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CROSS-SECTIONAL CORRELATION FROM PERIOD BASED SUBSAMPLING – MALAYSIAN CORPORATE SPIN-OFFS

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Abstract: *This paper aimed to report evidence on the effects and corresponding remedial measures of cross-sectional correlation arose due to a period-based subsampling for the case of Malaysian corporate spin-offs' shareholders wealth effect measurements. We examined shareholders' wealth effect of 90 listed companies' corporate spin-off announcements from the year 1987 to 2019 in Bursa Malaysia, previously known as Kuala Lumpur Stock Exchange and evaluate the cascading intensity arised through different periods of financial market conditions as sub-sampling criteria. The market Model analysis showed that spin-offs in Malaysia generally resulted in statistically significant positive short term cumulative average abnormal returns. We found the sub-sampling led to a higher intensity of cascading data points. Spin-offs wealth effect measurements under normal market conditions sub-sample group reported different statistical significance results when we use robust statistical tests. Whereas the other sub-sample group during financial crisis have consistent statistical significance on wealth effects measurements irrespective of statistical tests, and thus we conclude the distortion of the effects were minimal*

Keywords: *Corporate Spin-offs, Cross-sectional Correlation, Period based Sub-sampling, Event Studies*

Introduction

Due to the presence of transaction costs, potential de-synergy, and loss of valuable revenue capability, shareholders' value after spin-off exercise sets to decline. However, most spin-offs studies instead observed an increase in share price performance also known as positive shareholders' wealth effect and more intensely so, in emerging capital markets including Malaysia. Spin-off valuation impact studies question indigenously what happens when a piece of information on spin-off is published. This variation of capital market research (CMR) primarily aimed to measure and validate the effects of spin-off events at the point of time when it is made known to the public irrespective of whether it is formal or informal, towards capital prices movement and thus affecting stakeholder's capital wealth. The efficient market hypothesis (EMH) supported the main hypothesis to be tested for this research and it provides theoretical basis for these cause-and-effect observations by taking into account both considerations from the aspects of pricing theories and information lags in conjunction to the later spin-off theories. The two Malaysian spin-off studies, (Yoon & Ariff, 2007) and (Nadisah & Arnold, 2017) have established that spin-offs in Malaysia behaved similarly to spin-offs in developed capital markets. However, there were differences in the magnitude of wealth effect measured as well as their statistical significance. In an attempt to determine the linkages between the market economic conditions as well as post-exercise share performance with these wealth effect measurements, we employ period based statistical sub-sampling techniques and infer the presence of cumulative average abnormal returns (CAAR), therefore, testing the H_0: CAAR=0 also known as the residual error as the indicator of whether share prices respond to an event. Traditional parametric methods in testing the significance of these residuals have been found to be prone to misrepresentation as one of the key assumptions of traditional parametric methods was to assume normality in data distribution, goes contrary to the norms where daily stock data are often not normally distributed. Additionally, period based statistical sub-sampling methods induced higher intensity overlapping samples periods, affecting the averaging approach used to measure cumulative average abnormal return to be more vulnerable to cross-sectional correlation bias. The cross sectional correlation bias phenomenon was especially true for sample groups based on financial market condition that constitute largely by samples occurred in the same year or preceding years. Thus, we explore the problem "What are the changes to the intensity of overlapping windows period of observations resulted from period sub-sampling Malaysian spin-off samples?" and "Are there differences between the cross-sectional correlations bias robust statistical significance results and the traditional parametric and non parametric methods for period sub-sampled Malaysian spin-off samples?". Exploring these questions are important because if the cross-sectional correlation issues were not given due consideration, the consequences were a reduction bias in standard deviation and thus an upward bias t-statistic and finally increased vulnerability to Type I errors. Therefore, the objectives of this study are (i) to report the changes in overlapping sample period intensity arose due to utilising financial market condition as a criteria for subsampling, and, (ii) to compare the results between traditional and cross-sectional correlation bias robust statistical significance tests, for the case of Malaysian corporate spin-offs' shareholders wealth effect measurements. Our comparison involves classic t-test based parametric tests with non-parametric tests such as sign based test and rank based test that do not require normality assumptions, and those designed to address cross-sectional correlation bias.

Literature Review

Spin-offs

Empirical results of wealth effect studies were generally consistent for spin-offs in the US and European regions. (Hite & Owers, 1983), (Miles & Rosenfeld, 1983) and (Schipper & Smith, 1983) observed near consistent short term abnormal gains of 2.8% to 3.3% while others like (Seifert & Rubin, 1989), (Vijh, 1994), (Johnson & Klein, 1996), (Veld & Merkoulova, 2003), (Kirchmaier, 2003), (Murray, 2008), (Boreiko & Murgia, 2013) (Daniel, Lin, & Veld, 2018) reported average abnormal gains in the range of 1.8% to 4.8%. Citing an average for longer window period results is on other the hand difficult due to the inconsistent length of window periods across studies. Individually, (Hite & Owers, 1983), (Miles & Rosenfeld, 1983) as well as (McConnell, Ozbilgin, & Wahal, 2001) reported positive abnormal gain of 7%, 7.6%, and 5.69% respectively for longer window period and (McConnell, Ozbilgin, & Wahal, 2001), (Kirchmaier, 2003) and (Murray, 2008) reported abnormal gains at -1.84%, -0.30% and 2.01% respectively. When samples were further subjected to subsampling criteria, the magnitude of abnormal gain reported started to vary significantly. For example, (Hite & Owers, 1983) analysed wealth effects in relation to company size and in cases of preamble of a merger, found small equity spun off short window period average abnormal returns fell to as low as 0.8% whereas for spin-offs motivated by potential mergers the average abnormal returns went as high as 5.6%. Likewise, (Miles & Rosenfeld, 1983) observed higher gains for the subsample of firms who spun-off at least 10% of equity. (Kirchmaier, 2003) reported significant disparity among his subsamples where although in average the firms stood at 4.2% for very long period window, the subsamples see huge differences as large firms were at abnormal loss of -20% compared to small firms at abnormal gain of 25.7% and (Desai & Jain, 1999) observed a longer-term 13.49% abnormal gain for focus-increasing parents and 12.05% abnormal gain for non-focus-increasing parent firms. For other international studies that report results of other variation of spin-off effect through subsampling, see (Vroom & Frederikslust, 1999) and (Veld & Veld-Merkoulova, 2008), (Vera, Anabela, & Celeste, 2015).

For the case of Malaysia, (Yoon & Ariff, 2007) examined 84 Malaysian spin-offs and found statistically significant 22.7% cumulative abnormal gain one-day surrounding spin-off announcement date and 66.9% for the window period of 151 days. (Nadisah & Arnold, 2016) reported the presence of a spin-off effect for parent firms over a very short-run period at 4.99% but non-statistically significant long-term abnormal gains. Both papers' sample periods were weighted very differently across different periods and were on different sample sizes. Although the execution of the sub-sampling techniques of these studies is similar, they do not introduce much event-induced volatility bias or cross-sectional correlation bias as these criteria do not involve specific periods.

Statistical Significance Testing in Event Studies

Testing for the null hypothesis H_0: There is no shareholders wealth effect arising from spin-off announcements, where CAAR=0. The conventional parametric test Cross-Sectional T-Test were based on the simple T-Test. Despite Csect T's popularity, this significant test was proven weak against event induced volatility in (Brown, 1985) and cross-sectional correlation bias. (Boehmer, Musumeci, & Poulsen, 1991) tried to address event induced volatility not resolved in another widely used significant test for event studies, Patell Z by (Patell, 1976) by introducing stadardisation modifications to the design of Patell Z. Their standardized cross-sectional model is named after them as BMP Test. Notwithstanding the enhancements of BMP test, simulations result in (Kolari & Pynnonen, 2010) showed evidence of true null hypothesis been incorrectly rejected for both Patell Z and BMP Test. (Kolari & Pynnonen, 2010) suggested a re-specified version of Patell Z, known as Kolari and Pynnnen Adjusted Standardised Residual Test, that includes an additional modifier to adjust for non-normality. In the same manner, (Kolari & Pynnonen, 2010) also suggested the same modifier to be applied to BMP Test. Kolari and Pynnnen Adjusted Standardised Cross-Sectional Test. Unlike BMP's modification to Patell Z, these adjustments are independent of the design of the original statistics. The modifier largely acts as an add-on to the pre-adjusted statistic and are not intrusive. When $\bar{r}$ is equal zero, which translates to absence of cross-correlation in data, the modifier becomes 1 and essentially return values equal to pre-modified Patell Z and BMP Test scores. Notwithstanding the fact some of the test above showed resilience towards event induced volatility and cross-correlation issues, the tests above are still parametric tests as they are built upon the normality assumption in data distribution.

For non-parametric tests, (Cowan, 1992) generalized Sign Test converts data points to figures of "1"s representing a positive data point and 0 for negative data points. Then, the ratio of 1s against population is used to determine whether H_0: Mean = 0 is rejected (in the case of event studies, CAAR). The Wilcoxon Test (Wilcoxon, 1945) which is hybrid of rank test and sign test as it considers both the sign as well as the magnitude of abnormal returns. Where, the weight, *W* is the summation of the positive rank of abnormal returns in absolute value rank and within it do not possess absolute values that are nil. (Kolari & Pynnonen, 2011) modified the rank test by first standardizing the returns by the standard deviation of prediction errors before re-standardized by cross-sectional standard deviation to account for event induced volatility and cross-sectional correlation. The results were Generalised Rank T test and Generalised Rank Z test.

Data, Variables, Hypotheses, and Methodologies

Data

This study used 90 spin-off announcements from companies listed in the Bursa Malaysia, previously known as Kuala Lumpur Stock Exchange (KLSE) between the year 1987 to 2019. Announcement dates were obtained via publications including KLSE Daily Diary (up to 2004), analyst reports, articles and newspaper clippings. Share prices and FTSE Bursa Malaysia Kuala Lumpur Composite Index (KLCI), along with companies' financial information that form the sub-sample criteria of this study were extracted via DataStream.

Measuring Spin-off Wealth Effect

We ustilised Market Model by (Sharpe, 1964) and preferred the KLCI as market index to measure spin-off wealth effects. Market Model abnormal returns (AR) was used as the daily measurement of wealth effects and cumulative abnormal returns (CAR) for measurements with longer window period. Market Model was expressed as:

$$AR_{i,t} = R_{i,t} - B_i(R_{m,t}) - \alpha_i \tag{1}$$

Where, $AR_{i,t}$ is the abnormal return of company share *i* at day *t* , α_i is the intercept of company i , B_i is the systematic risk of company i's share, $R_{m,t}$ is the KLCI market return at matched day t. Beta B_i and intercept α_i are calculated by regressing 261 trading days share return $R_{i,t}$ with matched KLCI market return R_{mt}. The estimation windows started 320 daily trading days before (t_{-320}) the announcement date t=0 and end 60 trading days before (t_{-60}) the announcement date using Ordinary Least Square. Following the recommendations of Fama

(1976), both share return and market returns are transformed into log difference for statistical benefits. Rewriting equation (1), computations for cumulative abnormal returns are expressed in equation (2) and are populated into extended formulas as expressed in equation (3) and (4):

$$CAR_{it} = \sum_{t=s}^{t=e} AR_{i,t} \quad (2)$$

Where, CAR_{it} is the cumulative abnormal return of company share i for window period starting at trading day s and ending at trading day e. Average of abnormal returns are simply:

$$AAR_t = \frac{1}{N}\sum_{i-t}^{N}(R_{i,t} - \hat{\alpha} - \hat{\beta}R_{m,t}) \quad (3)$$

In the same manner, cumulative average abnormal returns are specified as:

$$CAAR_t = \frac{1}{N}\sum_{i-t}^{N}\sum_{t=s}^{t=e} AR_t \quad (4)$$

In order to take into account of the manifestation of spin-off wealth effect over time and considerations on information lags, cumulative average abnormal return window periods observed (s, e) for all observation groups consist of four different lengths of window periods namely, very short period of three days (-1,1), short period of five days (-5,5), longer period of forty-one days (-20,20), and very long period of one hundred and one days (-50,50).

Financial Market Condition as Period Based Sub-Sample Criteria

The financial market condition sub-sample criteria are constructed based on three major periods of stock market crash in Malaysia. The three financial crisis period comprised the commodity market crash in year 1985-1989, the currency crunch in year 1997-1998 and the worldwide financial crisis in year 2008-2009. Spin-offs with announcement dates fell on the financial crisis period were categorized as "crisis" group, while the rest are categorised as "normal" group.

The Statistical Tests

The null hypothesis specified for statistical significance tests is H_0: There is no shareholders wealth effect arising from spin-off announcements, where CAAR=0. The same null hypothesis is tested across non-subsample and all sub-sample groups. For parametric test, we compute conventional Cross-Sectional T-Test, t_{CAAR_t} (abbreviation: Csect T) as benchmark:

$$t_{CAAR_t} = \sqrt{N}\frac{CAAR_t}{S_{CAAR_t}}, \quad (5)$$

Additionally, the significant test for event studies by (Patell, 1976) Standardised Residual Test, Z_{Patell} (Abbreviation: Patell Z) with specifications of:

$$Z_{Patell} = \frac{1}{\sqrt{N}}\sum_{i=1}^{N}\frac{CSAR_i}{S_{CSAR_i}} \quad (6)$$

BMP Test, $Z_{BMP,t}$ (Abbreviation: StdCSect Z), are specified as:

$$Z_{BMP} = \sqrt{N}\frac{\overline{SCAR}}{S_{\overline{SCAR}}} \tag{7}$$

(Kolari & Pynnonen, 2010) re-specified version of Patell Z, known as Kolari and Pynnnen Adjusted Standardised Residual Test, Adj. Patell Z (Abrreviation: Adj. Patell Z) specified as:

$$AdjZ_{Patell} = z_{Patell}\sqrt{\frac{1-\bar{r}}{1+(N-1)\bar{r}}} \tag{8}$$

Kolari and Pynnnen Adjusted Standardised Cross-Sectional Test, $AdjZ_{BMP}$ (Abbreviation: Adj. Std. Csect Z) specified as:

$$AdjZ_{BMP} = z_{BMP}\sqrt{\frac{1-\bar{r}}{1+(N-1)\bar{r}}} \tag{9}$$

For non-parametric tests, the generalized version of sign test proposed by (Cowan, 1992), Cowan Generalised Sign Test, Z_{gsign} (Abbreviation: Gen. Sign Z) is specified as:

$$Z_{gsign} = \frac{(w - N\hat{p})}{\sqrt{N\hat{p}(1-\hat{p})}} \tag{10}$$

The hybrid rank and sign by (Wilcoxon, 1945), Wilcoxon Test, $Z_{wilcoxon,t}$ (Abbreviation: Rank Z) is specified as:

$$Z_{wilcoxon,t} = \frac{W - N(N-1)/4}{\sqrt{(N(N+1)(2N+1)/12)}} \tag{11}$$

Finally, the modified version of rank tests by (Kolari & Pynnonen, 2011), the Generalised Rank T test, t_{grank} (abbreviation: Gen. Rank T) and Generalised Rank Z test, Z_{grank} (abbreviation: Gen. Rank Z) are specified as:

$$t_{grank} = \frac{\overline{K_0}}{S_{\bar{K}}}\left(\frac{L_1-1}{L_1-\left(\frac{\overline{K_0}}{S_{\bar{K}}}\right)^2}\right)^2 \text{; and; } Z_{grank} = \sqrt{\frac{12N(L_1+2)}{L_1}}\,\overline{K_0} \tag{12}$$

Results and Discussions

We demonstrate the cascading effect present within the sub-samples group using two graphs per sample group. The first being Daily Abnormal Return of samples cascaded on unified timeline where higher overlapping intensity are represented by darker regions and the other being sample group population adjusted overlapping datapoints where higher overlapping datapoints are represented by higher adjusted values.

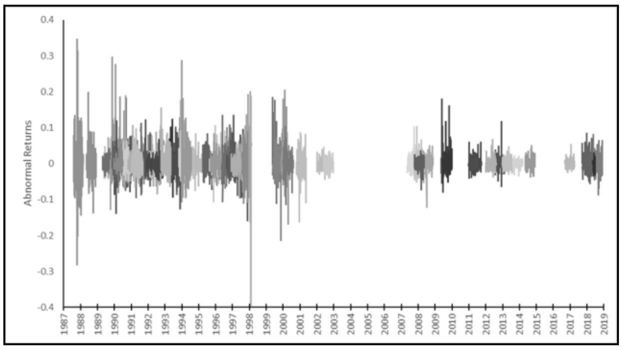

Figure 1: General Spin-offs Abnormal Return

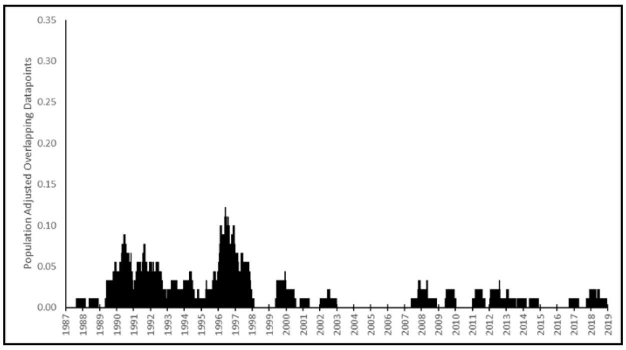

Figure 2: General Spin-offs Population Adjusted Overlapping Datapoints

Figure 1 and Figure 2 show the cascaded spin-offs abnormal return for the data population and population adjusted overlapping datapoints respectively, before any sub-sampling techniques were applied to the dataset. Specific to this general group, overlapping of datapoints were not more than 0.15. This measurement will serve as benchmark for measurements in other sub-sample groups.

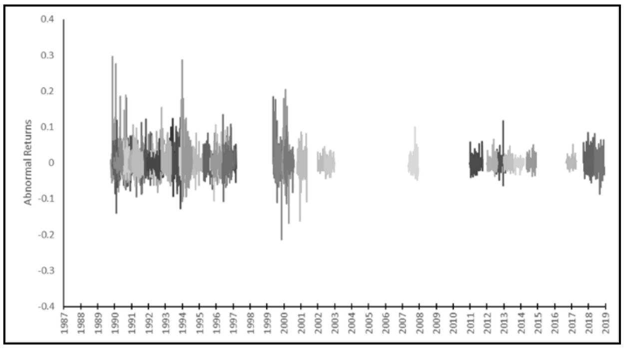

Figure 3: Normal Spin-offs Group Abnormal Returns

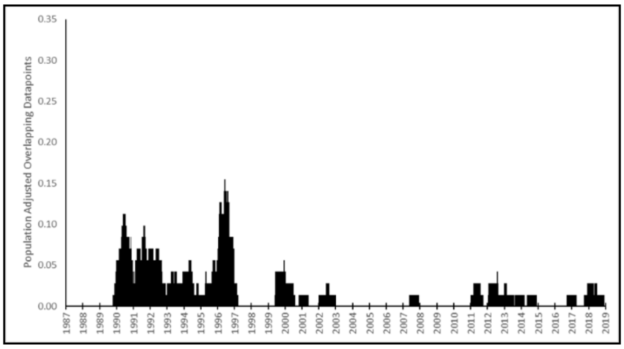

Figure 4: Normal Spin-offs Group Population Adjusted Overlapping Datapoints

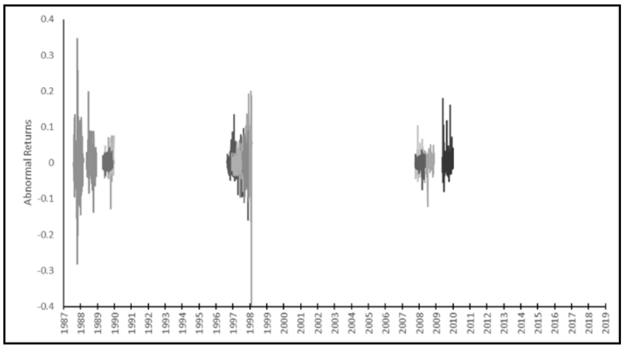

Figure 5: Crisis Spin-offs Group Abnormal Returns

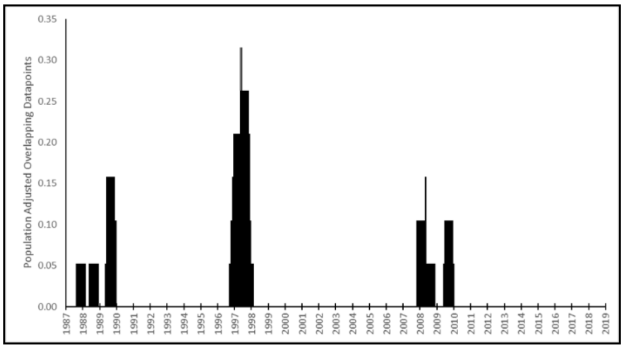

Figure 6: Crisis Spin-offs Group Population Adjusted Overlapping Datapoints

The results for sub-sample groups based on financial market condition criteria were presented in Figure 3 to 4 and Figure 5 to 6. It is apparent that sub-sampling based on financial market condition criteria, which is incidental to timeline based datapoints grouping saw increased intensity in overlapping datapoints. Additionally, these sub-sample groups also present narrower spread compared to general group. Especially for the case of crisis spin-offs group, judging purely on the above 0.30 population adjusted overlapping data point, it meant crisis group have increased exposure to event induced volatility and cross-sectional correlation biasness.

In Table 1, we present the cumulative average abnormal returns of samples generally as well as subsample groups based on market conditions for four window period lengths. Significance test statistics for each value were presented along with their respective p-values and notes indicating potential bias addressed by specific tests were annotated under the table with note abbreviated [a] and [b]. Results without sub-sampling were presented in Panel A to report wealth effect measurements without accounting for further criteria that affect wealth effect measurements served as the benchmark for following criteria-based measurements in Panel B.

Table 1: KLCI Market Model Cumulative Average Abnormal Returns

			Parametric Tests					Non-Parametric Tests			
Interval Days	CAAR Value	Sign +ve:-	Csect T	Patell Z [1]	Std-CSect [2,a]	Adj. Patell [3,]	Adj.Std- [4,a,b]	Gen. Sign Z [5]	Rank Z [6]	Gen. Rank T [7,a,b]	Gen. Rank Z [8,a,b]
Panel A: KLCI based Market Model by general conditions											
General											
(-50, 50)	2.16%	54:36	0.822	1.341	1.197	1.444	2.271 **	2.379 **	0.168	1.837 *	1.752 *
(-20, 20)	0.86%	52:38	0.565	1.728 *	1.484	1.861 *	2.364 **	1.957 *	0.830	2.047 **	1.952 *
(-5, 5)	1.01%	59:31	1.236	3.041 ***	2.375 **	3.275 ***	2.835 ***	3.435 ***	1.347	3.177 ***	3.029 ***
(-1, 1)	1.12%	53:37	2.667 ***	3.880 ***	3.281 ***	4.179 ***	3.490 ***	2.168 **	2.791 ***	3.445 ***	3.284 ***
Panel B: KLCI based Market Model by financial market conditions											
Normal											
(-50, 50)	2.95%	43:28	1.116	1.633	1.802 *	1.750 *	2.225 **	2.195 **	0.846	2.373 **	2.259 **
(-20, 20)	1.74%	41:30	1.238	2.047 **	2.194 **	2.193 **	2.639 ***	1.719 *	1.320	2.187 **	2.082 **
(-5, 5)	1.73%	48:23	2.163 **	3.605 ***	2.990 ***	3.863 ***	2.989 ***	3.383 ***	2.064 **	3.578 ***	3.407 ***
(-1, 1)	0.90%	41:30	1.877 *	2.980 ***	2.478 **	3.194 ***	2.770 ***	1.719 *	2.399 **	2.669 ***	2.542 **
Crisis											
(-50, 50)	-0.81%	11:8	-0.105	-0.239	-0.109	-0.244	0.873	0.937	-1.219	-0.049	-0.049
(-20, 20)	-2.40%	11:8	-0.478	-0.194	-0.110	-0.198	0.290	0.937	-0.703	0.261	0.262
(-5, 5)	-1.71%	11:8	-0.716	-0.349	-0.308	-0.356	0.183	0.937	-0.983	0.070	0.070
(-1, 1)	1.97%	12:7	2.227 **	2.684 ***	2.409 **	2.734 ***	2.474 **	1.396	1.460	2.256 **	2.259 **

*[1] (Patell, 1976) Standardised Residual Test [2] BMP Test by (Boehmer, Musumeci, & Poulsen, 1991) [3] Kolari and Pynnnen Adjusted Standardised Residual Test and [4] Kolari and Pynnnen Adjusted Standardised Cross-Sectional Test by (Kolari & Pynnonen, 2010) [5] Cowan Generalised Sign Test by (Cowan, 1992) [6] (Wilcoxon, 1945) Wilcoxon Test [7] Generalised Rank Z test and [8] Generalised Rank Z test by (Kolari & Pynnonen, 2011) respectively. ***, **, * denotes p-values at significance level 1%, 5% and 10%, respectively. [a] Addresses event induced volatitlity bias. [b] Addresses cross-sectional correlation bias.*

Panel A presented cumulative average abnormal return calculated based on KLCI without sub-sampling. Cumulative average abnormal returns remained positive 2.16% up to very long window period (-50,50) of one hundred and one days showed that wealth gain from spin-offs were in general persistent and sustainable. H_0: CAAR=0 was rejected for window periods (-1,1), (-5,5) for both traditional and robust tests showing p-values as strong as 0.01 to 0.10. Interestingly, statistical results for windows period longer than (-5,5) were only significant on statistical tests that remedy cross-sectional correlation bias.

Panel B showed cumulative average abnormal return of spin-off groups based on market conditions. Normal spin-offs group exhibit the same positive persistent value as the general spin-offs group, where normal spin-offs group's cumulative average abnormal return achieved higher and comparable positives 2.95% on window period (-50,50). Wealth gain from spin-offs under normal market condition were persistent. It is evident that like results for samples without sub-sampling, H_0: CAAR=0 was rejected for all window periods observed as both parametric and non-parametric significance tests showing p-values between 0.01 to 0.10. Again, we observed cross-sectional correlation bias in window period longer than (-5,5). Whereas, results for crisis group differed significantly. While cumulative average abnormal return in short window period (-1,1) was positive at 1.97%, results for (-5,5), (-20,20), and (-50,50) were negative at -1.71%, -2.40%, -0.81% respectively. We noted that cumulative average abnormal returns for (-5,5), (-20,20) and (-50,50) were not statistically significant irrespective of parametric or non-parametric tests. The results in this sub-sample group showed underlying market conditions affect spin-offs wealth effect. Since H_0: CAAR=0 was not rejected in any period longer than three days during financial crisis, the generalized theory that most Malaysian corporate spin-offs result in gain do not apply.

Conclusion

In Malaysia, whilst the average mean reported for (-50,50) window period for all samples was 2.16%, sub-sampling data based on market conditions saw that spin-offs under normal market conditions achieved more at 2.95% and spin-offs during financial crisis lost -0.81%. The sub-sampling samples using market conditions as criteria led to a higher intensity of cascading data points. For spin-offs during normal market conditions sub-sample group, the statistical significance results reported were stronger for window period (-20,20) and (-50,50) when robust statistical tests were used. However, irrespective of adjusting for cross-sectional correlation bias, wealth effect for spin-offs during financial crisis was consistent where results are only positively significant in three days surrounding the announcement dates and thus the distortion of the bias effects were minimal.

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