Some Tests on the Relationship Between Trading Volume and Stock Prices

José Miguel Pinto Dos Santos

1. Introduction

Trading volume is the number of units of a security, for example shares, that change hands during a given period of time, usually one day. Trading is an important economic phenomenom for at least two reasons. One is indirect: without trading the prices of assets would not be observed and thus the informational role played by prices (as well as other roles they play) would have to be performed by other mechanism. Another reason is direct: trading of assets, as well as any trading, is a wealth generating activity and its importance tends to increase with time in most economies. Thus the volume of trading is a subject worth of study.

However, research on trading volume in stock markets is much less abundant than that on stock prices. Also, while most pricing theories do not take in consideration trading volume, most theories that explain volume rely on price changes to do so. This is because in an efficient market trading volume can not affect the intrinsic or fundamental price of an asset. But prices changes can be used as a proxy to the arrival of information that makes investors want to adjust their portfolios and this adjustment will generate trading. However, it should be noted that this causal relationship from prices to trading volume and not vice-versa is not unanimously accepted. For example, explanations of stock price behaviour through the use of fads and fashions (Shiller (1989)) suggest that trading generates price changes.

To explain volume in asset markets some kind of investor heterogenity must be assumed. Differences among investors that can be considered include different information evaluation (Copland (1976) and Epps (1975)), and different endowments (Huffman (1987)).

Here we will not investigate theoretically the relationship between volume and prices but only investigate empirically if the relationships implied by the models of Copeland and Epps are present in Japanese stock prices. According to the model of Epps, stock prices' increases generate more volume than stock prices' decreases. In more more formal terms this can be expressed as $V^{+}/\Delta P^{+} > V^{-}/|\Delta P^{-}|$, or equivalently $\Delta P^{+}/V^{+} < |\Delta P^{-}|/V^{-}$, where V and P represent respectively trading volume and stock prices and the plus and minus signs indicate respectively that the value corresponds to a price increase or a price decrease.

The model proposed by Copland (1976) assumes that individuals receive information sequentially and in random order. From an initial equilibrium where all individuals possess an identical set of information a piece of new information arrives. As each individual receives this new information, he reacts by shifting his demand curve for shares by an amount δ. If he shifts his curve upwards by δ he is called an optimist, and if he shifts it downwards by $-\delta$ he is refered as a pessimist. The supply of shares is assumed constant. As each individual shifts his demand curve up (or down) he will buy (sell) shares from uninformed individuals who have not yet received the news. When all individual demand curves have been adjusted either up or down a new equilibrium price is reached and once again all individuals possess an identical information set. Assuming that the number of traders and the supply curve are constant the volume of trading depends on the impact a piece of news has on the individual demand curves, e.g. δ . This model implies a positive correlation between the absolute value of price changes and trading volume.

After presenting in the next Section 2 the data used we will present the results of a non parametic test in Section 3. In section 4 we present the results of some simple regressions.

2. The data

To perform the tests presented in the following sections we used five different sets of data. The first four sets consist of the daily closing stock price and the corresponding daily volume of stock sales of four different companies from the first section of the Tokyo Stock Exchange (TSE): Hitachi Seisakujo, Kyokuyou, Mistui Kouzan and Taisei Kensetsu. These companies were not choosen at random but represent four different sectors of activity present in the TSE: electric machinery, fisheries, mining and construction. These data sets span from January 4, 1994 to September 29, 1994, each sample having 185 observations. These time series were collected from the daily edition of the Nihon Keizai Shinbun.

The fifth data set consists of the daily Topix average and the Total Number of Shares Transactioned each day from January 7, 1985 to December 27, 1991, each sample having a total of 1724 observations. These time series were collected from the Nikkei Needs data bank. The Topix average was choosen instead of the more popular Nikkei index because it includes all companies whose shares are traded in the TSE, thus being directly comparable with the Total Number of Shares Transactioned series, what does not happen with the Nikkei index. Because the number of shares listed in the TSE changes with time, the Total Number of Shares Bought and Sold series should have been corrected to reflect that fact.

However, because the series of the number of shares listed is not available this correction is not made. To give an idea of the seriousness of the problem it can be noted that in January 6, 1986 there were 24,914.4 million shares listed in the TSE while in December 27, 1991, there were 32,232.7 million, an increase of about 29 percent.

The Topix series was used both not detrended and detrended. It should be noted, however, that since the Topix average peaked in December 18, 1989, and then decreased sharply for the next two years of the sample period, the linear trend used does not reflect appropriately the fact that two different trends seem to be present. To try to solve this problem, two suberiods were considered: from January 7, 1985 to December 18, 1989, and from December 18, 1989 to December 27, 1991. While during the first subperiod both prices and volume exhibit positive and sigificant trends, in the second one they exhibit negative trends, but not significant in the case of volume.

In what follows we use the following variables: changes in prices Δp_t ($= \ln(P_t/P_{t-1})$), volume v_t ($= \ln(V_t)$), and changes in volume Δv_t ($= \ln(V_t/V_{t-1})$), where P_t is the closing stock price or Topix average, and V_t is number of shares traded.

3. Non parametic tests

We begin by testing whether trading volume and stock prices are independent variables or not. A test usually used for this purpose is the chi-square test for independence (Ying (1966), Harnett (1982)). We group each variable (changes in prices Δp_t, volume v_t, and changes in volume Δv_t) into five classes as follows: let x_t be the variable; then:

$$\text{Class 1} = \{ x_t \mid x_t \leqq \mu_x - 0.85\sigma_x \}$$
$$\text{Class 2} = \{ x_t \mid \mu_x - 0.85\sigma_x < x_t \leqq \mu_x - 0.25\sigma_x \}$$
$$\text{Class 3} = \{ x_t \mid \mu_x - 0.25\sigma_x < x_t \leqq \mu_x + 0.25\sigma_x \}$$
$$\text{Class 4} = \{ x_t \mid \mu_x + 0.25\sigma_x < x_t \leqq \mu_x + 0.85\sigma_x \}$$
$$\text{Class 5} = \{ x_t \mid \mu_x + 0.85\sigma_x < x_t \}$$

where μ_x and σ_x are respectively the sample mean and standard deviation of x_t. The classes defined above are expected to contain one fifth of the observations of a variable x_t if this variable is normally distributed.

The joint distributions of v_t and Δp_t, and that of Δv_t and Δp_t for the four companies and for the Topix average are presented in the chi-square contigency tables (Tables 1 through 6). If the two variables are normally distributed and independent, the expected frequency in the ith row, jth column is 1/25 of all observations for all i and j. The chi-square statistic for independence is given by $\chi^2_{(r-1)(c-1)} = \Sigma^r \Sigma^c (O_{ij} - E_{ij})^2 / E_{ij}$, where O is the number of observations, E the number of expected observations, and r and c are the number of classes each variable was divided into. With 16 degrees of freedom in each case, the hypothesis that the two variables are independent is rejected for values of the chi-square statistic greater than 26.3, 28.8 and 32.0 for 5, 2.5, and 1 percent levels of significance.

As can be seen from the chisquare statistics for each case, transaction volume does not seem to be independent of price changes for Hitachi, Mitsui, Taisei and the Topix average (either detrended or not detrended). This test was also performed for other subperiods of the Topix average (from January 7, 1985 to December 18, 1989, and from December 18, 1989, to December 27, 1991) for both detrended and not detrended data, and in all cases the hypothesis of independence is rejected for all levels of significance (to save space the results are not presented). For Kyokuyo the hypothesis of independence can not be rejected at 1 percent level of significance. We can thus conclude that in general transaction volume is not independent of stock price changes.

Volume changes seem also to depend on price changes. Independence between the two is rejected for Mitsui, Taisei and the period considered for the Topix average. It cannot be rejected, however, for Hitachi and Kyokuyo respectively at the 5 and 2.5 percent levels of significance.This test was also performed for other two subperiods of the Topix average (from January 7, 1985 to December 18, 1989, and from December 18,1989, to December 27, 1991) for both detrended and not detrended data, and in all cases the hypothesis of independence is rejected for all levels of significance (again, to save space the results are not presented).

Since the dependence of volume and volume changes on price changes was verified we examine next if volume and prices exhibit the relationships implied by the models of Copeland and Epps.

4. Simple regressions

For each data set and for three diferent sample periods for Topix (both not detrended and detrended), volume v_t and volume changes Δv_t were regressed on price changes Δp_t . The results are presented in Tables 7 and 8. The results of the regressions of v_t and Δv_t on Δp_t when prices increase are presented in Tables 9 and 10, and of those same regressions when prices decrease in Tables 11 and 12. Finally, the results of the regressions of v_t and Δv_t on $|\Delta p_t|$ are presented in Tables 13 and 14.

From Epps' model we should expect that the regression curve of v_t on Δp_t^+ should always lie above that of v_t on $|\Delta p_t^-|$, or in other words, that the intercept and slope of the former should be larger than those of the later. Examination of Tables 9 and 11 shows that the intercepts and slopes of the former are always greater than those of the later, with only two exceptions: Kyokuyou and the Topix average when not detrended and covering the period from the beginning of 1985 to the end of 1991. However, it should be noted that since in both these two cases there were no observations to the right of the intersection of the two estimated lines, Epps' relationship holds in the relevant range (the range where there are sample observations). Epps' relationship seems thus to be confirmed in Japanese stock prices and trading volumes. Although not implied by Epps' model, but compatible with it, is the fact that stock price increases seem to generate more trading volume than stock price decreases as can be seen by comparing the absolute value of slopes of the regressions of Δv_t on Δp_t for price increases and price decreases, presented in Tables 10 and 12. In every case the absolute value of the slope for stock price increases is larger than that for stock price decreases.

From Copeland's model we should expect positive and significant slopes for the estimated relationship between v_t and $|\Delta p_t|$, or alternatively that the estimated curves of v_t on Δp_t for stock price decreases and increases should have the shape of a V with minimum value at $\Delta p_t = 0$. As can be seen from Table 13, the values of the estimated slopes for the four companies and for the Topix average for the two subperiods considered (either detrended and not detrended) are positive as expected and significant. Only for the case of the Topix average when the entire sample is used is the slope negative (data not detrended) or positive but not significant (data detrended). The values on Tables 9 and 11 confirm these results. Notice first that the intercepts for stock price increases is always above the one for stock price decreases (the intercept for the regression of v_t on Δp_t is also always between those two values). Notice then that the slopes for stock price decreases are in general negative and significant. This means that volume tends to increase with magnitude of the price decrease, as predicted by Copeland's model. But because the absolute value of the slope is less than that for stock price increases, volumes increase less for stock price decreases than for stock price increases, as predicted by Epps' model. However, when the Topix average is used detrended, the slopes in Table 11 are positive (or not significant), what sugests that the larger the magnitude of the price decrease, the smaller the trading volume. This seens to contradict the predictions of Copeland's model for stock price decreases. Notwithstanding this, Japanese data for stock prices and trading volume seems to confirm the validity of Copeland's model.

Finally it can be pointed that simply regressing v_t or Δv_t on Δp_t could lead to the conclusion that the relationship between trading volume and its changes and changes in stock prices is simply linear, as sugested by the positive and significant slope coeficients presented in Tables 7 and 8. This would lead us to miss the existence of the V relationship that seems to exist between v_t and Δv_t and Δp_t.

5. Conclusions

The results from the tests performed above suggest that the predictions of the models of Epps and Copeland are verified by the data used. The relationships found, e.g., that large stock price increases and decreases are acompanied by large and increasing trading volumes, and price decreases are accompanied by trading volumes smaller than those during price increases, are those expected under the assumptions of these models.

References

Copeland, Thomas E. 1976. "A Model of Asset Trading Under the Assumption of Sequential Information Arrival", Journal of Finance 31(4): 1149-1168.

Epps, Thomas W. 1975. "Security Price Changes and Transaction Volumes: Theory and Evidence", American Economic Review 65(4):586-597.

Harnett, Donald L. 1982. Statistical Methods. Addison Wesley.

Huffman, G. W. 1987. "A Dynamic Equilibrium Model of Asset Prices and Transaction Volume", Journal of Political Economy 95(1):138-159.

Shiller, Robert. 1989. Market Volatility. MIT Press.

Ying, Charles C. 1966. "Stock Market Prices and Volumes of Sales", Econometrica 34(3):676-685.

TABLE 1A Contigency Table for Hitachi: observed values of v_t and Δp_t

		Δp_t					
	Class	1	2	3	4	5	Total
v_t	1	4	10	12	13	0	39
	2	5	7	10	11	3	36
	3	11	10	6	9	3	39
	4	7	6	5	8	4	30
	5	4	3	10	7	16	40
	Total	31	36	43	48	26	184

$\chi^2=46.98$

TABLE 1B Contigency Table for Hitachi: observed values of Δv_t and Δp_t

		Δp_t					
	Class	1	2	3	4	5	Total
Δv_t	1	7	8	8	11	1	35
	2	7	8	8	9	3	35
	3	6	5	12	11	7	41
	4	6	11	8	11	5	41
	5	5	4	7	6	10	32
	Total	31	36	43	48	26	184

$\chi^2=24.42$

TABLE 2A Contigency Table for Kyokuyou: observed values of v_t and Δp_t

		Δp_t					
	Class	1	2	3	4	5	Total
v_t	1	7	10	11	6	4	38
	2	2	7	10	14	3	36
	3	8	8	8	10	5	39
	4	10	8	6	7	8	39
	5	6	2	7	5	12	32
	Total	33	35	42	42	32	184

$\chi^2=29.04$

TABLE 2B Contigency Table for Kyokuyou: observed values of Δv_t and Δp_t

	Class	Δp_t 1	2	3	4	5	Total
Δv_t	1	6	5	8	10	3	32
	2	8	10	12	10	2	42
	3	7	11	10	6	8	42
	4	10	6	7	8	10	41
	5	2	3	5	8	9	27
	Total	33	35	42	42	32	184

$\chi^2=26.33$

TABLE 3A Contigency Table for Mitsui: observed values of v_t and Δp_t

	Class	Δp_t 1	2	3	4	5	Total
v_t	1	1	12	11	7	4	35
	2	10	10	17	5	3	45
	3	6	10	6	7	4	33
	4	10	8	7	8	4	37
	5	3	4	6	7	14	34
	Total	30	44	47	34	29	184

$\chi^2=45.62$

TABLE 3B Contigency Table for Mitsui: observed values of Δv_t and Δp_t

	Class	Δp_t 1	2	3	4	5	Total
Δv_t	1	5	10	10	6	3	34
	2	11	9	12	10	4	46
	3	6	11	8	3	1	29
	4	5	8	9	11	11	44
	5	3	6	8	4	10	31
	Total	30	44	47	34	29	184

$\chi^2=33.12$

TABLE 4A Contigency Table for Taisei: observed values of v_t and Δp_t

	Class	Δp_t 1	2	3	4	5	Total
v_t	1	4	12	12	4	2	34
	2	11	10	10	4	6	41
	3	5	6	10	12	8	41
	4	6	4	8	6	5	29
	5	5	4	11	7	12	39
	Total	31	36	51	33	33	184

$\chi^2=33.12$

TABLE 4B Contigency Table for Taisei: observed values of Δv_t and Δp_t

	Class	Δp_t 1	2	3	4	5	Total
Δv_t	1	8	8	9	2	4	31
	2	12	9	9	9	3	42
	3	5	10	9	5	8	37
	4	3	8	14	10	8	43
	5	3	1	10	7	10	31
	Total	31	36	51	33	33	184

$\chi^2=35.02$

TABLE 5A Contigency Table for Topix (from 1985-1-7 to 1991-12-27): observed values of v_t and Δp_t

	Class	Δp_t 1	2	3	4	5	Total
v_t	1	60	117	116	50	26	369
	2	58	73	131	89	28	379
	3	32	61	86	73	46	298
	4	17	65	97	83	45	307
	5	24	59	115	111	61	370
	Total	191	375	545	406	206	1723

$\chi^2=369.67$

TABLE 5B Contigency Table for Topix (from 1985-1-7 to 1991-12-27): observed values of Δv_t and Δp_t

	Class	Δp_t 1	2	3	4	5	Total
Δv_t	1	52	95	94	44	18	303
	2	52	93	105	64	23	337
	3	33	85	152	92	27	389
	4	33	72	72	143	50	370
	5	21	30	77	108	88	324
	Total	191	375	545	406	206	1723

$\chi^2 = 475.54$

TABLE 6A Contigency Table for Topix (from 1985-1-7 to 1991-12-27, detrended): observed values of v_t and Δp_t

	Class	Δp_t 1	2	3	4	5	Total
v_t	1	51	114	132	65	18	380
	2	62	68	103	70	35	338
	3	40	69	99	77	45	330
	4	16	63	90	78	47	294
	5	22	61	121	116	61	381
	Total	191	375	545	406	206	1723

$\chi^2 = 359.55$

TABLE 6B Contigency Table for Topix (from 1985-1-7 to 1991-12-27, detrended): observed values of Δv_t and Δp_t

	Class	Δp_t 1	2	3	4	5	Total
Δv_t	1	52	95	94	44	18	303
	2	52	93	105	64	23	337
	3	33	85	152	92	27	389
	4	33	72	117	98	50	370
	5	21	30	77	108	88	324
	Total	191	375	545	406	206	1723

$\chi^2 = 475.54$

TABLE 7 Regression of v_t on Δp_t

	Intercept(1)	Slope(1)	R^2	Deg. Freedom
Hitachi	8.2590 (13.9585)	9.3970 (3.2021)	0.0533	182
Kyokuyou	4.9794 (7.2265)	3.0802 (1.4193)	0.0109	182
Mitsui	5.4662 (7.4887)	7.0922 (2.6202)	0.0363	182
Taisei	6.9487 (11.4898)	10.4868 (3.5108)	0.0634	182
Topix(85.1.7-91.12.27, not detrended)	10.9685 (19.3386)	9.6573 (8.3694)	0.0391	1721
Topix(85.1.7-89.12.18, not detrended)	11.1309 (20.6007)	7.8690 (5.3231)	0.0226	1225
Topix(89.12.18-91.12.27, not detrended)	10.5691 (25.4543)	8.1445 (6.4011)	0.0765	494
Topix(85.1.7-91.12.27, detrended)	11.1620 (20.0128)	9.0968 (8.0170)	0.0360	1721
Topix(85.1.7-89.12.18, detrended)	10.7483 (21.8965)	8.0866 (6.0213)	0.0288	1225
Topix(89.12.18-91.12.27, detrended)	10.5625 (25.4383)	8.1446 (6.4011)	0.0766	494

(1) Numbers in parenthesis are t-values

TABLE 8 Regression of Δv_t on Δp_t

	Intercept(1)	Slope(1)	R^2	Deg. Freedom
Hitachi	-0.006155 (-0.01165)	10.3180 (3.9360)	0.0784	182
Kyokuyou	0.001754 (0.002388)	6.4345 (2.7815)	0.0408	182
Mitsui	0.001013 (0.001660)	7.4800 (3.3032)	0.0566	182
Taisei	-0.003664 (-0.6476)	15.2260 (4.7604)	0.1107	182
Topix(85.1.7-91.12.27, not detrended)	-0.002988 (-0.009302)	7.8467 (12.0050)	0.0773	1721
Topix(85.1.7-89.12.18, not detrended)	-0.00820 (-0.02495)	9.6353 (10.7126)	0.08566	1225
Topix(89.12.18-91.12.27, not detrended)	0.00341 (0.01140)	5.6848 (6.2017)	0.0722	494
Topix(85.1.7-91.12.27, detrended)	0.000723 (0.002250)	7.8467 (2.0050)	0.0773	1721
Topix(85.1.7-89.12.18, detrended)	0.0003191 (0.0009705)	9.6353 (10.7126)	0.0857	1225
Topix(89.12.18-91.12.27, detrended)	-0.001204 (-0.004025)	5.6848 (6.2017)	0.0722	494

(1) Numbers in parenthesis are t-values

TABLE 9 Regression of v_t on Δp_t^+

	Intercept(1)	Slope(1)	R^2	Deg. Freedom
Hitachi	8.1312 (13.7848)	20.2748 (3.5887)	0.1228	92
Kyokuyou	4.8208 (6.8611)	12.5193 (2.7158)	0.07653	89
Mitsui	5.3493 (7.0043)	17.3135 (3.1005)	0.1027	84
Taisei	6.8221 (12.0864)	22.5044 (3.9640)	0.1642	80
Topix(85.1.7-91.12.27, not detrended)	11.0507 (19.8286)	5.0319 (2.2543)	0.0056	902
Topix(85.1.7-89.12.18, not detrended)	11.1381 (20.9032)	11.5820 (4.0309)	0.0234	678
Topix(89.12.18-91.12.27, not detrended)	10.6202 (25.4550)	8.1964 (3.1647)	0.0432	222
Topix(85.1.7-91.12.27, detrended)	11.2267 (20.1958)	6.3982 (2.8189)	0.0092	860
Topix(85.1.7-89.12.18, detrended)	10.7598 (22.3011)	11.8874 (4.3910)	0.0304	816
Topix(89.12.18-91.12.27, detrended)	10.6188 (0.4103)	7.9504 (3.2146)	0.0418	237

(1) Numbers in parenthesis are t-values

TABLE 10 Regression of Δv_t on Δp_t^+

	Intercept(1)	Slope(1)	R^2	Deg. Freedom
Hitachi	-0.2298 (-0.4232)	25.5153 (4.9064)	0.2074	92
Kyokuyou	-0.1407 (-0.1714)	13.6595 (2.5364)	0.0674	89
Mitsui	-0.09924 (-0.1744)	14.3232 (3.4429)	0.1237	84
Taisei	-0.0132 (-0.0218)	18.7457 (3.0862)	0.1064	80
Topix(85.1.7-91.12.27, not detrended)	0.01451 (0.04452)	9.2825 (7.1122)	0.0531	902
Topix(85.1.7-89.12.18, not detrended)	0.005744 (0.01724)	10.9770 (6.1117)	0.0522	678
Topix(89.12.18-91.12.27, not detrended)	0.027065 (0.08940)	7.2701 (3.8686)	0.0632	222
Topix(85.1.7-91.12.27, detrended)	0.02020 (0.06147)	9.2007 (6.8537)	0.0518	860
Topix(85.1.7-89.12.18, detrended)	0.02350 (0.06996)	10.4024 (5.5081)	0.0470	816
Topix(89.12.18-91.12.27, detrended)	0.01487 (0.2990)	7.5535 (4.1907)	0.0690	237

(1) Numbers in parenthesis are t-values

TABLE 11 Regression of v_t on Δp_t^-

	Intercept(1)	Slope(1)	R^2	Deg. Freedom
Hitachi	7.9921 (14.1954)	-11.3747 (-1.5793)	0.0326	74
Kyokuyou	4.6605 (7.4257)	-12.8668 (-2.4257)	0.0727	75
Mitsui	5.0934 (8.3610)	-15.8906 (-2.9251)	0.0924	84
Taisei	6.7507 (11.6586)	-7.4988 (-1.1364)	0.0150	85
Topix(85.1.7-91.12.27, not detrended)	10.8828 (19.0538)	-5.2160 (-2.5430)	0.0081	816
Topix(85.1.7-89.12.18, not detrended)	11.0385 (20.3962)	-0.5654 (-0.2303)	0.0001	545
Topix(89.12.18-91.12.27, not detrended)	10.4416 (26.0190)	-0.07523 (-0.03193)	0.0000	270
Topix(85.1.7-91.12.27, detrended)	11.0789 (19.9976)	4.0597 (2.1125)	0.0052	859
Topix(85.1.7-89.12.18, detrended)	10.6608 (21.6858)	0.1795 (0.08256)	0.0000	607
Topix(89.12.18-91.12.27, detrended)	10.4161 (25.8331)	-1.3319 (-0.5468)	0.0012	255

(1) Numbers in parenthesis are t-values

TABLE 12 Regression of Δv_t on Δp_t^-

	Intercept(1)	Slope(1)	R^2	Deg. Freedom
Hitachi	-0.1431 (-0.3015)	-3.3974 (-0.5594)	0.0042	74
Kyokuyou	-0.1084 (-0.1704)	-0.5266 (-0.1011)	0.0001	75
Mitsui	-0.1975 (-0.3120)	-4.9063 (-0.8689)	0.0089	84
Taisei	-0.1320 (-0.2061)	4.7659 (0.6530)	0.0050	85
Topix(85.1.7-91.12.27, not detrended)	-0.07916 (-0.2571)	-1.9297 (-1.7793)	0.0039	816
Topix(85.1.7-89.12.18, not detrended)	-0.06847 (-0.2153)	4.5381 (3.1460)	0.0178	545
Topix(89.12.18-91.12.27, not detrended)	-0.1092 (-0.3876)	-2.0313 (-1.2273)	0.0055	270
Topix(85.1.7-91.12.27, detrended)	-0.07195 (-0.2351)	2.2278 (2.0987)	0.0051	859
Topix(85.1.7-89.12.18, detrended)	-0.05969 (-0.1891)	4.7881 (3.4300)	0.0190	607
Topix(89.12.18-91.12.27, detrended)	-0.1166 (-0.4112)	-2.4779 (-1.4457)	0.0081	255

(1) Numbers in parenthesis are t-values

TABLE 13 Regression of v_t on $|\Delta p_t|$

	Intercept[1]	Slope[1]	R^2	Deg. Freedom
Hitachi	8.1105 (13.7356)	14.3036 (3.3228)	0.0572	182
Kyokuyou	4.7767 (7.1393)	11.6141 (4.6298)	0.0675	182
Mitsui	5.2294 (7.3819)	16.5262 (4.3027)	0.0923	182
Taisei	6.7753 (11.2605)	16.2869 (3.7849)	0.0730	182
Topix(85.1.7-91.12.27, not detrended)	10.9771 (18.9740)	-0.7724 (-0.5048)	0.0002	1721
Topix(85.1.7-89.12.18, not detrended)	11.1031 (20.3837)	5.4221 (2.8688)	0.0067	1225
Topix(89.12.18-91.12.27, not detrended)	10.5213 (24.4543)	3.7907 (2.0648)	0.0086	494
Topix(85.1.7-91.12.27, detrended)	11.1597 (19.6453)	0.1880 (0.1252)	0.0000	1721
Topix(85.1.7-89.12.18, detrended)	10.7202 (21.5730)	4.3611 (2.5268)	0.0052	1225
Topix(89.12.18-91.12.27, detrended)	10.5117 (24.4925)	4.7535 (2.5955)	0.0135	494

(1) Numbers in parenthesis are t-values

TABLE 14 Regression of Δv_t on $|\Delta p_t|$

	Intercept[1]	Slope[1]	R^2	Deg. Freedom
Hitachi	-0.1531 (-0.2881)	14.2290 (3.6742)	0.0691	182
Kyokuyou	-0.1315 (-0.1777)	7.7918 (2.2013)	0.0259	182
Mitsui	-0.1392 (-0.2268)	9.8825 (2.9685)	0.0462	182
Taisei	-0.1055 (-0.1554)	9.7655 (2.0103)	0.0217	182
Topix(85.1.7-91.12.27, not detrended)	-0.02247 (-0.06741)	2.9350 (3.3290)	0.0064	1721
Topix(85.1.7-89.12.18, not detrended)	-0.01341 (-0.0391)	2.1891 (1.8372)	0.0028	1225
Topix(89.12.18-91.12.27, not detrended)	-0.04813 (-0.1568)	4.4183 (3.3722)	0.0225	494
Topix(85.1.7-91.12.27, detrended)	-0.01860 (-0.05572)	2.4558 (2.7838)	0.0045	1721
Topix(85.1.7-89.12.18, detrended)	-0.005933 (-0.01726)	0.9474 (0.7934)	0.0005	1225
Topix(89.12.18-91.12.27, detrended)	-0.05477 (-0.1791)	5.0925 (3.9014)	0.0298	494

(1) Numbers in parenthesis are t-values