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An Examination of the Relationship Between Trading Volume and Price Volatility on the CME-SIMEX Link

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ABSTRACT

For DM futures contracts traded on the Chicago Mercantile Exchange (CME) and the Singapore International Monetary Exchange (SIMEX) a positive relationship between trading volume and price volatility was found.

A strong positive relationship was found between the volume of trading on the CME and the subsequent trading volume on the SIMEX. Whereas the price volatility on the CME did not appear to be strongly related to the subsequent price volatility on the SIMEX.

An Examination of the Relationship Between Trading Volume and Price Volatility on the CME-SIMEX Link

The opening of the CME-SIMEX Link in September 1984 provides a unique opportunity to study the relationship between price and volume movements for the IMM (International Monetary Market) Deutschemark Futures Contracts. The SIMEX (Singapore International Monetary Exchange), formerly the Gold Exchange of Singapore is a futures market almost identical to the IMM of the CME (Chicago Mercantile Exchange), except that it is considerably newer and smaller than the CME, and that it is, of course, located in Singapore instead of Chicago. The Deutschemark Futures Contracts traded on either exchange are identical and thus fungible. There exists a fourteen hour difference in time between Chicago and Singapore, so that a 24 hour trading day with respect to Chicago time would consist of an 8:00 a.m. opening in Chicago trading until 2:00 p.m., then a five hour non trading period followed by a 7:00 p.m. opening on the SIMEX and trading until 1:00 a.m., followed by a seven hour non trading period.

The existence of these two non overlapping trading periods, during which the exact same contract is traded allows for the investigation of the relationship between price volatility and volume at divergently different levels of trading activity. In the next section a review of the literature on the relationship between price and volume is presented. Section II describes the hypotheses to be tested and the data and methodology used in the study. The results and conclusions are given in the final section.

I. Literature Review

Much of the work in the area of price and volume relationships has been done in the evaluation of equity securities. An early study by Ying (1966) looked at the relationship between the S&P 500 stock index and the New York Stock Exchange daily trading volume. He found that large price changes appeared to be associated with a large volume of trading, that large volumes are associated with price increases, and that small volumes accompany price declines. Although Ying's findings are flawed by methodological problems, he has presented an interesting issue.

Epps (1975) develops a theoretical argument for the relationship between volume and price change. He shows that the number of shares exchanged on a transaction in which price rises exceeds the volume accompanying a price decline of the same magnitude. Empirically he shows this to be true for the secondary market for publicly traded bonds. In a follow on study, Epps (1977) also confirms this finding for common stocks.

Cohen, Maier, Schwartz and Whitcomb (1978) develop a theoretical model which establishes that the variance of a security's return will be inversely related to thinness of trading. Under a specific set of assumptions, the thinly traded issues will be more volatile.

Morse (1980) examined the effect of asymmetrical information on securities prices through an analysis of the relationship between trading volume and prices. He found that during periods of high trading volume, serial correlations of returns residuals are high. And that trading on the day before large return residuals is significantly different from trading on the day before small return residuals, thereby indicating a linkage between trading volume and returns.

James and Edmister (1983) hypothesize that if differences in trading activity are the cause of the return differences associated with firm size due to the existence of a liquidity premium, then an inverse relationship between mean daily returns and trading activity should be observed. This is similar to the relationship expressed by Cohen, Maier, Schwartz, and Whitcomb (1978). James and Edmister find that there is no significant difference between the mean returns of the highest and lowest trading activity portfolio, nor is there any evidence of an inverse relationship between trading activity and mean daily returns.

The literature on the volume and price relationship for common stock trading is in a state of flux, with no definitive theory or evidence predominating. The literature on the volume and price relationship for futures trading is rather sparse. Rutledge (1984) and Stansell (1983) investigate the direction of causality in the volume and price relationship for 15 commodities futures and Treasury Bill Futures respectively. Rutledge finds that in 31 of 136 contracts studied, that price variability "causes" trading volume. In only 2 cases does he find that volume "causes" price variability. And in the remaining 103 cases he can't identify a relationship or no significant relationship exists. Stansell investigates nine different T Bill contracts using four different methodologies. He finds four cases in which causality goes from volume to prices; five cases in which causality goes from prices to volume; eight cases of bidirectional causality; and 19 cases where there was no statistical relationship.

Cornell (1984) studied the relationship between volume of trading and price variability for futures contracts of 18 commodities. He found a significant, positive, contemporaneous correlation between changes in average daily volume and changes in the standard deviation of daily log price relatives for 14 of the 18 commodities studied. For the remaining 4, the relationship was found to be positive although not significant.

As it is in the equity markets, the relationship between volume and price volatility has not been clearly identified nor empirically tested to a satisfactory degree. This paper serves to fill this gap and provide a basis for inquiry into the interesting question. A useful extension of the findings of this paper can be made in linking the volume of trading and the systematic risk of securities. Dimson (1979) provides a methodology for estimating the Beta of infrequently traded (low volume) securities. Building on Dimson's methodology, if it can be shown that volume of trading is systematically related to price volatility a better measure of systematic risk may be developed. In the next section of this paper, a linkage between volume and price volatility will be hypothesized and the data and methodology used to test the hypothesis is described.

II. Data, Hypotheses and Methodology

This study examines the relationship between price volatility and trading volume for the Deutschmark Mark Futures Contract, which has traded on the CME and the SIMEX since the 7th of September 1984. The period of study is from the initiation of trading (7 September 1984) to 21 June 1985. This period encompassed the trading of three contracts, December, March, and June. The measure of price volatility was the daily range, or the high price of the day minus the daily low price. This measure of volatility was used rather than the more conventional variance of the rate of return on investment, because the initial investment in a futures position is zero. Additionally using the rate of return on initial margin would not be of any use, because not all investors face the same margin requirements and T-Bills can be used to meet the margin requirements, thereby making the opportunity cost of the margin equal to zero. The volume is measured by the number of contracts traded on a given day on each of the exchanges.

Price range information and trading volume were gathered for the near DM contract on both exchanges. Missing data and/or holidays on one or both of the exchanges resulted in a different number of trading days for each contract. Table I presents descriptive statistics for the data set used in this study.

The relationship between volume and price volatility are investigated by four hypotheses:

H_1 The average price volatility on the CME is greater than the average price volatility on the SIMEX for the DM contract. The average volume of trading in the CME is greater than the average volume of trading on the SIMEX for the DM contract.

H_2 A positive relationship exists between the relative volume on the CME-SIMEX and the relative price volatility on the CME-SIMEX for the DM contract.

Table I. Statistics of the Data Set

Contract & Exchange	Variable	# of Observation	Mean	Standard Deviation	Minimum	Maximum
A. December						
CME	Range	66	0.0033	0.0017	0.0012	0.0128
	Volume	66	22030	9325	2579	47498
SIMEX	Range	66	0.0013	0.0009	0.0001	0.0050
	Volume	66	579	352	8	1635
B. March						
CME	Range	48	0.0025	0.0014	0.0010	0.0085
	Volume	48	17115	7427	2441	37861
SIMEX	Range	48	0.0009	0.0008	0.0002	0.0033
	Volume	48	422	481	7	3132
C. June						
CME	Range	61	0.0038	0.0018	0.0014	0.0122
	Volume	61	24494	10116	2546	50125
SIMEX	Range	61	0.0021	0.0017	0.0000	0.0111
	Volume	61	865	550	2	2417

H_3 The intercept and slope of the regression equation for the volatility and volume relationship on the CME is equal to the intercept and slope for the volatility and volume relationship on the SIMEX.

H_4 The volume of trading on the CME is positively related to the subsequent volume of trading on the SIMEX. The price volatility on the CME is positively related to the subsequent price volatility on the SIMEX.

The first hypothesis was tested by use of a standard t-test for the equality of means. It tested whether the price volatility and volume were significantly greater for the CME than for the SIMEX. Affirmation of this hypothesis would indicate on average that for the DM futures contract high volume was associated with high price volatility and low volume was associated with low price volatility.

The second hypothesis examines the relationship between the relative volume on the CME-SIMEX and the relative price volatility on the CME-SIMEX. The correlation coefficient, ρ, was calculated for the natural log of the volume on the CME divided by the natural log of the volume on the SIMEX, with the price range of the CME divided by the price range of the SIMEX. In notational form the second hypothesis is shown in equation 1:

$$\rho\left(\frac{\ell n \ Vol_C}{\ell n \ Vol_S}, \frac{R_C}{R_S}\right) > 0 \qquad (1)$$

A high correlation would indicate that a large volume of trading was associated with a large amount of price fluctuation.

The third hypothesis was investigated by the use of a regression equation with qualitative and quantitative explanatory variables. The dummy variable regression is:

$$R_i = \beta_0 + \beta_1 D + \beta_2 \ell n(Vol) + \beta_3 D*\ell n(Vol) + e \qquad (2)$$

where

R_i is the daily price volatility

Vol is the daily volume of contracts

D is $\begin{cases} 0 \text{ for CME} \\ 1 \text{ for SIMEX} \end{cases}$

β_0, β_1, β_2, β_3 are the regression parameters

The third hypothesis in notational form is:

$$\beta_1 = \beta_3 = 0 \qquad (3)$$

which would indicate that there is no difference between the relationship of price and volume on the CME and price and volume on the SIMEX.

The final hypothesis dealt with the relationship between trading on the CME and the subsequent trading on the SIMEX. Two regressions were run. The first regression evaluated the relationship between the volume of trading on the SIMEX and the previous days volume of trading on the CME. Likewise the price volatility on the SIMEX was regressed against the previous days price volatility on the CME. The regressions are shown in equation 4.

$$Vol_{S,t} = \alpha_0 + \alpha_1 Vol_{C,t-1} + e \qquad (4a)$$

$$R_{S,t} = \beta_0 + \beta_1 R_{C,t-1} + e \qquad (4b)$$

We felt that the trading behavior on the CME and SIMEX were similar enough to cause the residuals of equations 4a and 4b to be correlated. Hence we used the Seemingly Unrelated Regression (SUR) approach on both of the equations. We hypothesized that the α_1 and β_1 would be significantly positive. High volume of trading on the CME are followed by high volume of trading on the SIMEX. And large price fluctuations on the CME are followed by large price fluctuations on the SIMEX.

The results of the four parts of the study are presented in the following section.

III. Results and Conclusion

Table II presents the results of the t-tests for the equality of the mean trading volume and mean price fluctuations on the CME and SIMEX.

In all cases the volume of trading and price volatility on the CME significantly exceeded the volume of trading and price volatility on the SIMEX. We can conclude that a low volume of trading is associated with a small amount of price volatility and a large amount of trading is associated with a large amount of price volatility. This empirical finding supports the finding of Cornell (1984) of a positive relationship between volume and price volatility.

An extension of this research would be to determine the nature of this positive relationship between volume and volatility. Various forms such as a step function, linear relationship, or non linear relationship can be envisioned suggesting various types of phenomena occurring as the volume of trading increases.

Table II. T-test Results

Contract & Exchange	Variable	# of Observation	Mean	T-statistic
A. December				
CME	Range	66	0.0033	8.21**
SIMEX	Range	66	0.0013	
CME	Volume	66	22030	27.30**
SIMEX	Volume	66	579	
B. March				
CME	Range	48	0.0025	7.20**
SIMEX	Range	48	0.0009	
CME	Volume	48	17115	20.46**
SIMEX	Volume	48	422	
C. June				
CME	Range	61	0.0038	5.67**
SIMEX	Range	61	0.0021	
CME	Volume	61	24494	18.55**
SIMEX	Volume	61	865	

** = Significant at 1% level.

Additional evidence supporting a strong positive relationship between volume and volatility was the large highly significant correlation coefficients of relative volume with relative price volatility. These results are presented in Table III.

The third hypothesis which dealt with the relationship between volume and volatility in both markets was supported by the results for the December and March contracts. However for the June contract the results indicate that there is a significant difference in the volume and volatility relationships between both markets. Table IV presents the results of the dummy variable regression.

The mixed results of the β_1 and β_3 coefficients being not significantly different from zero for the December and March contracts and being very significant for the June contract prevents us from reaching a conclusion about the similarity or difference of the volume and volatility relationship of the CME and SIMEX. As more contract cycles are completed and more data become available, this issue will be able to be resolved.

The final area of interest was the relationship between volume on the CME and subsequent volume on the SIMEX and price volatility on the CME and subsequent price volatility on the SIMEX. This issue was approached from two different ways. Independent regressions for each relationship and seemingly unrelated regressions (SUR) for both relationships simultaneously. The results of these two approaches are presented in Tables V and VI respectively.

Under either method, a strong positive relationship was found between trading volume on the CME and next day trading volume on the

Table III. Correlation Coefficients for Relative Volume and Volatility

$$\rho\left(\frac{\ell n\ Vol_C}{\ell n\ Vol_S}, \frac{R_C}{R_S}\right)$$

Contract	Correlation Coefficient
December	.82**
March	.80**
June	.85**

** = Significant at 1% level.

Table IV. Dummy Variable Regression Results

$$R = \beta_0 + \beta_1 D + \beta_2 \ell n(VOL) + \beta_3 D^* \ell n(VOL) + \varepsilon$$

where R = range;

$$D = \begin{cases} 1 & \text{if SIMEX} \\ 0 & \text{if CME} \end{cases};$$

VOL = Volume

Contract	β_0	β_1	β_2	β_3	F	R^2
December	-0.00666 (-2.55)*	0.00504 (1.79)	0.00010 (3.82)**	-0.00053 (-1.68)	33.63**	0.441
March	-0.00319 (-1.19)	0.00342 (1.24)	0.00059 (2.13)*	-0.00047 (-1.55)	19.75**	0.392
June	-0.01184 (-3.86)**	0.01035 (3.24)**	0.00157 (5.12)**	-0.00101 (-3.00)**	28.90**	0.424

** = Significant at 1% level.
 * = Significant at 5% level.

Table V. Independent Regression Results

$$\ell n(VOL_{St}) = \beta_0 + \beta_1 \ell n(VOL_{Ct-1}) + \varepsilon$$

where S = SIMEX and C = CME

Contract	β_0	β_1	F	R^2
December	-5.035 (-3.75)**	1.127 (8.29)**	68.66**	0.518
March	-6.906 (-2.62)*	1.288 (4.71)**	22.18**	0.425
June	-12.056 (-7.11)**	1.841 (10.84)**	117.50**	0.666

$$R_{St} = \beta_0 + \beta_1 R_{Ct-1} + \varepsilon$$

Contract	β_0	β_1	F	R^2
December	0.0012 (4.76)**	0.0471 (0.72)	0.53	0.008
March	0.0002 (1.01)	0.270 (3.61)**	13.04**	0.221
June	0.0014 (2.80)**	0.168 (1.40)	1.96	0.032

** = Significant at 1% level.
 * = Significant at 5% level.

Table VI. Seemingly Unrelated Regression Results

$$\ell n(VOL_{St}) = \beta_0 + \beta_1 \ell n(VOL_{Ct-1}) + \varepsilon$$

$$R_{St} = \alpha_0 + \alpha_1 R_{Ct-1} + \varepsilon$$

Contract	β_0	β_1	R^2
December	-9.247 (-3.88)**	1.531 (6.20)**	0.470
March	-11.015 (-6.84)**	1.736 (10.76)**	0.499
June	-3.836 (-2.96)**	1.006 (7.66)**	0.419

Contract	α_0	α_1	R^2
December	0.0001 (0.66)	0.304 (4.50)**	0.370
March	0.0010 (2.11)*	0.270 (2.37)*	0.499
June	0.0010 (4.29)**	0.091 (1.44)	0.319

** = Significant at 1% level.
* = Significant at 5% level.

SIMEX. For all three contracts the slope coefficient was significantly positive and the R^2 were relatively high. This indicates that a high volume day on the CME will usually precede a high volume day in the SIMEX.

For the pricing relationship between volatility on the CME and next day volatility on the SIMEX the results are not as clear cut. From Table V we see that only the March contract has a significantly positive slope coefficient indicating support for the hypothesis. However the December and June contracts have a slope not significantly different than zero and very low R^2 indicating very little relationship between CME and SIMEX price volatility. The SUR results for the price volatility are somewhat more encouraging. The December contract has a significantly positive slope at the 1% level and the March contract has a significantly positive slope at the 5% level and the R^2s are much higher.

Overall we can conclude that there is a very strong relationship between the volume of trading on the CME and the volume of trading on the SIMEX. The relationship between the markets for price volatility is not as strong.

The research studied the relationship between the volume of trading and price variability for DM futures contracts being traded on the CME and SIMEX. A significant positive relationship between volume of trading and price volatility was found. The correlations between relative price and relative volume movements on the CME-SIMEX link was found to be quite high.

In assessing the relationship between volume and trading on the CME and volume of trading on the SIMEX, a very strong positive relationship was found. Whereas these results on the price volatility relationship between the two models is mixed.

The results of this research are encouraging given that less than one years worth of data on only one type of contract was available. Further research when more data becomes available in terms of time and contracts is warranted.

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