3\left(\frac{FV_t}{CV_t}\right)^U + \varepsilon_t \tag{III}$$

Daily observations of the dollar value of NYSE stocks traded were used as a proxy for the value of stocks traded during the period April 4, 1982 through March 30, 1990. The daily volume and settlement prices of the S&P 500 index futures are from the Commodity Futures Trading Commission's (CFTC) Permanent Records data base. Intraday cash values of the S&P 500 index are from the Chicago Mercantile Exchange's (CME) time and sales data. Table I presents a summary of the data, including autocorrelation coefficients and unit root test statistics. The statistics show that for the volume series, the existence of a unit root can generally be rejected. Partial autocorrelation coefficients are also uniformly significant for the volume series.

## EMPIRICAL EVIDENCE

Concern over trading volume is greatest during times of large price movements. Examining the level of balance at these times presents an obvious starting point in analyzing the relationship between balance and

**TABLE I**

Summary Statistics—Daily Observations, April 4, 1982 to March 30, 1990

| | | | *Partial Autocorrelations* | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Variable* | *Mean* | *Standard Deviation* | *1* | *2* | *3* | *4* | *5* | *Unit Root Test Statistic* |
| S&P 500 return (%) | 0.054 | 1.133 | 0.037 | −0.053 | −0.017 | −0.051 | 0.054 | |
| Dollar Value of NYSE volume (billions) | 4.663 | 2.042 | 0.834[a] | 0.270[a] | 0.210[a] | 0.111[a] | 0.144[a] | −5.245[a] |
| Dollar value of S&P 500 futures volume (billions) | 6.022 | 3.580 | 0.899[a] | 0.213[a] | 0.236[a] | 0.185[a] | 0.091[a] | −5.577[a] |
| Ratio of dollar value or NYSE to S&P 500 futures volume | 1.236 | 0.462 | 0.830[a] | 0.271[a] | 0.185[a] | 0.128[a] | 0.100[a] | −7.138[a] |

[a]Denotes significance at the 0.05 level.

**TABLE II**
Twenty Highest and Lowest Average Return Days and the Ratio of Futures to Cash Market Volume—Daily Observations, July 1, 1984 to March 30, 1990

| *20 Highest Average Return Days* | | | *20 Lowest Average Return Days* | | |
|---|---|---|---|---|---|
| *Date* | *Average Return* | *Futures/Cash Volume* | *Date* | *Average Return* | *Futures/Cash Volume* |
| 10-21-87 | 0.00110 | 0.7927 | 10-19-87 | −0.00277 | 0.7779 |
| 10-20-87 | 0.00075 | 0.7383 | 10-26-87 | −0.00154 | 0.4525 |
| 10-29-87 | 0.00071 | 0.5990 | 1-8-88 | −0.00090 | 1.0974[a] |
| 1-4-88 | 0.00047 | 1.0387[a] | 10-13-89 | −0.00083 | 1.0469[a] |
| 10-27-87 | 0.00041 | 0.4895 | 10-16-87 | −0.00071 | 1.3143[a] |
| 5-31-88 | 0.00041 | 1.2004[a] | 9-11-86 | −0.00066 | 1.8604[a] |
| 8-3-84 | 0.00039 | 0.8189 | 4-14-88 | −0.00058 | 1.1299[a] |
| 10-30-87 | 0.00038 | 0.4761 | 10-22-87 | −0.00051 | 0.5556 |
| 12-18-84 | 0.00038 | 1.4691[a] | 11-30-87 | −0.00051 | 1.1902[a] |
| 12-14-87 | 0.00035 | 1.3999[a] | 12-3-87 | −0.00043 | 1.2734[a] |
| 9-22-87 | 0.00035 | 1.7020[a] | 7-7-86 | −0.00042 | 1.8799[a] |
| 11-12-87 | 0.00033 | 0.7514 | 10-14-87 | −0.00039 | 1.7992[a] |
| 8-2-84 | 0.00033 | 1.0735[a] | 11-9-87 | −0.00039 | 1.0233[a] |
| 4-6-88 | 0.00033 | 1.3775[a] | 1-8-86 | −0.00038 | 0.1897 |
| 8-9-84 | 0.00032 | 1.2808[a] | 12-28-87 | −0.00036 | 0.5627 |
| 10-18-84 | 0.00032 | 1.1868[a] | 11-18-86 | −0.00035 | 2.0746[a] |
| 1-15-88 | 0.00031 | 0.8959 | 1-20-88 | −0.00034 | 1.1827[a] |
| 1-21-85 | 0.00031 | 1.3405[a] | 10-6-87 | −0.00033 | 1.9701[a] |
| 4-3-87 | 0.00031 | 1.3926[a] | 4-14-87 | −0.00033 | 1.4357[a] |
| 11-5-87 | 0.00031 | 0.7558 | 1-12-90 | −0.00033 | 1.4162[a] |

[a]Indicates balance level above the mean balance level of 1.0133.

cash prices. Table II shows the highest and lowest 20 average return days, as measured by the average of five-minute returns during a day, and the associated balance ratios. For the 20 highest return days, 11 show a balance level above the average, while balance levels on the remaining nine days are below the average. On 15 of the 20 lowest return days, however, the ratio is above the average, indicating that futures trading tends to be higher relative to the cash market when prices fall. Thus, possibly due to short-sale restrictions in the stock market, liquidity falls off faster in the stock market than in the futures markets when prices plummet. These results are also consistent with Karpoff's (1988) observation that a positive relationship between volume and price changes per se in the stock market is likely caused by short-sale restrictions, based on the absence of a similar relationship in the futures market.

The regression results for the three specifications described above appear in Table III. The estimated coefficients of expected and unexpected balance in specification (I) are negative but not significant. The

**TABLE III**

Regressions of Estimated Daily Returns Standard Deviations on Expected and Unexpected Components of the Daily Dollar Value of Cash and Futures Trading and Balance—Daily Observations, April 4, 1982 to March 30, 1990

| | *Specification I* | *Specification II* | *Specification III* |
|---|---|---|---|
| Intercept | 0.5595 (4.695)[a] | 0.9554 (9.066)[a] | 0.2381 (2.484)[a] |
| Monday | 0.1286 (1.660) | 0.2868 (4.229)[a] | 0.1474 (1.899) |
| Tuesday | 0.0914 (1.229) | −0.0522 (−0.790) | 0.1132 (1.510) |
| Wednesday | −0.0399 (−0.545) | −0.1689 (−2.594)[a] | −0.0204 (−0.278) |
| Thursday | −0.0259 (−0.353) | −0.0911 (−1.398) | −0.0182 (−0.248) |
| ΣSDEV | 0.5105 (109.228)[a] | 0.5244 (176.013)[a] | 0.4873 (84.877)[a] |
| ΣRES | −0.2866 (15.452)[a] | −0.3493 (31.089)[a] | −0.2981 (16.763)[a] |
| Expected balance | −0.1169 (−1.671) | −0.4212 (−6.632)[a] | |
| Unexpected balance | −0.0444 (−0.449) | | −0.0895 (−0.896) |
| Expected futures volume | | | −0.0118 (−0.861) |
| Unexpected futures volume | | 0.0426 (2.575)[a] | |
| Expected cash volume | | | 0.0539 (1.906) |
| Unexpected cash volume | | 0.4036 (16.700)[a] | |
| Adjusted $R^2$ | 0.1168 | 0.3195 | 0.1200 |

[a]Denotes significance at the 0.05 level.
Test statistics for individual coefficients are $t$-statistics for the hypothesis that the coefficient is zero, computed using White (1980) heterskedasticity consistent standard errors. Test statistics for ΣSDEV and ΣRES are $F$-statistics for the hypothesis that the sum of the ten lag coefficients is zero.

adjusted $R^2$ of the equation is 0.1168. These results suggest that cash price volatility cannot be explained by the observation that total futures volume is in excess of that of cash volume. This is regardless of whether the excess volume is the result of uninformed trading or an information shock. It also suggests that trading volumes may not serve as a consistent indicator of the level of information entering the markets and that at any point in time a unit of trade in one market may be transmitting more or less information than a unit of trade in the other market.

Specification (II) contains the expected balance variable and the unexpected components of futures and cash volume. The coefficient estimates for the expected balance variable is negative and significant while the estimates for the unexpected futures and cash volume coefficients are positive and significant. The significant coefficients and the higher adjusted $R^2$ of 0.3195 indicate that this model specification is better able to explain the association between trading volumes and price volatility. The positive coefficient estimates for unexpected futures and cash volumes confirm the findings of Bessembinder and Seguin (1992). This result indicates that information shocks cause prices to move and generate volume in the markets. The negative coefficient for the expected balance series indicates a decrease in the level of cash market volatility when the expected level of futures to cash market trading rises.

Specification (III) includes the unexpected balance series and the expected futures and cash market volume series. The estimated coefficients for the focus variables are not significant and the low adjusted $R^2$ of 0.12 is also about the same as in specification (I). The insignificant coefficient on unexpected balance suggests that information shocks exert a differential and inconsistent effect on the relative volume of trading in the cash and futures markets.

To summarize, the regression results of specification (II) indicate that information shocks generate trading volume in both the cash and futures markets and cause prices to move. Failure to observe a significant coefficient for unexpected balance in either specification (I) or (III), however, indicates that information shocks do not exert a consistent similar effect on trading volumes in the two markets at any point in time. The positive coefficient for expected balance in specification (II) indicates that a high expected futures volume relative to expected cash volume is associated with smaller price moves. This result is consistent with the findings of Bessembinder and Seguin that showed that higher expected futures volume was associated with lower cash market volatility, but goes further to show that higher futures volume relative to cash market volume is associated with lower cash price volatility.

## CONCLUSIONS

While cash equity markets and stock index futures are interrelated, there is no a priori reason to believe that the levels of trading in the markets are inextricably linked. Theoretical models establish a basis for trading in cash and futures markets but do not support the assertion that trading volumes should necessarily be in some sort of balance between the two markets.

This study examines the relationship between relative trading volumes in the stock market and stock index futures market and cash price volatility. The results indicate that on days experiencing large price increases, the ratio of futures trading to cash market trading does not appear to be out of balance. When prices fall, however, futures trading tends to be greater than cash market trading.

A general analysis of the relationship between balance and volatility models the conditional standard deviation of prices as a function of futures and cash market volumes and their relative value to each other. The analysis confirms the findings of other studies showing a positive relationship between cash market volume and cash price volatility. There is evidence that a higher expected level of futures trading relative to cash market trading is associated with lower cash price volatility, and no evidence to suggest that a higher level of futures market trading to cash market trading is associated with increased cash price volatility.

As noted in the introduction, many have proposed transactions taxes, increased margins, and other measures to reduce futures trading volume based on the view that speculative trading in futures markets leads to instability in cash equity prices. While such initiatives may be pursued for other purposes, this investigation provides no theoretical or empirical support for regulatory policy that seeks to curtail trading in pursuit of market stability. Regulatory initiatives designed to limit futures trading premised on the assumption that futures trading has a destabilizing effect on the cash market are unsupported by the findings of this study. The premise that excessive futures volume or an imbalance between futures and cash volume leads to cash market volatility remains unsubstantiated.

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