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MODELING ASYMMETRY IN THE PRICE-VOLUME RELATION: EVIDENCE FROM NINE STOCK MARKETS

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Abstract

This paper investigates asymmetry in the price-volume relation. An autoregressive distributed lag approach along with a series of coefficient restrictions tests are employed to detect asymmetry in the price-volume relation in nine stock market indices in eight different countries. The results indicate the existence of asymmetric effect and that higher volume is associated more with price increase rather than with price decrease. Possible interpretations, implication and recommendation are presented.

Key words: asymmetry, price-volume relations and international markets.
JEL Classification: G10 and G15.

1. Introduction

If the adage that says that volume is relatively heavy in bull markets and light in bear markets is true, then the understanding of such a relation is important. This adage suggests that we need test for asymmetry in this relation among stock markets.

Ever since the work of Osborne (1959), the relation of stock prices and trading volumes has been attracting a considerable attention from scholars and investors. Although earlier research attempts found no solid connection between the price series and the corresponding volume series, subsequent empirical investigations provided strong evidence for the existence of such a relation. In fact some researchers are confident enough to conclude that "prices and volumes of sales in the stock market are joint products of a single market mechanism, any model that attempts to isolate prices from volumes or vice versa will inevitably yield incomplete if not erroneous results" (Ying, 1966).

Although empirical studies have provided sufficient evidence for the association between changes in stock prices and changes in volume, few attempts have been concerned with the asymmetry of such a relation. The question here is: do rising stock prices affect trading volume in a significantly different way from declining prices? This paper intends to answer this question using data on nine stock markets in eight different countries. The inclusion of such a number of markets will help us draw more sound and robust conclusions.

In the next section of this paper, the relevant literature will be reviewed with the objective to formulate a conceptual framework. Research methodology to test for asymmetry in the price-volume relation will be discussed next. Data description, model estimation and the discussion of results will follow. In the last section, conclusions will be presented.

2. Review of the Relevant Literature

Granger and Morgenstern (1963) were the first among economists trying to relate price to volume in the stock market. Applying spectral analysis, they found no connection between the price and volume. Using the same methodology, Ying (1966) was the first to document price-volume association. The following are the significant results found:

1. A small volume is usually accompanied by a fall in price.
2. A large volume is usually accompanied by a rise in price.
3. A large increase in volume is usually accompanied by either a large rise in price or a large fall in price.
4. A large volume is usually accompanied by a rise in price.

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5. If the volume has been decreasing consecutively for a period of five trading days, then there will be a tendency for the price to fall over the next four trading days.
6. If the volume has been increasing consecutively for the period of five trading days, then there will be a tendency for the price to rise over the next four trading days.

Because of the method used to adjust data and using the price data from one market (SP 500) and the volume data from another (NYSE), the data sample of Ying's research was found to be inconsistent. However, his research has encouraged a strand of empirical research attempts to verify the findings.

With regard to asymmetry, the empirical evidence is inconclusive. Therefore, the literature relevant to price-volume relation can be divided into three groups. The first group, which is the majority, provides support for a strong association between positive price change and volume. The second one presents empirical evidence of a strong association between negative price change and volume. The third group finds no asymmetric effect of price change on volume. We will discuss these groups of studies in turn, starting with those providing evidence for positive association.

As mentioned earlier, and despite the legitimate criticism of his data and methodology, Ying (1966) was the first to document an asymmetric effect with a strong positive correlation between the change in price and volume. However, having also concluded that "a large increase in volume is usually accompanied by either a large rise in price or a large fall in price", Ying implies a symmetric relation between the price change and volume.

Using data for the market index and individual stocks, Crouch (1970a, 1970b) was also able to provide statistical evidence for positive correlation between price change and volume. Similar conclusions were provided by Westerfield (1977) and by Tauchen and Pitts (1983).

Morgan (1976) investigated the relation between the variance of the price change and volume for individual stocks and documented positive correlation. The same relation was tested by Epps and Epps (1976) and similar results were obtained.

For the futures market, a positive relation between changes in volume and changes in the variability of prices for individual futures contracts was found by Cornell (1981), later confirmed by Rutledge (1984), and then by Grammatikos and Saunders (1986). Statistical evidence for asymmetry and positive association was also provided by Bessembiner and Seguin (1993), Brailsford (1996) and Cooper et al. (2000).

Investigating asymmetry in the relatively small and emerging market of Kuwait, Al-Saad (2004) provided evidence of the existence of an asymmetric relation between the change in price and volume represented by the number of shares, the number of transactions and the value of traded shares. Al-Saad and Moosa (2007) provided additional evidence for asymmetry in the small market of Kuwait. They also found that trading volume tends to be higher in a rising market than in a falling market. They interpreted this result by the fact that major traders in the Kuwait stock exchange do not have to be involved in mass selling fearing a crash because the government is always expected to support market. This interpretation, however, is unique for this market.

The literature provides different but common interpretations and explanations for the positive correlation between the change in price and volume. Jennings et al. (1981) refer to the disparity of opinions held by optimists (the more informed traders) and the pessimists (the less informed traders) as a possible explanation. Their main argument is that short sellers are more responsive than long investors to information that stimulates price change than long positions which leads to higher volume association with positive price change. Investigating asymmetry in the futures market, Karpoff (1987) argues that if the key is short sale constraints, as indicated by Karpoff (1986), then "future markets data would reveal no correlation between the price change and volume". Therefore the higher cost of short sale is a valid explanation for the positive association in the stock market. Wang (1994) explains asymmetry by the differential trading behavior of the informed versus the uninformed investors. Wang's model was adopted later by Cooper et al. (2000) to investigate asymmetry and validate the interpretation in the real estate market and found the same results.

Now, we turn to the evidence for negative association. Supporting evidence for asymmetry with a negative association between the price change and volume was provided by Smirlock and Starks (1985), Wood et al. (1985), Moosa and Korczak (1999) and Moosa et al. (2003). Smirlock and Starks found the relation of volume to the absolute change in price to be lower for upticks than for downticks. They attribute this finding to the higher transaction costs of upticks and the lack of information arrival. The same results were documented by Wood et al. Investigating symmetry in the price-volume relation in the crude oil future markets, Moosa and Kroczak (1999) and Moosa *el al.* (2003) have reported stronger negative relation.

Finally, some studies found weak or no evidence for symmetry. As mentioned earlier, using weekly data over twenty two years, Granger and Morgenstern (1963) documented no relation between the price index movement and the level of volume. Using daily transactions, Godfrey, Granger and Morgenstern (1964) found no correlation between the change in price and volume. Studying the relation between common stock returns trading activity and market value, James and Edmister (1983) found no cross-sectional correlation between annual measures of turnover and price change, implying a symmetric relation. Weak evidence for asymmetry was also reported by Rogalski (1978). Harris and Raviv (1993) did not find asymmetry between stock returns and volume. Investigating the dynamic relation between market-wide trading activity and returns in a large number of stock markets using weekly and daily data, an explicit support for a symmetric relation between the change in price and volume was provided by Griffin et al. (2004). In support of the participation costs models such as Orosel (1998), Griffin el al. (2004) report a symmetric response of volume to both positive and negative return shocks using asymmetric VARs.

3. Data and Methodology

In this study, daily data on trading volume and price index were compiled for nine stock markets in eight different countries from the Yahoo Finance website. Although, the Yahoo finance website is a free source of raw financial and economics data as well as specialized information, the data provided are up to date and reliable. Ending on May the 31st, 2005, the number of observations for each market varied for the various markets depending on its availability from the source. In order to detect possible different patterns, the sample included stock markets with different levels of transparency, information availability and disclosure. The markets covered are:

1. DJIA (DOW), The Dow Jones Industrial Average.
2. S&P 500 (SP500).
3. FTSE 100 (FTSE), The London Stock Exchange.
4. CAC 40 (CAC), The French Stock Exchange.
5. MadGen (Madrid), The Madrid Stock Exchange.
6. Nikkie 225 (NK), The Tokyo Stock Exchange.
7. Hang Seng (HS), The Hong Kong stock Exchange.
8. Seoul Composite (Seoul), The South Korean Stock Exchange.
9. S&P TSX Composite (Toronto), The Toronto Stock Exchange.

To test for asymmetry, this study adopts an autoregressive-distributed lag (ARDL) model with order selection on the basis of Schwartz Bayesian information criterion (SBC). The asymmetric ARDL model that recognizes both positive and negative price changes is used. It can be written as

$$v_t = \alpha + \sum_{j=1}^{p} \beta_j v_{t-j} + \sum_{j=0}^{q} \gamma_j^+ \Delta p_{t-j}^+ + \sum_{j=0}^{r} \gamma_j^- \Delta p_{t-j}^- + u_t, \tag{1}$$

where v_t is the logarithm of the trading volume, Δp_t^+ is a positive (logarithmic) price change, Δp_t^- is a negative (logarithmic) price change, Δp is decomposed as $\Delta p_t^+ = \Delta p_t$ if $\Delta p_t \geq 0$ and $\Delta p_t^+ = 0$ otherwise; $\Delta p_t^- = \Delta p_t$ if $\Delta p_t \leq 0$ and $\Delta p_t^- = 0$ otherwise.

To avoid bias regarding the process of model selection, a value of 5 is selected as the maximum lag order for *p*, *q* and *r* for the ARDL specification. The model will then be estimated for all possible combinations of the values of lags, ranging from 0 to 5. The best model is subsequently selected on the basis of Schwarz Bayesian information criterion. The estimation process involves selecting one of $(m+1)^{k+1}$ (that is 216) models. Where *m* is the maximum lag selected and *k* is the number of regressors (in this case Δp_t^+ and Δp_t^-).

The step following the estimation of equation (1) is to test for the existence of asymmetry using a series of coefficient tests as in the following hypotheses:

$$H_1 : \gamma_j^+ = 0 \qquad \forall j \tag{2}$$

$$H_2 : \gamma_j^- = 0 \qquad \forall j \tag{3}$$

$$H_3 : \gamma_j^+ - \gamma_j^- = 0 \tag{4}$$

$$H_4 : \gamma_j^+ = \gamma_j^- = 0 \tag{5}$$

$$H_5 : \sum \gamma_j^+ = 0 \tag{6}$$

$$H_6 : \sum \gamma_j^- = 0 \tag{7}$$

Hypotheses H_1 to H_4 will be tested using a Wald Test with a χ^2 distribution (with one degree of freedom), while H_5 and H_6 will be tested on the basis of the t statistic of estimated linear functions of the coefficients. H_1 is the null hypothesis that the positive change in stock price affects trading volume variability. H_2 is the null hypothesis that the negative change in stock price affects trading volume variability. H_3 is the null hypothesis that both positive and negative changes in stock price have similar effects on trading volume variability. H_4 is the null hypothesis that both positive and negative changes in stock price affect trading volume variability. H_5 is the null hypothesis that the collective contemporaneous and lagged positive changes in stock prices have an effect on trading volume variability. H_6 is the null hypothesis that the collective contemporaneous and lagged negative changes in stock prices have an effect on trading volume variability.

4. Results and Discussion

Before discussing the results of the estimated ARDL equation and that of the coefficient restriction tests, it would be useful to analyze the nature of the correlation between the trading volume and the change in price.

Table 1 shows three types of useful information. The first two columns present the correlation coefficients between the trading volume and the two regressors: the positive change and negative changes in stock prices. These two columns show high significant correlation between the trading volume and the two regressors. They also show that for eight markets (out of ten) the value of the correlation coefficient between the trading volume and the positive change in stock price is higher when compared with the absolute value of the correlation coefficient between the trading volume and the negative change in stock price. This result is consistent with the studies that reported that higher volume is associated more with positive price changes. Because all the markets included in this study permit short selling, the literature interpretation that this is due to the fact that short sellers are more responsive than long investors to information that stimulate price change than long positions which leads to higher volume association with positive price change may be valid.

Table1

Correlation between the trading volume and the change in price

Market	*V* correlation with:		Average means of *V* associate with:		t-Test for two means
	Δp^+	Δp^-	Δp^+	Δp^-	
DJIA	0.62	-0.56	8.31	6.75	3.30*
NASDQ	0.62	-0.61	8.78	6.49	4.78*
London	0.56	-0.60	11.33	9.81	1.94*
SP500	0.59	-0.60	7.05	7.40	-0.76

Table1(continued)

Market	V correlation with:		Average means of V associate with:		t-Test for two means
	Δp^{+}	Δp^{-}	Δp^{+}	Δp^{-}	
Paris	0.70	-0.64	9.70	8.60	0.98
Madrid	0.70	-0.64	11.38	7.77	3.08*
Tokyo	0.67	-0.61	6.64	6.63	0.00
Hong K.	0.61	-0.60	9.83	9.58	0.42
Seoul	0.59	-0.61	7.87	6.86	2.92*
Toronto	0.60	-0.55	9.63	8.85	1.56

Notes: *V* is the natural logarithm of the trading volume, Δp^{+} is the positive (logarithmic) price change, Δp^{-} is the positive (logarithmic) price change. * Significant at 0.05 level.

The next two columns show the average means of the logarithmic volume associated with Δp^{+} and Δp^{-}. They indicate that, except for SP500 market, for all the markets, the average mean of the volume associated with positive change in stock price is higher than that associated with negative change in stock price. However, the last column indicates that difference between the two means is statistically insignificant for half of the sample.

When considering the markets with the significant mean difference, we can observe that, for the markets with less transparency (Madrid and Seoul), the absolute value of the correlation coefficient between the volume and Δp^{-} is higher than that between volume and Δp^{+}. Comparing this result with that of the markets with more transparency (DJIA and NASDAQ), except for the London Stock Exchange, an opposite result can be observed. This result can be explained by the fact in a bearish market, and in order to minimize their losses, investors tend to respond quickly to negative price changes, whereas, in a bullish market, investors tend to desire further price increase to maximize their capital gains.

In addition to the market index name, model selected and number of observation, Table 2 presents the results of estimating the ARDL equation, the results of coefficient restriction tests, and goodness of fit and diagnostic tests. All of the estimated equations have reasonable goodness of fit and they all pass the diagnostic test for autocorrelation (*LM*)[1], implying a valid dynamic specification.

Table 2

Estimation and testing results: equation estimated,

$$v_t = \alpha + \sum_{j=1}^{p} \beta_j v_{t-j} + \sum_{j=0}^{q} \gamma_j^{+} \Delta p_{t-j}^{+} + \sum_{j=0}^{r} \gamma_j^{-} \Delta p_{t-j}^{-} + u_t$$

Market ARDL(*p*,*q*,*r*)*	N	γ_0^{+}	γ_0^{-}	$\overline{R}^2$	*LM*	H_1	H_2	H_3	H_4	H_5	H_6
NASDQ ARDL(5,1,5)	1000	7.15** (7.20)	-5.79** (-6.41)	0.83	2.33	8.4.98**	83.66**	99.71**	114.71**	9.11**	0.30
DJIA ARDL(5,1,0)	1000	6.85** (4.78)	-6.76** (-4.97)	0.54	3.69	34.39**	24.74**	34.75**	6.21**	5.82**	-4.97**

[1] The test statistic used is Lagrange Multiplier test of residual serial correlation. The χ_1^2 (with 1 degree of freedom) value to reject the null hypothesis of "no-serial correlation" is 3.84. This value is below the critical value for all the markets therefore the hypothesis cannot be rejected, implying no serial correlation problems in the models selected for all the markets.

Table 2 (continued)

Market ARDL(*p*,*q*,*r*)*	N	γ_0^+	γ_0^-	$\overline{R}^2$	*LM*	H_1	H_2	H_3	H_4	H_5	H_6
London ARDL(3,0,0)	728	2.44 (1.48)	-4.24** (-2.48)	0.36	0.01	2.19	6.16**	6.63*	6.63**	1.48	-2.48**
Paris ARDL(1,0,0)	266	22.12** (4.47)	-23.60** (-4.63)	0.24	0.35	13.95**	21.47**	28.84**	28.85**	4.47**	-4.63**
Madrid ARDL(0,1,0)	258	-1.84 (-0.08)	-23.58 (-0.94)	0.02	1.39	5.61***	0.89	0.28	7.66***	-1.56	-0.94
Tokyo ARDL(3,0,0)	828	6.33*** (1.88)	-2.11 (-0.68)	0.97	2.61	3.54***	0.46	2.40	3.56	1.88***	-0.68
Hong K. ARDL(5,0,4)	1010	17.37** (13.39)	-15.28** (-10.80)	0.49	7.33	179.25**	154.93**	2.09.88**	250.46**	13.39**	0.63
Seoul ARDL(5,1,0)	1838	2.14 (1.24)	2.93*** (1.69)	0.83	1.01	15.82**	2.85***	0.08	21.69**	3.52***	1.69***
Toronto ARDL(5,0,0)	1366	2.49*** (1.78)	-2.37*** (-1.94)	0.23	2.20	3.18***	3.77***	5.14***	5.21***	1.78***	-1.94***

Notes: * Autoregressive Distributed Lag model selected based on Schwarz Bayesian information Criterion. ** Significant at 0.05 level, *** significant at 0.10 level.

Table 2 indicates:

1. Considering the individual coefficients on the contemporaneous price change variables, the coefficient of the positive price change is significantly positive for six markets and insignificant for three markets. This implies that positive change in price would lead to an increase in the trading volume or have no effect at all.

2. The coefficient of the negative price change is significantly negative (at the .05 level) for five markets, significantly positive for one market and insignificant for the remaining two markets. This result implies that a negative price change would lead to a decrease, an increase or have no effect on trading volume.

3. Five of the markets with a significant positive effect of price change, realized significant negative effect of price change. This implies that the trading volume is affected by both the increase as well as the decrease in stock price change. The result does not, however, provide evidence of whether or not the effect is symmetric.

4. The above results partially support the evidence provided by AL-Saad and Moosa (2007). They argue that "higher volume is definitely associated with rising prices, but anything can happen with negative price change". This study, however, indicates that higher volume is associated with rising prices and lower volume is associated with declining price. However, there are chances that the decline in price would lead to an increase in volume or has no effect. The correlation analysis discussed earlier supports these arguments.

5. The joint restrictions hypotheses tests for H_1 and H_2 provide additional support for the arguments. H_1, the null hypothesis of "no positive effect" is rejected in all cases but one, providing strong evidence of association between positive price changes and trading volume. H_2, the null hypothesis of "no negative effect" is rejected in all cases but two, indicating strong evidence of the association between the declining prices and volume.

6. The results of testing the coefficient restrictions implied by H_3 show considerable support for the presence of asymmetry. The null hypothesis that positive and negative price changes have the same effect is rejected in six out of the nine cases. The hypothesis is not rejected for Madrid, Tokyo and Toronto stock markets. For these three markets, although symmetry is not rejected, we can observe that only Toronto can be considered to have a highly significant symmetric effect of price change on volume. That is because it

is the only market with an almost identical coefficients of contemporaneous variables (γ_0^+ and γ_0^-) and supported by the values of the two Wald test statistics represented by H_1 and H_2 for the lagged effect are also almost identical.

7. The null hypothesis, H_4, that positive and negative price changes (contemporaneous or lagged – if any) are equal and have no effect on volume is rejected in all cases but one, implying that the price-volume relation is significant. Although it indicates a significant effect of the two variables, this hypothesis does not help in identifying whether or not it is asymmetric.

8. Allowing for the combined effects of both contemporaneous and lagged – if any we also find evidence for significant effect. The null hypothesis, H_5, that there is no-combined contemporaneous and lagged positive price change effect on trading volume is rejected in seven out of the nine cases. The null hypothesis, H_6, that there is no-combined contemporaneous and lagged negative price change effect on trading volume is rejected in five out of the nine cases. Although they do not indicate whether or not the effect is asymmetric, the results of testing hypotheses H_5 and H_6 provide reasonable evidence that higher volume is associated with positive price change. These results are consistent with our earlier analysis of correlation.

5. Conclusion

By reviewing the relevant literature, it has been concluded that the stock market price-volume relation is still a controversial issue. With regard to evidence of asymmetric effects, empirical research can be divided into three main groups. The first group detects asymmetry with higher volume associated with positive stock price change. The second group provides evidence of asymmetry with higher volume associated with negative price change. The third and last group could not find an evidence of asymmetric effects.

As surveyed by Karpoff (1987), most of the research was based on samples of individual stocks. In this paper, nine different developed and less developed stock markets were studied to find out whether or not the price-volume relation is asymmetric.

The paper used an Autoregressive-distributed lag approach to model asymmetric effects relating trading volume to positive and negative changes of stock prices. The results of the model estimation and hypotheses testing reveal that the relation, significantly, exists and is asymmetric for most of the markets included.

In general, higher volume was found to be associated with rising prices. As all the markets included in this study permit short selling, the short selling interpretation may be valid to explain these results.

The results have two kinds of implications, theoretical and practical. The theoretical implication is that it adds an additional evidence of asymmetry from a sample covering a considerable number of stock markets in different countries. The practical implication is that, because of the strong association between positive price change and volume, investors preferring to trade large number of shares should do so when stock prices are rising.

Relative to the general findings of this study, it would be recommended for future empirical studies to differentiate between two groups of stock markets. One group that permits short selling and another that does not. Using the same modeling approach, we would be able to test the short selling interpretation hypothesis adopted by many studies including this one.

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