THE DAY-OF-THE-WEEK EFFECT AMONG INDUSTRIES- EVIDENCE FROM TAIWAN

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ABSTRACT

Previous literature points out that industrial structure plays an important role in describing the stock price behavior. After classifying various industry groups, this study examines the day-of-the-week effect in an emerging market, Taiwan. Methodologies include ARCH/GARCH type corrections and Bayesian-t large sample size adjustments. After appropriate corrections were applied, the day-of-the-week effect became insignificant on the aggregate market basis. However, it was found that the day-of-the-week effect remains statistically significant in some industry groups. The evidence observed from this study indicates that industry classification is an important factor to be considered for the calendar anomaly issues. The case of Taiwan strongly suggests that the previously documented day-of-the-week effect in the US and other countries should be further inquired into the basis of industry classification. Financial managers who invest based on calendar anomaly strategies are suggested to pay more attention to industry classifications when they provide financial services to market investors.

Keywords: day-of-the-week effect; market efficiency; financial services; Taiwan

1. INTRODUCTION

After 1970's, abundant empirical studies indicate that stocks returns are significantly lower on Mondays than the other days of a week. For example, Cross (1973) examines the performance of the S&P 500 Index from 1953 to 1970 and finds relatively higher possibilities of stock uptrend on Friday than Monday. French (1980), Gibbons and Hess (1981), Lakonishok and Smidt (1988), and Siegel (1998) observe that Monday's returns are lower and significantly negative compared with the returns of the rest days of a week. Few studies also indicate that Friday's returns tend to be positive and higher than Monday's.

In addition to the US market, Jaffe and Westerfield (1985) investigate the weekend effects in four developed countries (Japan, British, Canada, and Australia) and obtain similar results. Dubois and Louvet (1996) also discover significant negative Monday returns in eleven international markets from nine developed countries over the period 1969 to 1992. Aggarwal and Rivoli (1989) provide evidence of strong Tuesday effect in four Asian emerging markets which might be influenced by the Monday effect of the New York market due to the time differential. In China, Cai, Li, and Qi (2006) find some supports of negative Monday returns. However, recent studies such as Mehdian and Perry (2001), Brusa, Liu, and Schulman (2000, 2003, 2005), Gu (2004), and Brusa and Liu (2004), have shown the existence of a reverse Monday effect in both the US and several international markets. The reverse Monday effect, namely, means the Monday returns are positively higher than other weekdays. This reverse phenomenon exists especially in large equity firms. Furthermore, researchers indicate that positive Monday returns are often followed by positive Friday returns but not the negative returns on previous Friday.

However, the results of these studies vary depending on the quantitative methodologies employed and the markets studied. Connolly (1989, 1991), for example, found that the day-of-the-week effect in the US stock market disappeared when more stringent statistical tests were applied. Chang, Pinegar and Ravichandran (1993), on the other hand, found that some foreign stock markets sustained a significant day-of-the-week effect after robustness tests were conducted. The results of the latter study, however, could have been affected by the international market integration problem (Pettengill (1986)) because the authors examined stock markets where international investors generally participated interactively. To avoid potential problem generated from the market integration, Lin and Walker (1996) tested the day-of-the-week effect in a local-oriented market, Taiwan. After robustness tests were applied, no evidence of a day-of-the-week effect was found in the Taiwan stock market.

Although the day-of-the-week effect is widely discussed, previous studies have not investigated whether this effect exists consistently among various industries. Industry movements of common stocks have been widely discussed. For example, Reilly and Drzycimski (1974) point out that there are substantial divergences in the performance of stock returns among different industry groups. Grinold, Rudd, and Stefek (1989) and Drummen and Zimmermann (1992) indicate that industry is an important factor for describing the variabilities of stock returns. Roll (1992) showed that the industrial structure plays a significant role in explaining stock price behavior. In addition, security analysts in large brokerage houses generally specialize in particular industry groups rather than the market when they provide financial services for investors.

Therefore, the primary objective of this study was to analyze whether industry classification plays a role in describing the presence of the day-of-the-week effect. The effect was examined on both the aggregate market and the various industry groups bases. To minimize possible bias caused by international market integration, this research focused on early data of an emerging market – Taiwan.[1] The paper is organized as follows. The first section introduces the motivation behind this study. The second section describes the data and methodology. The third section presents the results and the final section concludes.

2. DATA AND METHODOLOGY

2.1 Data

In this research, the daily returns of the Weighted Index and eight major industry indexes provided by the Taiwan Stock Exchange (TSE) were used. The eight industries include: 1. the cement/ceramics industry (I1), 2. the foods industry (I2), 3. the plastics/chemical industry (I3), 4. the textiles industry (I4), 5. the electrical industry (I5), 6. the paper/pulp industry (I6), 7. the construction industry (I7) and 8. the banking/insurance industry (I8). All return information was obtained from the Taiwan Economic Journal Data Bank file. The sample consisted of 3,082 observations.

2.2 Methodology

To find out if there is a potential day-of-the-week effect in Taiwan, first a dummy variable OLS regression model was used as follows:

$$R_t = \sum_{i=1}^{6} a_i D_{it} + e_t, \quad \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

where R_t represents the daily return for the TSE Weighted Index and various Industry Indexes on day t. D_{1t} is a dummy variable that is equal to one if R_t is observed on Mondays and is equal to zero otherwise. D_{2t} is a dummy variable for Tuesday and so on. The disturbance term is e_t.

The days with significant returns observed from Equation (1) were further tested using the following regression model:

$$R_t = a_0 + \sum_{i=1}^{n} a_i DAY_{it} + e_t \quad \ldots\ldots\ldots\ldots\ldots\ldots(2)$$

where n is the number of days which show significant abnormal returns in Equation (1), a_0 is the intercept, a_i is the coefficient on the dummy variable DAY_{it}. DAY_{it} equals one if the return observed on a particular day exhibits an abnormal average return.

the error terms are homoskedastic. However, when applying time series data in examining the calendar anomalies, it is highly possible that the conventional assumptions about the OLS regression error terms will be violated. Second, large sample size is usually included in the model for examination. To make an appropriate conclusion, we should be aware that the null hypothesis is more easily to be rejected for a given significance level when the sample size is increasing. (see Chang, Pinegar and Ravichandran 1993).

To render insightful views, potential autocorrelation and heteroskedasticity problems of Equation (2) were inspected by residual tests including: Breusch-Godfrey serial correlation Lagrange multiplier (LM) test, White heteroskedasticity test and ARCH (autoregressive conditional heteroskedastic) LM procedure test. Any violations observed were further corrected by GARCH (1,1) associated with first-order autoregressive correction (AR(1)) and 'consistent standard error' heteroskedasticity adjustments.[2] The large sample size problem was corrected by using adjusted Bayesian-t critical value which is calculated as:

$$\text{t - crit} = [(T - k) \cdot (T^{1/T} - 1)]^{0.5} \quad \ldots\ldots\ldots\ldots(3)$$

where T is the number of observations, k is the number of parameters to be estimated, and T - k is the number of degrees of freedom.

3. RESULTS

Table 1 shows estimates of Eq. (1). A potential Saturday effect can be observed for both the aggregate market and all the industry groups. The electrical industry also reveals an abnormal mean return on Fridays. The observed potential day-of-the-week effect was then tested by Eq. (2). The coefficients, t-values and significancy of various residual tests are given in Table 2. It can be noticed that the Saturday effect remains significant for both the market and most industry groups. But no conclusion should be drawn at this stage. As demonstrated in Table 2, the assumptions of non-autocorrelation and homoskedasticity in regard to the error terms are violated for most cases.

Table 3 contains the corrected coefficients and t-values of Eq. (2) after the application of all appropriate adjustments. The t-values are underlined if they were greater then the Bayesian-t critical value calculated by Eq. (3). Consistent with the evidence provided by Lin and Walker (1996), this study indicates that error term and/or sample size adjustments render the day-of-the-week effect in the Taiwan market (on the aggregate basis) insignificant. However, the abnormal Saturday returns remain robust for two industry groups: the plastics/chemical industry and the construction industry. These results imply that previous research on the day-of-the-week effect may have ignored the industry factor in describing the patterns of stock returns.

4. CONCLUSION

Numerous studies have been conducted to investigate the presence of the day-of-the-week effect. Almost all of them used aggregate data for examination whereby the variability across industry groups had been neglected.

In this study, the day-of-the-week effect in Taiwan was examined using data on the bases of the aggregate market and of various industry groups. The assumptions of non-autocorrelation and homoskedasticity regarding the OLS error terms were inspected and any observed violations were corrected. After all necessary adjustments had been made for the observed violations regarding OLS error terms as well as for the large sample size problem, it was found that a Saturday effect remained significant in some industry groups even though the aggregate market showed no day-of-the-week effect anymore.

The results of this study suggest that the day-of-the-week effect reported in the US and other countries should be further inquired into industry classifications. The day-of-the-week effect across industry groups can provide valuable information in making investment decisions. Portfolio managers who provide financial services based on findings of calendar anomalies are recommended to follow industry lines instead of aggregate market perspective.

ENDNOTES

[1] Lin and Walker (1996) indicated that Taiwan stock market became active since 1986 and did not open its market to foreign investors until December 28, 1990. According to the *Monthly Review* published by the Taiwan Stock Exchange (TSE), the total trading value for foreign institutions and individuals updated to the end of the year 1997 amounted to less than 2.5% in the Taiwan stock market. Thus, this study applies daily data for the period from January 6, 1986 to October 2, 1997. The period ends on October 2, 1997 for avoiding potential bias caused by Asian Crisis.

[2] GARCH is the generalized autoregressive conditional heteroskedastic model. According to a survey by Bollerslev, Chou and Kroner (1992), the GARCH (1,1) model is preferred in most cases.

REFERENCES

1. Aggarwal, R. and P. Rivoli, "Seasonal and day-of-the-week effects in four emerging stock markets," *The Financial Review*, 24, 541-550 (1989).
2. Breusch, T. and A. Pagan, "A simple test for heteroscedasticity and random coefficient Variation," *Econometrica*, 47, 1287-1294 (1979).
3. Bollerslev, T. "Generalized autoregressive conditional heteroskedasticity," *Journal of Econometrics*, 31, 307-327 (1986).
4. Bollerslev, T., R. Chou, and K. Kroner, "ARCH modeling in finance: A review of the theory and empirical evidence," *Journal of Econometrics*, 52, 5-59 (1992).
5. Brusa, J. and P. Liu, "The day-of-the-week and the week-of-the-month effects: An analysis of investors' trading activities," *Review of*

Quantitative Finance and Accounting, 23, 19-30 (2004).
6. Brusa, J., P. Liu and C. Schulman, “The weekend effect, 'reverse' weekend effect and firm size,” *The Journal of Business Finance and Accounting,* 27, 555-570 (2000).
7. Brusa, J., P. Liu and C. Schulman, “The weekend and reverse weekend effects: An analysis by month-of-the-year, week-of-the-month, and industry,” *The Journal of Business Finance and Accounting,* 30, 863-890 (2003).
8. Brusa, J., P. Liu and C. Schulman, “Weekend effect, 'reverse' weekend effect, and investor trading activities,” *The Journal of Business Finance and Accounting,* 32, 1495-1517 (2005).
9. Chang, E.C., J.M. Pinegar and R. Ravichandran, “International evidence on the robustness of the day-of-the-week effect,” *Journal of Financial and Quantitative Analysis,* 28, 497-513 (1993).
10. Cai, J., Y. Li and Y. Qi, “The day-of-the-week effect: New evidence from the Chinese stock market,” *The Chinese Economy,* 39, 71-88 (2006).
11. Connolly, R.A., “An examination of the robustness of the weekend effect,” *Journal of Financial and Quantitative Analysis,* 24, 133-169 (1989).
12. Connolly, R.A., “A posterior odds analysis of the weekend effect,” *Journal of Econometrics,* 49, 51-104 (1991).
13. Cross, F., “The behavior of stock prices on Fridays and Mondays,” *Financial Analysts Journal,* 29, 67-69 (1973).
14. Drummen, M. and H. Zimmermann, “The structure of European stock returns,” *Financial Analyst Journal,* 48, 15-26 (1992).
15. Dubois, M. and P. Louvet, “The day-of-the-week effect: The international evidence,” *Journal of Banking and Finance,* 20, 1463-1484 (1996).
16. Engle, R.F., “Autoregressive conditional heteroscedasticity with estimates of the variance of United Kingdom inflation,” *Econometrica,* 50, 987-1008 (1982).
17. Engle, R.F. and V. K. Ng, “Measuring and testing the impact of news on volatility,” *Journal of Finance,* 48, 1749-1778 (1993).
18. French, K.R., “Stock returns and the weekend effect,” *Journal of Financial Economics,* 8, 56-69 (1980).
19. Gibbons, M. and P. Hess, “Day of the week effects and asset returns,” *Journal of Business,* 54, 579-596 (1981).
20. Grinold, R., A. Rodd and D. Stefek, “Global factors: fact or fiction?” *Journal of Portfolio Management,* 16, 79-88 (1989).
21. Jaffe, J. and R. Westerfield, , “The weekend effect in common stock returns: The international evidence,” *The Journal of Finance,* 40, 433-454 (1985).
22. Lakonishok, J. and S. Smidt, “Are seasonal anomalies real? A ninety-year perspectives,” *The Review of Financial Studies,* 1, 403-425 (1988).
23. Lin, C. and M.M. Walker, “The robustness of the day-of-the-week effect: Evidence from the Taiwan Stock Exchange,” in: J. Doukas and L. Lang, (Eds). *Research in International Business and Finance*, Supplement 1, 343-359 (1996).
24. Pettengill, G., “A non-tax cause for the January effect? Evidence from early data,” *Quarterly Journal of Business and Economics,* 25, 15-34 (1986).
25. Reilly, F. and E., Drzycimski, “Alternative industry performance and risk,” *Journal of Financial and Quantitative Analysis*, 423-446 (1974).
26. Roll, R., “Industrial structure and the comparative behavior of international stock market indices,” *Journal of Finance,* 47, 3-41 (1992).
27. Siegel, J., , *Stocks for the long run*, McGraw Hill, New York (1998).
28. *TSE Monthly Review*, Taiwan Stock Exchange publication (2000).
29. White, H., “A heteroscedasticity-consistent covariance matrix estimator and a direct test for heteroscedasticity,” *Econometrica,* 48, 817-838 (1980).

TABLE 1: Coefficients and t-values observed from Eq. (1)

	M	I1	I2	I3	I4	I5	I6	I7	I8 [+, ++]
MON	.000840	.001446	.001598	.001049	.001390	.000126	-.000095	.001346	-.000334
	(0.8218)	(1.5579)	(1.6501)	(1.0917)	(1.4419)	(0.1050)	(-0.0913)	(1.2642)	(-0.2929)
TUE	-.000797	-.001079	-.000867	-.001383	-.001206	-.000456	-.001180	-.001318	.000450
	(-0.7980)	(-1.1895)	(-0.9159)	(-1.4728)	(-1.2795)	(-0.3873)	(-1.1653)	(-1.2660)	(0.4032)
WED	-.000474	-.000099	-.000053	-.000050	-.000537	.000611	-.000367	-.000223	.000824
	(-0.4741)	(-0.1092)	(-0.0559)	(-0.0527)	(-0.5691)	(0.5185)	(-0.3620)	(-0.2145)	(0.7390)
THU	.000691	-.000318	-.000666	-.000574	-.000782	-.001202	-.000680	-.001122	.000288
	(0.6909)	(-0.3503)	(-0.7026)	(-0.6109)	(-0.8286)	(-1.0201)	(-0.6701)	(-1.0765)	(0.2577)
FRI	.001297	.001000	.001011	.000720	.000919	.002857	.001705	.001476	.001597
	(1.2935)	(1.0982)	(1.0630)	(0.7639)	(0.9715)	(2.4174)*	(1.6765)	(1.4119)	(1.4258)
SAT	.002649	.001939	.002821	.003073	.002816	.003608	.002437	.003096	.002519
	(2.5804)**	(2.0784)*	(2.8973)**	(3.1834)**	(2.9055)**	(2.9810)**	(2.3406)*	(2.8926)**	(2.1968)*

* Significant at a 5% level. ** Significant at a 1% level. [+] The t values are in parentheses. [++] M represents the aggregate market. Various industry groups are represented by: I1-cement/ceramics industry, I2-foods industry, I3-plastics/chemical industry, I4-textiles industry, I5-electrical industry, I6-paper/pulp industry, I7-construction industry and I8-banking/insurance industry.

TABLE 2: Coefficients, t-values and significancy of residual tests observed from Eq. (2)

	M	I1	I2	I3	I4	I5	I6	I7	I8 [+, ++, #]
SAT	.002345	.001761	.002629	.003132	.002873	.003842	.002563	.003078	.001948
	(2.0922)*	(1.7294)	(2.4742)*	(2.9718)**	(2.7150)**	(2.8520)**	(2.2552)*	(2.6335)**	(1.5568)
FRI						.003091			
						(2.3388)*			
Corr.	NS	S	S	S	S	S	S	S	S
Heter.	NS	NS	NS	S	S	NS	S	NS	NS
ARCH	S	S	S	S	S	S	S	S	S

* Significant at a 5% level. ** Significant at a 1% level. [+] The t values are in parentheses. [++] M represents the aggregate market. Various industry groups are represented by: I1-cement/ceramics industry, I2-foods industry, I3-plastics/chemical industry, I4-textiles industry, I5-electrical industry, I6-paper/pulp industry, I7-construction industry and I8-banking/insurance industry. [#] Equation (2) is first inspected by Breusch-Godfrey serial correlation LM test (represented by Corr.) Homoskedasticity assumption is checked by White heteroskedasticity test (represented by Heter.) ARCH represents the ARCH LM procedure test for autoregressive conditional heteroskedasticity (see Engle 1982). NS and S represents 'not significant' and 'significant' respectively at a 5% level.

TABLE 3: Coefficients and t-values of Eq. (2) after the application of all appropriate adjustments

	M	I1	I2	I3	I4	I5	I6	I7	I8 +, ++, #
SAT	.002300 (1.7028)	.000297 (0.4354)	.001582 (1.8538)	.002115 (2.8625)**	.001975 (2.6438)**	.000889 (0.9311)	.001205 (1.5047)	.003199 (3.6234)**	.001767 (1.9149)
FRI						-.001201 (-1.6317)			

** Significant at a 1% level. + The t values are in parentheses and are underlined if they are significant under a Bayesian approach. By using Equation (3) described in the text, the Bayesian-t critical value here is about 2.84. ++ M represents the aggregate market. Various industry groups are represented by: I1-cement/ceramics industry, I2-foods industry, I3-plastics/ chemical industry, I4-textiles industry, I5-electrical industry, I6-paper/pulp industry, I7-construction industry and I8-banking/ insurance industry. # The coefficients and t-values reported here have been corrected by GARCH (1,1) associated with AR(1) and 'consistent standard error' heteroskedasticity adjustments.