A Re-examination of Day of the Week Effect in Australia

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Abstract: Day of the week (DOW) effects have been well known in many financial markets. Stock markets in the United States, the United Kingdom, Canada, and Switzerland all have been found to exhibit significant average negative Monday return. Stock markets in developing countries like Indonesia, Malaysia and Thailand are also found to have the same effect. Australia however displays its DOW effect on Tuesdays rather than on Mondays. Jaffe and Westerfield suggest that there might be a linkage between the U.S. Monday DOW effect and the Asia-Pacific DOW effect as they are one day out of phase due to different time zones. Since then, a few studies have examined the relationship of daily returns among the markets. But to our knowledge, no study has directly investigated the relationship between U.S. Monday and Australian Tuesday effects. We therefore re-examine the anomaly and document that the DOW effect in Australia is Granger caused by the weekend effect in U.S. and not the other way conditional on the weekend effects in the U.K. and Japanese markets. We also find that in the post-1987 period, where the U.S. Monday returns are positively significant, the sign of the Australian Tuesday return is also reversed. This latter finding provides further evidence that the anomaly in Australia is induced by the weekend effect in the U.S.

Keywords: Day of the week effect; Granger causality; Australian Tuesday returns; U.S. Monday returns

1. INTRODUCTION

Day of the week (DOW) effects have well been documented in the major stock markets since French [1980] discovered it. Stock markets in the United States, the United Kingdom, Canada, and Switzerland all have been found to exhibit significant average negative Monday returns [Agrawal and Tandon, 1998]. Other developing stock markets in Indonesia, Malaysia and Thailand are also found to exhibit similar DOW effects [Choudhry, 2000]. Although numerous studies have attempted to offer explanations of U.S. evidence such as settlement procedures, institutional trading and delayed announcements of bad news, [see, for example, Keim and Stambaugh, 1984; Lakonishok and Smidt; 1988; Chang et al., 1993], no complete explanation has yet been offered to solve the puzzle.

What is interesting in the Australian stock market is that the DOW effect occurs on Tuesdays rather than on Mondays [see Jaffe and Westerfield, 1985; Finn et al., 1991; and Easton and Faff, 1994].[1]

While there are few studies that examine the Australian data, Jaffe and Westerfield [1985] suggest that there maybe a linkage between the U.S. Monday DOW effect and the Asia-Pacific DOW effect. They find that other major countries do exhibit similar DOW effect as the U.S., but due to different time zones, Far Eastern countries may experience a one day out of phase effect. In fact, there is a 14 hour time difference between Sydney and New York and the Australian Stock Exchange opens on Tuesday 3 and half hours after the U.S. markets close on Monday. Therefore, one could conjecture that the U.S. negative Monday returns potentially cause the negative Tuesday returns in Australia as the average negative performances of the U.S. markets on Mondays have an immediate impact on the subsequent performance of the Australian market on Tuesdays. Jaffe and Westerfield, however, find some weak support for the linkage when they test the cross-correlation of non-contemporaneous daily returns between the U.S. and Australia. They conclude that the DOW effect in Australia is independent from the U.S. DOW effect. Easton and Faff [1994] extend Jaffe and Westerfield study by incorporating Connolly [1989]'s methodology to adjust for the upward

[1] Japan is also found to have Tuesday effect.

bias in the F-statistics when the sample is large and the distribution is non-normal. Their empirical results also support the strong independence from the U.S. effect.

Although the DOW effect centres upon Monday returns in the U.S. and Tuesday returns in Australia, these studies examine the overall linkage on each day of the week between the two markets rather than the specific causality relationship between the anomalies. Their findings therefore may not necessarily provide direct evidence as to whether the Tuesday effect is the result of the weekend effect in the U.S. when other positive weekday returns in the U.S. may not have significant impact on the other weekday returns in Australia. Hence, further examination on the issue is warranted.

With advances in computer technology and increased integration of the world markets, it is important to consider the effects of other major markets while re-examining the U.S.-Australia linkages. We investigate whether U.K. Monday returns and Tuesday returns in Japan may also have any effect on Tuesday returns in Australia since these two major markets also exhibit DOW regularities and have strong economic ties with Australia in trades.

In this paper, we document that the Tuesday effect in Australia is Granger caused by the weekend effect in U.S. and not the other way conditional on the returns in the U.K. and Japanese markets. We also find that in recent years where the U.S. Monday effect has reversed, the Tuesday effect in Australia also turns into significantly positive. This latter finding provides further evidence in the causality relationship between these two countries. Finally, we also found a two-way Granger causation between returns in the Australian and U.K. markets, but no causation was found between the Australian and Japanese markets.

The paper is structured as follows. Section 2 describes the data. Section 3 outlines the methodology for various tests conducted. Section 4 reports the empirical results. Some concluding remarks are given in Section 5.

2. DATA

The data for this study are daily total market return indices for Australia, Japan, U.K. and U.S. stock markets obtained from DATASTREAM. These indices have been adjusted for dividends and provide the longest sampling period we can find from the same database dating back from January 1973 through December 2000. The whole sample period for each contry consists of 1,461 weeks. Most studies reported on the DOW and weekend effects for time period from the 1960s to early 1980s, as both effects seems to have disappeared by 1980. Thus, we also examine the returns for two sub-periods, namely 1 January 1973 to 1 January 1988 (783 weeks) and 4 January 1988 to 29 December 2000 (678 weeks).

The daily returns are calculated from the first difference of the logarithm of the indices multiplied by 100. These data are then sorted to each day of the week, as our focus is on the negative Monday and Tuesday returns in the U.S. and Australia, respectively. Missing daily return data due to national holidays in each country are assumed to be zero. The numbers of daily returns missing vary across days of the week and countries. The maximum number of missing day of the week returns for Australia, Japan, U.K. and U.S. are 6, 12, 1 and 6, respectively.

3. METHODOLOGY

In this paper, simple t-tests are first conducted to examine the significance of the DOW effects in Australia U.S., U.K. and Japan. As financial time series data are typically non-stationary, it is important to test whether each return series contains a unit root using the augmented Dickey-Fuller [1981] test. Finally, Granger causality tests are conducted to test the significance and direction of causality between the market returns.

According to Granger [1969], a variable X is said to 'Granger cause' Y if past values of X help in the prediction of Y after controlling for past values of Y, or equivalently if the coefficients on the lagged values of X are statistically significant. We extend the definition of Granger causality to test if U.S. returns Granger cause the Tuesday effect in Australia conditional on the returns in the U.K. and Japanese markets. On the assumption that all returns are stationary, the equations for two-way causality tests are given by

$$A_{2,t} = a_t + \sum_{i=1}^{5}\sum_{j=1}^{n} b_{i,t-j}A_{i,t-j} + c_{1,t}US_{1,t} + \sum_{i=1}^{5}\sum_{j=1}^{n} c_{i,t-j}US_{i,t-j} + d_{1,t}J_{1,t} + \sum_{i=1}^{5}\sum_{j=1}^{n} d_{i,t-j}J_{i,t-j} + e_{1,t}UK_{1,t} + \sum_{i=1}^{5}\sum_{j=1}^{n} e_{i,t-j}UK_{i,t-j} + u_t \quad (1)$$

$$US_{1,t} = a_t^* + \sum_{i=1}^{5}\sum_{j=1}^{n} b_{i,t-j}^* A_{i,t-j} +$$
$$\sum_{i=1}^{5}\sum_{j=1}^{n} c_{i,t-j}^* US_{i,t-j} + \sum_{i=1}^{5}\sum_{j=1}^{n} d_{i,t-j}^* J_{i,t-j} \quad (2)$$
$$+ \sum_{i=1}^{5}\sum_{j=1}^{n} e_{i,t-j}^* UK_{i,t-j} + u_t^*$$

where i = 1, 2, ..., 5 represents day of the week, $A_{2,t}$ and $J_{2,t}$ are Tuesday returns in Australia and Japan, $US_{1,t}$ and $UK_{1,t}$ are Monday returns in U.S. and U.K., respectively, at week t, and u_t and u_t^* are random disturbances with zero means and finite variances. Equations (1) and (2) are estimated using ordinary least squares (OLS). A test of the null hypothesis that U.S. Monday returns do not Granger cause the Tuesday effect in Australia is obtained using an F-test for joint significance of lagged Y in equation (1), that is, $c_{1,t} = \sum_{i=1}^{5}\sum_{j=1}^{n} c_{i,t-j} = 0$. To determine the optimal lag length for each lagged variables in (1) and (2), an initial lag of three (i.e. j = 3) for each country is chosen. If all the t-statistics for the largest lag are insignificant, the lag length is reduced successively until a significant lag length is obtained.

Evidence suggests that stock returns have time-varying volatility and error terms from OLS regressions involving stock returns are also not normally distributed. Thus, the generalised autoregressive conditional heteroscedasticity (GARCH) model developed by Bollerslev [1986] which incorporates heteroscedasticity and distinguishes between non-normal conditional and unconditional errors is also used to examine the DOW effect.

4. EMPIRICAL FINDINGS

4.1 Another Look at the Weekend Effect

The summary statistics of day of the week returns for Australia, U.S., U.K., and Japan from January 1973 to December 2000 are presented in Table 1. Consistent with the previous studies, we find that the U.S. and the U.K. markets exhibit negative average returns only on Mondays and with high positive average returns on Fridays. We also find that Japan and Australia have the largest negative average returns on Tuesdays and largest positive returns on Wednesday and Thursdays, respectively. The skewness and kurtosis of the daily returns of each market also show significant non-normality at the 1% level as reported by the Jarque-Bera [1980] test. Since many large negative returns centered around Mondays in the U.S. and U.K. markets and around Tuesdays in Australia and Japan, not surprisingly, these returns are the most negatively skewed.

Panel A of Table 2 reports the t-statistics of the day of the week returns of the four major markets for the full period from January 1973 to December 2000. Contrary earlier findings in the literature, the weekend anomalies in the U.S. have all but disappeared. Similarly, Australia and Japan's average negative returns on Tuesdays are not statistically significant. The only exception is the U.K. market where it still exhibits the Monday effect. One reason that our statistical results may differ from others is that earlier studies derive their results from the sampling period in the 80s and earlier whereas ours come from the sampling period that extends to the end of 2000. We therefore look into the difference in the DOW returns further by examining the behaviour in two sub-periods.

Panel B documents the t-statistics of the first sub-period from January 1973 to December 1987.[2] All four markets clearly show the anomalies on either Monday or Tuesday at either the 1 or 5 percent level. This is consistent with the results of earlier studies which are driven by the first sub-period where the negative Monday and Tuesday returns are the most dominant. The contrast of the t-statistics with those in the second sub-period also supports this finding.

The last panel in Table 2 shows that from January 1988 to December 2000, the Monday and Tuesday effects in the U.S. and Australian markets have reversed themselves from significantly negative to positive, and have disappeared in the U.K. and Japanese markets. From the t-statistics, we find that the reversal or the disappearance of the effects in the sub-period has offset those in the earlier sub-period and attenuates the overall effects of Monday and Tuesdays in the full period. This trend is consistent across all of the four markets and provides indirect evidence that the Tuesday effect in Australia maybe related to the anomalies of the other markets but one day out of phase due to the different time zone. Therefore, we further investigate the linkage directly by examining whether the U.S. weekend effect Granger caused Australia's Tuesday effect conditional on the weekend effects in U.K. and Japan.

[2] When the week of October 1987 crash is excluded from the sample, we still find significant negative returns on Mondays and Tuesdays in the four major markets.

Table 1. Summary Statistics of Day of the Week Returns for Australia, U.S., U.K. and Japan January 1973 – December 2000 (1,461 weeks).

	Mean	Std Dev	Skewness	Kurtosis	Jarque-Bera
		Panel A: Australia			
Monday	-0.0125	1.1661	-0.733	13.85	7297.166*
Tuesday	-0.0522	1.2741	-8.303	197.31	2315187*
Wednesday	0.0907	1.0541	0.305	8.55	1899.1*
Thursday	0.1255	1.005	-0.167	8.83	7297.2*
Friday	0.0909	0.9998	-0.679	11.53	4541.6*
		Panel B: U.S.			
Monday	-0.0101	1.1155	-5.043	87.42	440067.6*
Tuesday	0.065	0.9453	0.453	5.64	472.99*
Wednesday	0.0816	0.8839	0.612	9.72	2842.8*
Thursday	0.0358	0.9037	0.118	6.22	636.97*
Friday	0.0631	0.9286	-0.692	9.3	2536.6*
		Panel C: U.K.			
Monday	-0.0807	1.0753	-0.548	11.71	4687.8*
Tuesday	0.1068	1.0437	-1.276	21.62	21491*
Wednesday	0.0922	0.9725	0.009	6.46	731.3*
Thursday	0.0452	0.9946	0.49	9.68	2777.4*
Friday	0.1222	0.9935	0.516	10.82	3784.3*
		Panel D: Japan			
Monday	-0.0124	1.1338	-0.554	8.81	2128.4*
Tuesday	-0.0349	0.979	-2.182	55.47	168754*
Wednesday	0.0921	0.9444	0.574	12.3	5341.5*
Thursday	0.0242	0.9204	-0.017	7.38	21168.3*
Friday	0.0496	0.9225	0.686	10.86	3876.2*

Notes: Std Dev is the standard deviation of the returns.
Jarque-Bera is the test statistic for testing whether the series is normally distributed.
* denotes significant at the 1% level.

Table 2. t-Test Statistics for the Average Returns on Each Day of the Week for Australia, U.S, U.K. and Japan.

	Australia	U.S.	U.K.	Japan
	Panel A: January 1973 to December 2000			
Monday	-0.4111	-0.3469	-2.8673*	-0.4170
Tuesday	-1.5662	2.6277*	3.9097*	-1.3618
Wednesday	3.2892*	3.5291*	3.5459*	3.7259*
Thursday	4.7719*	1.5136	1.7372	1.0068
Friday	3.4766*	2.6003*	4.7029*	2.0565*
	Panel B: January 1973 to December 1987			
Monday	-1.0309	-2.1906*	-3.1964*	1.9307
Tuesday	-3.0008*	1.5033	2.7475*	-3.0965*
Wednesday	2.0674*	2.9783*	2.7241*	5.6663*
Thursday	5.0260*	1.8570	1.0894	1.5003
Friday	3.7345*	1.9723*	4.1580*	3.4887*
	Panel C: January 1988 to December 2000			
Monday	0.6852	2.5508*	-0.3252	-1.9018
Tuesday	2.3545*	2.2390*	2.9718*	0.9479
Wednesday	2.8252*	1.9263	2.3274*	0.7047
Thursday	1.0462	0.2594	1.4855	0.2067
Friday	0.6974	1.7228	2.2928*	0.0463

Note: * denotes significant at the 5% level.

4.2 Do the U.S., U.K. and Japan Anomalies Granger cause Australia's Tuesday Effect?

Before conducting Granger causality tests, augmented Dickey-Fuller (ADF) test is used to determine if each of the return series is stationary. For weekly data, an initial lag length of twelve is used for the unit root test. The t-statistics for the ADF tests reject the null hypothesis of a unit root in each day of week return series for Australia, U.S., U.K. and Japan at the 1% level. Similarly, the unit root hypothesis is rejected when the data is divided into two sub-samples used in Table 2. We therefore conclude that each series is stationary.

We run the Granger causality tests according to equations (1) and (2). In the week of international markets crash in October 1997, extreme negative returns of 4.5% and 8.4% were recorded for Australia's Tuesday and U.S. Monday, respectively. To control for these extreme observations which can adversely affect the estimates of equations (1) and (2), a dummy variable is included. The dummy variable is set to unity for the week of the market crash and to zero for all other weeks. Results of the estimation for the whole sample period and two sub-periods (excluding the dummy) are reported in Table 3. The F-statistics show that the U.S. past returns captures variation in Australia's Tuesday effect at the 1% level, while Australia lagged returns are not statistically significant in explaining the U.S weekend effect.[3] We therefore find that the U.S. past returns Granger caused the Australian Tuesday effect.

In fact, although not reported in Table 3, we find that among the lagged returns, the U.S. Monday returns are the most significant factor in explaining the Tuesday returns in Australia based on the t-statistics. Although we have the similar finding that the U.K.'s lagged returns also have significant effect on Australia's Tuesday returns, the same can

[3] We incorporate GARCH (1,1) in the tests, and the results are similar to those reported here.

be said on the returns of Australia on the U.K's. For the two sub-samples, however, there is only one-way Granger causality from the U.K. returns to Australian Tuesday effect at the 1% level of significance. Lastly, we are surprised that Japan's and Australia's returns have no significant effect on each other's anomalies.

Table 3. F-statistics on the Granger Causality Test of Equations (1) and (2).

	Australia		
	Jan 1973–Dec 2000	Jan 1973–Dec 1987	Jan 1988–Dec 2000
U.S.	31.289*	44.610*	33.000*
	1.262	1.666	0.399
U.K.	9.813*	7.126*	2.887*
	4.449*	1.146	2.792
Japan	0.900	1.490	2.455
	1.337	1.726	0.199

Notes: The first row shows the F-statistics for testing whether the lagged values of returns in U.S., U.K. or Japan Granger caused Australian returns.
The second row shows the F-statistics for testing whether lagged Australian returns Granger caused returns in the U.S., U.K., or Japan.
* denotes significant at the 1% level.

5. CONCLUSION

In this study, we find that the Australia's Tuesday effect that has been documented in earlier studies has disappeared due to the reversal of the effect in the recent period. We also find similar pattern exists in the anomalies of the U.S. and returns in Japan with the exception of U.K. in the overall period. We examine whether the anomalies of these major markets have influenced the behaviour of the Tuesday returns in Australia and provide evidence of one-way Granger causality from U.S. returns to Australia's Tuesday effect and not the other way conditional on the lagged returns of the U.K. and Japanese markets. Although this paper does not explain the weekend effect in the U.S., the disappearance of the anomalies in the major markets casts doubt on any explanations of microstructure theories on the weekend effect. Furthermore, the evidence we find here suggests that the weekend anomalies in other markets may be first induced by the U.S. Monday effect.

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