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Bachelor thesis

On the persistence of calendar anomalies

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Abstract

Several studies from the 80's onward have reported a variety of calendar anomalies on stock markets. Empirical evidence published in the early 2000's however suggests a disappearance of these anomalies after academical publication. This paper attempts to discover whether there is a re-emergence of a number of calendar anomalies by looking at structural breaks in the sample. Specifically the Turn-of-the-month effect, January effect and Day-of-the-week effect are analysed with return data from the AEX, S&P500 Composite Index, Nikkei 225 and ASX 300 during 2000-2019. Although some evidence of a disappearance of the Day-of-the-week effect was found, no clear indication of a re-emergence of any anomaly is found apart from a negative Turn-of-the-month effect after 2016 in Australia. The disappearance is in line with previous literature suggesting an increasingly efficient market. The Australia case however has no immediate explanation and therefore needs to be investigated further.

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1. Introduction

The efficiency of stock markets is a well discussed topic that has kept economists busy ever since its inception. Over the years economists try to explain market behaviour with models based on a variety of variables. Many influential theories that explain market behaviour and in its extent stock value behaviour are based on the axiom that markets are efficient. This was formally postulated in the Efficient Market Hypothesis (EMH) in 1970 by Fama. This immediately begs the question whether this is a realistic assumption and, whether this assumption influences the results of the respective models. A notable example of these models relevant to this paper is the Capital Asset Pricing Model (CAPM). This will also be explored further in combination with the EMH later on in this paper.

Ever since the pursuit of explaining stock prices began, economists have been quick to point out anomalies in results produced by these models. In 1973 Cross found statistical evidence for the existence of anomalies on the stock market. Examples were found of returns repeatedly showing anomalous behaviour, not explained by the models of the time. These consistent deviations were called calendar anomalies. Notable anomalies are the fact that returns consistently and significantly varied on different days of the week, periods during months and, months during the year. Many different anomalies have been found between the early 70’s and early 2000’s. A 2006 paper by Marquering, Nisser and Valla (MNV) however analyses the behaviour of these anomalies before and after they are academically published, finding a significant disappearance on many of the anomalies after publication. They note however, that some showed signs of reappearance. Their paper caused a shift in research focus, moving from discovering whether it exists to how it behaves over a time period. A 2019 literature review by Plastun et al. comes to a similar conclusion as MNV. They find that the ‘golden age’ for calendar anomalies was in the mid 1900’s but that no anomalies were found in the 2010-2015 period. Furthermore, Giovanis (2009) concludes that no significant effects can be found apart from the Turn-of-the-month effect.

Three different anomalies will be discussed in this paper. Firstly, the day-of-the-week effect, which is a significant anomalous return during different days of the week. Secondly, the turn-of-the-month effect, which found to create more positive returns in the [-1. +3] interval around the turn of the month than throughout the rest of the month combined. Lastly, the January effect will be discussed. MNV found for all these effects a significant disappearance in the early 2000’s, noting that in some markets they have never been significant in the first place. Many of the anomalies were initially found on major indices like the S&P500. Later research expanding to different European and Asian markets showed mixed results however, suggesting that this might not be an inherent factor of all markets but rather a behavioural aspect of market participants. In this paper a global approach will be taken by using returns from developed geographically distant markets, namely the United States, Netherlands, Japan and Australia. These were chosen because of their distance from each other, meaning it can indicate differences between continents. Furthermore developed countries were chosen over developing countries because recent research is mainly focussed on these emerging markets but ignore established markets like those used in this paper. Additionally, the anomalies will be specifically measured over the 2000-2019 period, ignoring earlier data in order to attempt to prevent data snooping. Based on these known anomalies the following hypotheses are formulated:

An observable day-of-the-week effect emerges in the period 2000-2019.

An observable turn-of-the-month effect emerges in the period 2000-2019.

An observable January effect emerges in the period 2000-2019.

By examining these hypotheses it can be determined whether a calendar anomaly actually disappeared, is still present or emerges. Recent papers regarding this topic are almost uniformly literature reviews that review older papers regarding these markets and use more recent conclusions from papers regarding developing markets to form the conclusion that no calendar effects can be observed in developed markets. Others like Jacobs (2015) and Jacobs & Muller (2020) move away from calendar anomalies and look at cross-sectional anomalies. By examining recent data (until the end of 2019) this paper hopes to empirically derive a conclusion on these hypotheses. This paper will be using Quandt-Andrews breakpoint tests to determine whether structural breaks in the dataset can be found. Where previous research generally takes a dynamic approach, looking at the effect on a yearly basis, this paper tries to identify a re-emergence by looking at sub-samples determined by the identified breakpoints. This method may provide a better indication of anomaly behaviour and its persistence.

Firstly the theoretical framework on which this research is based, highlighting the different anomalies discussed, will be explored. Secondly relevant literature will be discussed. Then data and methodology will be discussed followed by the results. This will be concluded by a conclusion and discussion, discussing the hypotheses, results of the research and research recommendations.

2. Definitions

2.1 Efficient market hypothesis

Three different degrees of EMH are distinguished.

Strong form of market efficiency is the strongest form. All information, including 'inside information' which is information not publicly available, is incorporated in the price. It is inherently impossible to structurally make abnormal returns because all information is immediately reflected on the price.

Semi-strong form of market efficiency is a weaker efficiency form. It theorises all fundamental information is perfectly and immediately incorporated in the price. However no private information is taken into account meaning investors with inside information can consistently achieve abnormal results.

Weak form of market efficiency is the weakest form of EMH. It states all historical exchange rates are incorporated in the price. It is thus not possible to achieve abnormal returns based on this information. However public and private information is not incorporated in the price, meaning investors can consistently take advantage of information becoming available.

2.2 Capital Asset Pricing Model

One of the most common and least complicated ways of computing expected returns is the CAPM. First introduced by Sharpe in 1964 and by Lintner in 1965, it uses the risk-free rate, the expected return of the market and the market beta to determine the expected return of a stock. The formula is as follows:

$$E(Rp) = Rf + \beta[E(Rm) - Rf]$$

The risk premium of the systematic risk of a stock is linked to the risk premium of the market by multiplying the difference of the risk free rate and the expected market return with beta. The beta thus reflects how strongly a stock reacts to market variation. The CAPM also shows that when a stock has no systematic risk and therefor a beta of 0, its return should not exceed the risk free rate. This means that there is a linear relation between return and beta. This relation is called the Security Market Line.

2.3 Calendar anomalies on the stock market

Although CAPM goes some way in explaining stock behaviour, there is still evidence that significantly deviates from this and the EMH. These anomalies either show inefficiencies of the market or show flaws in the underlying model on which it is based. Calendar anomalies are one of such deviations. The Day-of-the-week effect, the turn-of-the-month effect and, the turn of the year effect are one of the most common and most researched effects. Other anomalies include the Holiday effect, the Sell in May principle and (in America) the Superbowl indicator.

The day-of-the-week effect, which is to an extent an expansion of the weekend-effect, describes how significantly different returns can be obtained on different days of the week. Smart investors should therefore be able to use this information to make abnormal returns. The turn-of-the-month effect works in a similar way in which it describes anomalous returns around the turn of the month. It was actually shown that the last day of the month and the first three days of the next month show stronger returns than the rest of the month combined. This same effect also applies even stronger to the turn of the year. The January effect describes how January consistently shows the strongest results of the year. In the next part the source of these effects and their current status will be discussed.

3. Literature review

Previous research on calendar anomalies and effects

It is remarkable how no ex-ante model has been able to predict the existence of calendar effects. Theories regarding the anomalies were only formed after they were observed. According to Samuelson (1965), LeRoy (1973) and Lucas (1978) stock prices follow a martingale process; meaning there are no systematic patterns in returns when risk is constant. This should indicate that there is no possibility of calendar anomalies. The random-walk model from Fama (1965) cannot explain the existence of such anomalies either. According to this model the future path of prices and returns is equally as explainable as a series of random numbers. The empirical evidence of calendar anomalies shows predictability of returns and is therefore inherently not random. EMH cannot explain these anomalies either because news, which influences prices, is unpredictable and therefore the returns that result cannot be predicted either.

MNV show with a dynamic analysis that both the Day-of-the-week effect and the January effect have disappeared in the U.S. after the first publications appeared.

3.1 Day-of-the-week effect (DOWE)

The day-of-the-week effect is an extension of the weekend effect. Cross (1973) was the first to publicise this weekend effect and concluded that the S&P Composite Stock Index showed a significant difference between returns on Fridays and those on Mondays between 1953 and 1970. French (1980) studied the S&P500 between 1953 and 1977 testing two hypotheses. Firstly that on average all days have the same return and secondly a so called calendar time hypotheses. The latter suggests that the return on every calendar day (in contrast to trading day) is equal, meaning that Mondays should have triple the return because they follow two non-trading days. Both hypotheses were rejected with the results suggesting that Mondays observe systematically lower returns than other trading days, proving in his opinion the inefficiency of the market.

Multiple explanations can be found for the source behind the day-of-the-week effect. The roll of short sellers who close their position on Friday and take a new short position on Monday [Chen, H and Singal, V. (2003)], a delay in payment of the stocks [Lakonishok and Levi (1982), Dyl and Martin, (1985)], measurement errors [Gibbons and Hess (1981)], the timing of profits and dividends announcement after Friday closing [Damodaran (1989)] and a decrease in trading activity by institutional investors combined with an increase by individual investors on Monday [Lakonishok and Maberly (1990) and Chan, Leung and Wang (2005)].

Research regarding the day-of-the-week effect in Japan, Netherlands, United states of America and Australia shows a variety of results which could be attributed to the actuality of the respective papers. Van der Sar and Dröge (2000) find a substantially higher standard deviation of daily returns on Monday followed by a slow decrease the other four days for all four of the relevant countries. Boudreaux et al. (2010) find consistent evidence of weekend returns being greater than non-weekend returns only in non-bear periods in the S&P500. Keef and Roush (2005) research an extension of the Friday effect to pre-holiday trading days and find that a similar effect cannot be found in the S&P500. Marrett and Whortington (2009) examine a holiday effect in extension of the day-of-the-week effect from 1996-2006 in Australia and find a positive pre-holiday effect most pronounced with small stocks.

3.2 Turn-of-the-month effect (TOME)

Ariel (1987) is the first to publish an article discussing calendar anomalies in a month. In the period of 1963-1981 of the CRSP-index he finds that positive returns are only achieved during the first two weeks of a month and the last day of the previous month. In the first half of the month a positive return of 0,83% is observed while in the second half this is a negative -0,18%.

Inspired by Ariel, Lakonishok and Smidt (1988) and Hensel and Ziemba (1996) for the U.S. and Cadsby and Ratner (1992), Agrawal and Tandon (1994), and Van der Sar and Dröge (2000) for other countries find evidence for such an effect around the turn of each month, specifically [-1. +3]. A plausible explanation for this effect is the increased availability of cash around the turn of the month due to all kinds of payments. This suggests an increase of capital flow with an increase in cash availability (cf. Ogden, 1987, 1990). Hensel and Ziemba (2000) illustrated with the S&P500 that in anticipation of this effect an increase in trading may lead to abnormal returns manifesting even on -4, -3 and -2 days.

Zwergel (2010) assesses an investment strategy based on TOME using previous literature to determine the test period. In both Japan and the US he finds a positive abnormal return on both stocks and futures. He notes however, that the returns are quite volatile and that the liquidity at the close, when trades are assumed to be executed, is too low for institutional investors.

3.3 January effect (TOYE)

The January effect, also commonly known as the January effect, was first discovered by Rozeff and Kinney in 1976 on the New York Stock Exchange. They show that in the period 1904 – 1974 the return in the first few days of January is significantly higher than that in other months. Keim (1983) also finds that often over 50% of the return in January is achieved on the first trading day in January. Keim (1989) argued that systematic shifts in bid-ask spread around the turn of the year should be taken in account. Due to selling pressure at the end of the year, the closing prices are often at bid prices, while trading at the beginning of January is often buy initiated resulting in closing prices at ask quotes.

Lakonishok and Smidt (1988) find a relation between the January effect and the small-firm effect. They show that on the Dow Jones Industrial Average, which only trades big stocks, there is no January effect. This indicates that smaller companies are more often involved in trades that result in this systematic effect. Rogalski and Tinic (1986) found empirical evidence of this, finding higher Beta's for small firms, especially in January.

A common explanation for TOYE is window dressing. Haugen and Lakonishok (1988, see also Ritter 1988) argue with their portfolio rebalancing hypothesis that large, institutional investors often employ this strategy at the end of the accounting or reporting year. A portfolio is then rebalanced to hide painful mistakes.

Another explanation which more applies to smaller or individual investors is tax-loss selling (Roll 1983, Poterba and Weisbenner, 2001). Individual investors can gain from the tax deductibility of realised losses, resulting in poorly performing stocks being sold before the end of the year. These are often smaller stocks which are inherently more volatile than large stocks.

Van der Sar and Dröge (2000) found more recent evidence of a disappearance of the TOYE in the Netherlands. Their findings suggest a global decrease in the effect which they explain as the result of a possibility of institutional investors developing profitable strategies in anticipation of calendar anomalies. Finally, Haugen and Jorion (1996, p.27) stated that "one would expect to see the January effect slide into the preceding year until it utterly disappears."

4. Data and methodology

4.1 Data

In this paragraph the acquired data will be discussed and the different conditions necessary to properly examine and handle the data will be explored. In order to most accurately interpret the data, the Classic Linear Regression Model (CLRM) assumptions will be taken into account.

4.1.1 Data Description

This paper looks at data from the Netherlands, United States, Japan and Australia from the period of 2000 - 2019. For this the AEX Index, S&P500 composite, Nikkei 225 stock average (from 2002 on) and ASX300 respectively are used. The advantage of these are that all these indices are value-weighted and therefore closely correspond to economic development. The data is acquired from Thomson Datastream. Thomson Datastream is a massively useful databank for all kinds of equity related data. However, as Ince and Porter (2006) note, there are quite a few things that need to be taken into account when handling Datastream data. When using individual equities careful screening needs to be carried out in order to insure overall integrity. Since this paper is not using individual equities but indices, individual screening is not in order.

This paper uses return data in order to accommodate for dividend returns. When a stock pays its dividend it is expected to decrease in price. By using return data this dividend is incorporated in the value of the index. Table 1.1 shows the data properties.

	Observations	Mean	Standard deviation	Minimum	Maximum
AEX	5219	1084.55	372.7	417.31	2115.89
S&P500	5219	2716.62	1339.3	1095.04	6571.03
Nikkei 225	4694	20028.33	7922.3	9300.06	38951.08
ASX 300	5219	35221.41	15252.4	13760.90	73320.44

Table 1.1: Summary statistics of return data.

Furthermore a first difference was taken of the indices and computed into factors to obtain daily returns. The properties of the differenced return data are represented in table 1.2

	Observations	Mean	Standard deviation	Minimum	Maximum
AEX	5218	.0001997	.01362	-0.09145	0.10546
S&P500	5218	.0002936	.01167	-0.09026	0.11581
Nikkei 225	4693	.0003272	.01413	-0.11406	0.14150
ASX 300	5218	.0003518	.00944	-0.08334	0.05725

Table 1.2: Summary statistics of differenced return data.

Appendix 1 shows a line graph of both returns and differenced returns over time.

4.1.2 Normality and heteroskedasticity

In order to determine normality a skewness and kurtosis test is performed. This test is preferred over a more common Jarque-Bera test as this test consists of more than 4000 observations, at which point a Jarque-Bera test could produce false significant results due to the availability of data. Table 1.3 shows the results of these tests.

	Pr(skewness)	Pr(kurtosis)	Adjusted Chi2	Prob>chi2
AEX	0.1060	0.0000	613.76	0.000
S&P500	0.2975	0.0000	707.23	0.000
Nikkei 225	0.0000	0.0000	623.80	0.000
ASX 300	0.0000	0.0000	636.81	0.000

Table 1.3: Test statistics of skewness and kurtosis test on differenced returns.

It quickly shows that none of the returns are normally distributed. In order to address this the return data is Winsorised at the second deviation. The advantage of this test is that it caps the extreme outliers, limiting the effect they have on tests while keeping the dataset intact and prevents missing values. The histograms in appendix 2 show the original data and appendix 3 the Winsorised data. From this point on normality will be assumed (Brooks, 2019) as the dataset inhibits 5218 observations of the S&P500, AEX and ASX 300 and 4693 observations of the Nikkei 225.

In order for CLRM to hold, homoskedasticity is necessary to maintain a BLUE (best linear unbiased estimator) model. Specifically when a dataset is heteroskedastic OLS may not be efficient as it may not achieve the smallest variance. This will be done by White testing the residuals of the regressions. Furthermore, Newey-west estimator will be used if it is necessary to overcome autocorrelation and heteroskedasticity.

4.2 Methodology

Because OLS will be used, the CLRM assumptions need to be met. First of all, the expected errors have zero mean. Due to the properties of OLS regression this is the case by construction. Secondly it needs to be the case that the variance of the errors is constant and finite over all values of the return data. This means homoskedasticity must hold. Although this is not formally the case, the Winsorising significantly limits this variance, as can be seen in Appendix 1 and is discussed in 4.1.2. Thirdly, errors cannot be correlated. In order to address this a Breusch-Godfrey test with five lags (due to daily data) is conducted after each regression. When these are significant they will be reported. However, an inherent problem might arise. When a fifth lag is significant the solution would be to include a lagged variable of that lag. This however violates the non-stochastic nature of the fourth CLRM assumption, namely that there cannot be covariance between the error term and the explanatory variables. The results of the Breusch-Godfrey test will be included with those of the regressions, however under current assumptions serial correlation cannot be accounted for and results therefore may need to be interpreted with caution because of this.

For the day of the week effect the following regression will be ran:

$$R_t = A_{Mon} D_{Mon} + A_{tue} D_{tue} + A_{Wed} D_{Wed} + A_{thu} D_{thu} + A_{fri} D_{fri}.$$

The coefficient estimations measure the returns, on average, on Monday, Tuesday, …, Friday and the relative t-values tell whether these significantly differ from 0. No constant will be used as the variables explain all variation. A Wald-test for equality indicates whether the regressions works and therefore if there is a day-of-the-week effect or not. According to Berument and Kiymaz (2001) specifically in stock markets there can be big problems with autocorrelation, so to overcome this problem autocorrelation has been tested when the data was prepared. Over the entire sample period, the day-of-the-week effects can be caused by excessive effects during a particular sub-period. Therefore the Quandt–Andrews breakpoint test is carried out on the OLS regression. This test is looking for unknown structural breaks in the estimated parameters. The null hypothesis for this test is that there are no structural breaks in all variables simultaneously. Quandt–Andrews test conducts a single Chow Breakpoint test at every observation between two observations, τ_1 and τ_2 . When this test shows a significant break the same regression will be ran with sample data before and after the break separately.

To investigate the turn of the year effect I will start with an ordinary least square regression analysis. With the turn of the year effect there has to be significant higher abnormal returns in January compared to other months. The OLS regression that will be used to test for this hypothesis is:

$$R_t = \alpha_0 + \alpha_{jan} D_{jan} + \varepsilon_t$$

D_{jan} is a dummy variable which takes value 1 if it is a day in January and 0 otherwise. With this manner Rt is the dependent variable and represents the daily returns. There could be a possibility that these results are influenced by outliers. It is assumed that this will be appropriately dealt with by using the Winsorised data. As well as for the day-of-the-week effect, a Quandt–Andrews test will be performed to check for breakpoints. When a breakpoint is found the same regression will be ran with data before and after the break separately.

To investigate if there is a significant higher return around the turn of the month the following formula will be used:

$$R_t = \alpha_0 + \alpha_{turn} D_{turn} + \varepsilon_t$$

In the formula $Dturn$ is the dummy variable that it will be a day in the interval between -1 until +3 around the turn of the month. Again a breakpoint test will be done to examine whether there is a structural break in the data set, possibly showing an appearance or a disappearance of the anomaly.

5. Results

5.1 Day-of-the-week effect

Table 1.1 shows the results of the regression of Winsorized returns on the dummy variables of the days for the whole sample. They also include the F-test statistic of the Wald test and the Chi squared value of the Breusch-Godfrey test with 5 lags.

	Monday	Tuesday	Wednesday	Thursday	Friday	Wald-test	Breusch-Godfrey
AEX	0.0003	-0.0001	0.0004	0.0000	0.0003	0.32	16.885***
S&P500	-0.0000	0.0000	0.0004	0.0004	0.0006**	0.81	19.289***
Nikkei 225	0.0004	0.0003	-0.0000	0.0005	0.0008**	0.69	5.804
ASX 300	0.0003	0.0003	0.0003	0.0003	0.0007***	0.49	6.504

*Table 1.1 Regression results on dummy variables over the entire sample, test statistic of Wald-test on equality and Breusch-Godfrey test on serial correlation. * 10% significance, ** 5% significance *** 1% significance*

From the Wald tests it is clear that the dummy beta’s are not significantly different from each other. What is interesting however is the significance of the Friday returns on three of the four indices. This suggests that Friday returns are consistently above average for these indices. Furthermore the results of the Breusch-Godfrey test indicate a strong serial correlation on the AEX and the S&P500. As mentioned in the methodology section this cannot be properly accounted for and therefore its results need to be interpreted with caution.

Next a Quandt-Andrews breakpoint test is introduced to explore whether there is a breakpoint in the sample. Table 1.2 shows the result of these tests. Based on these results new regressions will be devised when a result is significant.

	Estimated breakpoint	Test statistic
AEX	14/03/2003	26.4356***
S&P500	13/02/2003	19.2743**
Nikkei 225	10/10/2007	8.1750
ASX 300	27/02/2008	8.9265

*Table 1.2: The test results of the Quandt-Andrews test for a structural break. * 10% significance, **5% significance, *** 1% significance*

It can be seen that for the AEX and S&P500 a significant break is found. Furthermore it is interesting to note that these breaks are observed relatively close to each other. This suggests that there may have been a permanent exogenous shock in 2003 and 2007. As the Nikkei and ASX results are not significant I will continue with the full sample for those indices. Table 1.3 shows the result of the new regressions before and after the breakpoints, their respective Wald-test statistic and the Chi-square value of the White test in order to determine whether heteroskedasticity needs to be taken into account. If this is necessary this adjusted regression will also be included.

	Monday	Tuesday	Wednesday	Thursday	Friday	Wald	White
AEX Pre break	-0.0005	-0.0015	-0.0006	-0.0036***	0.0009	2.16*	3.29
AEX Post break	0.0005	0.0002	0.0005	0.0007**	0.0002	0.40	3.46
S&P500 pre break	-0.0017*	-0.0002	-0.0015	-0.0014	0.0007	1.12	1.97
S&P500 post break	0.0003	0.0000	0.0007**	0.0007**	0.0006*	0.94	2.28
Nikkei 225	0.0004	0.0003	-0.0000	0.0005	0.0008**	0.65	2.25
ASX 300	0.0003	0.0003	0.0003	0.0003	0.0007***	0.49	11.73**
ASX 300 Newey-West (5 lags)	0.0003	0.0003	0.0003	0.0003	0.0007***	0.47	n.a.

*Table 1.3: Results of adjusted regressions for breakpoints and heteroskedasticity and the original Nikkei 225 and ASX 300 regression. * 10% significance, ** 5% significance, *** 1% significance*

Table 1.3 shows some interesting findings. It can be seen that both the AEX and the S&P500 clearly inhibit two different periods. The pre 2003 period shows a highly significant negative return on Thursday after three days of insignificant negative days and is then followed by a barely insignificant (t-values omitted, for AEX pre break all around 1.5) return on Friday. Furthermore it is the only regression with a somewhat significant Wald-test. Thus far this is the strongest suggestion of a day-of-the-week effect. The AEX post 2003 has overall less significant values for the t-tests. Interesting is the significant Thursday return which contrasts, together with the pre break AEX, the significant Friday returns when the entire sample was assessed. The S&P500 pre and post break returns show a similar tendency in daily return significance and sign. The post break S&P500 also shows multiple significant returns on Wednesday and Thursday but a clearly anomaly could not be detected because of an inconclusive Wald-test. The Nikkei and ASX, who did not show a sign of a structural break in the data, show no sign of a day-of-the-week effect throughout the sample period either. Interestingly the ASX 300 clearly showed a significant white test, indicating a possibility of heteroskedasticity and autocorrelation. However, no significant improvement could be made using Newey-west regression and a variety of lags (5 lags, equivalent to one week, shown but multiple were tested). Overall no significant day-of-the-week effect was found. The AEX pre 2003 showed the most positive signs of it however, which is in line with previous research suggesting a disappearance of the anomaly. Lastly it is interesting to note how the U.S. and The Netherlands, and Japan and Australia behave similarly, possibly due to their geographical properties and market interdependence.

5.2 Turn-of-the-month effect

Table 2.1 shows the results of the regression on the returns and the dummy variable indicating the [-1, +3] interval. Also the breakpoint test and the Breusch-Godfrey test results are included.

	Constant	TOTM	Estimated breakpoint	Test statistic	Breusch-Godfrey
AEX	0.0001	0.0006	8/4/2009	14.37**	16.579***
S&P500	0.0002	0.0004	10/3/2009	12.14**	19.463***
Nikkei 225	0.0004**	-0.0001	10/6/2010	7.53	5.782
ASX 300	0.0004***	0.0000	1/4/2016	12.05**	6.534

Table 2.1: Regression results of index returns on TOTM dummy variable and results of breaktests. 10% significance, ** 5% significance, *** 1% significance*

The results of table 2.1 show that the AEX, S&P500 and ASX 300 show a significant structural break. These breaks will be further explored in table 2.2. Furthermore the results of the Breusch-Godfrey test on serial correlation show that again the AEX and S&P500 inhibit a strong serial correlation whereas this is not present in the Nikkei 225 and ASX 300.

	Constant	TOTM
AEX pre	-0.0006**	0.0019***
AEX post	0.0006***	-0.0005
S&P500 pre	-0.0004	0.0010*
S&P500 post	0.0007***	-0.0001
Nikkei 225	0.0004**	-0.0001
ASX 300 pre	0.0003	0.0003*
ASX 300 post	0.0008***	-0.0018***

*Table 2.2: results of pre- and post-break regressions of index returns on TOTM. * 10% significance, ** 5% significance, *** 1% significance.*

Table 2.2 shows some very interesting results. It can be concluded that the AEX showed on average 0.13% returns on the days around the turn of the month while it being -0.06% on the other days of the month. This strongly suggests a turn-of-the-month effect before April 2009. After that the

TOTM variable loses its significance and shows a more consistent 0.06% return per day. This is in line with previous conclusions by MNV that by 2002 there still was a significant TOTM effect although it's t-values were downward sloping, suggesting a disappearance of the effect. The S&P500 also shows a suggestion of a TOTM effect pre break, however, its significance is lower (p=0.07) and the constant (p = 0.99) indicates to much variance to draw conclusions from. After March 2009 its behaviour becomes similar to that of the AEX where it shows a consistent 0.07% return per day and an insignificant deviation during the turn of the month. In contrast to previous indices, the ASX shows a (re)appearance of a significant TOTM effect. This effect however is negative (-0,10%, p < 0.000) compared to the usual positive effect. This unusual finding cannot immediately be explained by previous research although it may be in line with the notion that after the discovery of an effect it investors can anticipate the effect therefore making it disappear. It may also be an anomaly based on the limited data after the break due to its recency.

These findings are in line with the theory that the anomalies have disappeared after the publication of the effects. This paper examines a possible reappearance of the TOTM effect however finds no evidence indicating such a thing. Interesting is the existence of a TOTM effect in the AEX until early 2009. There is no immediate explanation for this timing and should be explored in future research.

5.3 January effect

Table 3.1 shows the results of the regression and the result for the Quandt-Andrews breakpoint test and the Breusch-Godfrey test. A similar approach is used as with the DOTW and TOTM effect. First we look at the Winsorised data as is and depending on the test results adjustments will be applied.

	Constant	January	Estimated breakpoint	Test statistic	Breusch-Godfrey
AEX	0.0002	-0.0004	13/3/2003	8.81	16.734***
S&P500	0.0003**	-0.0004	28/1/2016	9.97*	19.412***
Nikkei 225	0.0005***	-0.001	22/1/2016	2.85	6.054
ASX 300	0.0004***	-0.0004	2/11/2007	3.56	6.583

*Table 3.1: Regression results of index returns on January dummy and results of the break test. * 10% significance, ** 5% significance, *** 1% significance.*

The results from the regression indicate no evidence of a TOTY effect, nor that of a possible break. This is in line with the evidence of a disappearance after the publication. It is however interesting to note that this effect in comparison to the other effects mentioned in this paper is suggested to be founded on fiscal explanations like window dressing and tax-loss selling. These explanations would suggest that they are based on more foundational aspects of investor behaviour and therefore would persist longer, being less dependent on behavioural aspects of an investor. The lack of significant results suggest that the market has sufficiently incorporated information and may be evidence for a more efficient market. Regressions were performed pre- and post-break in order to possibly find significant results. However none were found and therefore are omitted. Lastly the Breusch-Godfrey test shows a similar result as those of the other effects where the AEX and S&P500 show significant serial autocorrelation and none is found on the ASX 300 and the Nikkei 225.

6. Conclusion

This paper evaluates the persistence of the day-of-the-week effect, the turn-of-the-month effect and the January effect in The Netherlands, United States, Japan and Australia. The sample consists of data gathered from 2000 until 2019. The data was then Winsorised to prevent extremes bias which could disproportionately affect the estimation. By regressing the sample on dummy variables and looking for structural breaks in the sample, the behaviour of possible anomalies is examined.

The evidence suggests that the day-of-the-week effect disappeared in the early 2000’s with no significant anomalous returns after 2003. Interesting to note is the consistently significant Friday and Thursday returns. The U.S. and Netherlands show post 2003 significantly consistent positive Thursday returns while Japan and Australia show this effect on Friday. Lastly, the correlation in breaks and returns indicates that the U.S. and the Netherlands, and Japan and Australia markets are geographically dependent. Ultimately, no day-of-the-week effect is found in the 2000-2019 sample.

The turn-of-the-month effect seems to have been present in the Netherlands until early 2009. This is not in line with expectations. It was assumed that it had disappeared before 2000 and could emerge later. Finding a significant effect in contrast to other research may be explained by a different approach, using Quandt-Andrews structural break tests as opposed to a dynamic estimation. Furthermore the Breusch-Godfrey test revealed strong serial correlation which could have an impact on these results. Australia did show an emergence of a turn-of-the-month effect after early 2016. This effect however was negative, as opposed to an expected positive effect. A clear reason for this was not found. It could however be influenced by the relatively small remaining sample of 4 years. Lastly the effect was not observed in the U.S. and Japan. All in all some interesting results were found. Looking into the Australia case could reveal the reason for the re-emergence of the TOTM effect.

The January effect showed no significant results indicating such an effect. This is in line with previous research looking into the effect. It is often suggested that due to anticipating investor behaviour the effect recedes into the previous year before it disappears completely. These results cannot reject this notion. A variable for December could show some results that would support this however.

This research shows that there are some remnants of calendar anomalies in different markets. It is clear however that there are no more significant effects to be found like they were when they were first found. Some remarks need to be made on this conclusion however. First of all it can be argued that a sample of 2000-2019 is too short to reliably assess the breakpoint estimation as it can be that the actual (should there be one) breakpoint was earlier, meaning the structural break was an anomaly by itself. Secondly this paper looks at whether an anomaly emerges or disappears in the specified time-period. This however implicates that an anomaly would persist. This assumption may be wrong and this paper did not properly adjust for that. A dynamic approach, looking at the anomaly year by year might be a more proper way to address this issue.

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Appendix

1. Line graphs summary data

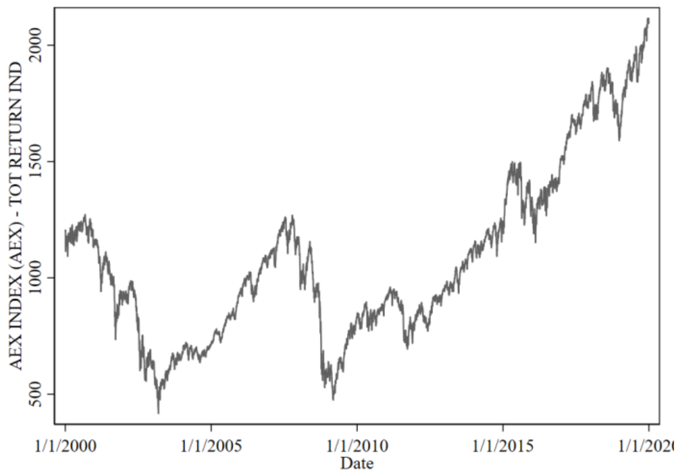

Figure 1.1: return data AEX over time

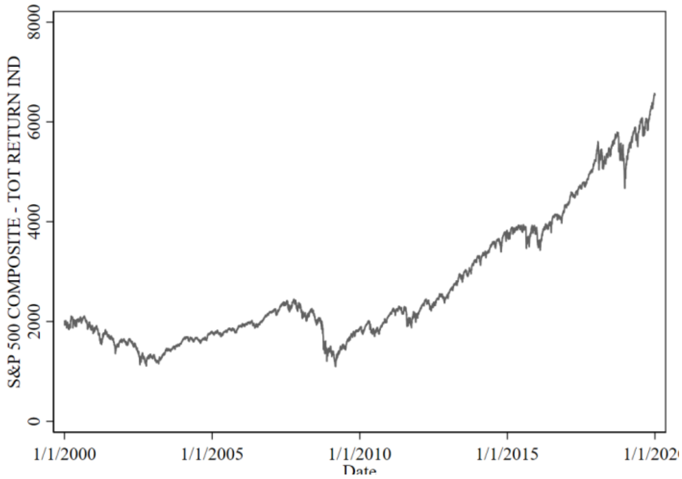

Figure 1.2: return data S&P500 over time

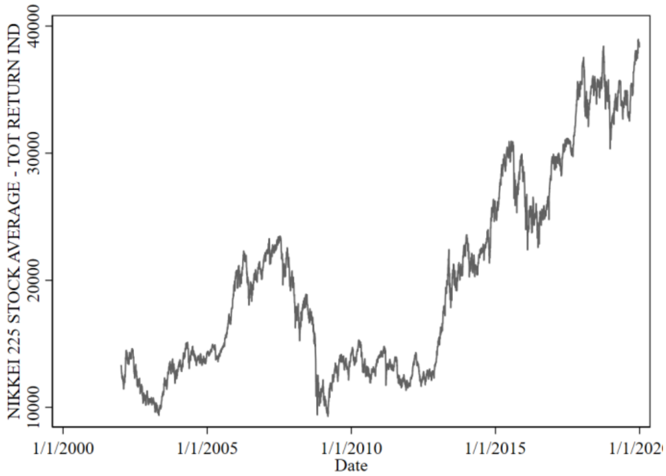

Figure 1.3: return data Nikkei 225 over time

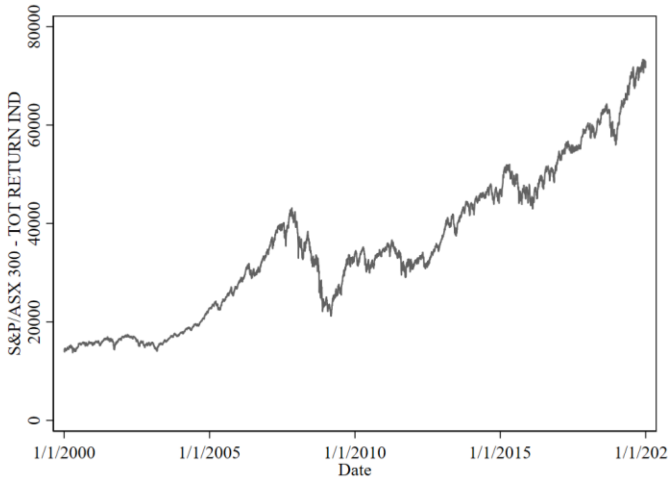

Figure 1.4: return data ASX 300 over time

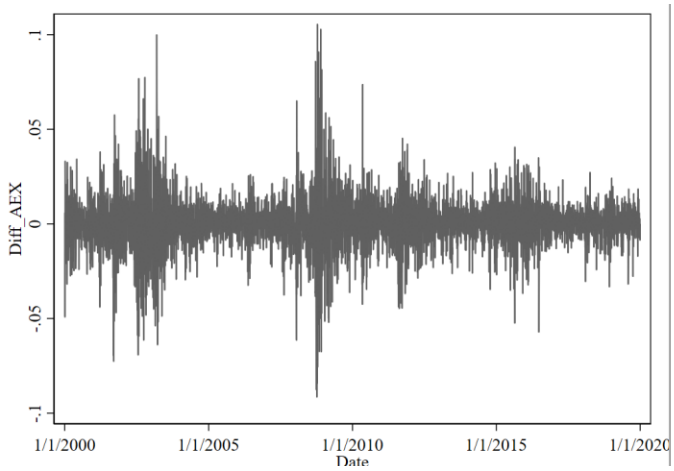

Figure 1.5: differenced return data AEX over time.

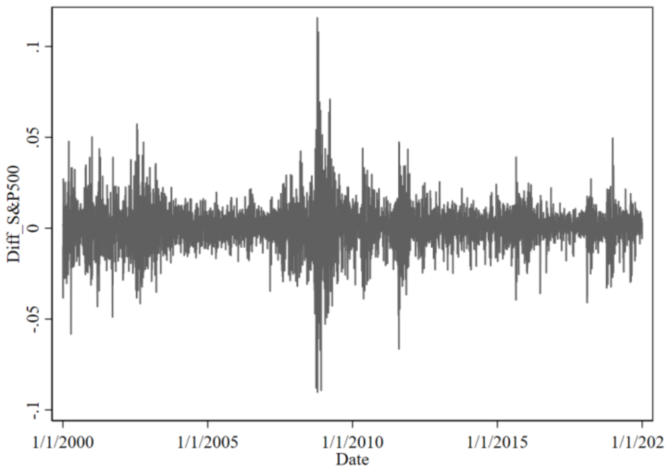

Figure 1.6: differenced return data S&P500 over time.

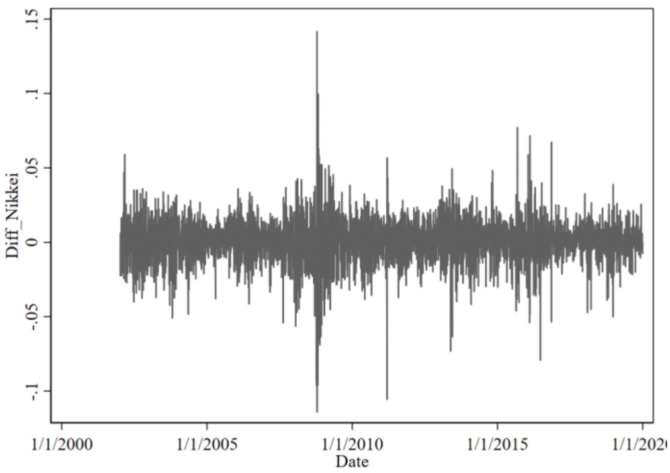

Figure 1.7: differenced return data Nikkei 225 over time

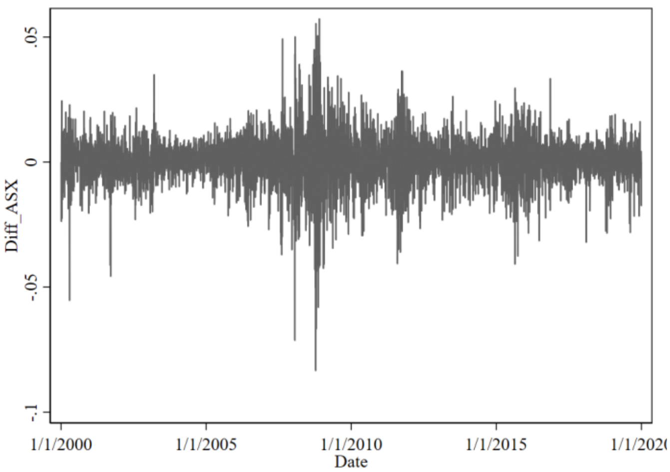

Figure 1.8: differenced return data ASX 300

2. Differenced returns

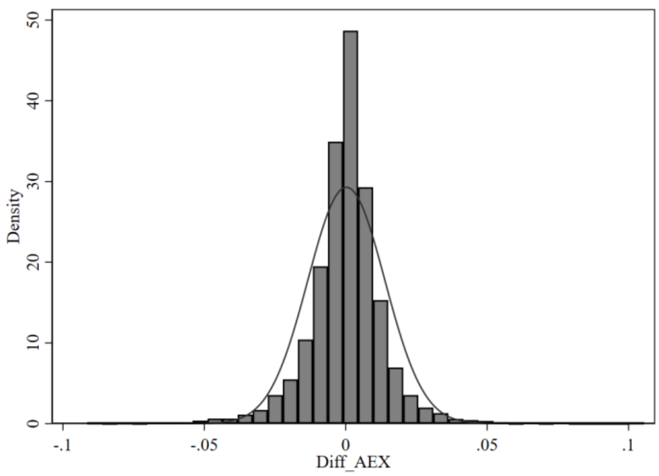

Figure 2.1: original distribution of AEX returns with a standard normal distribution line

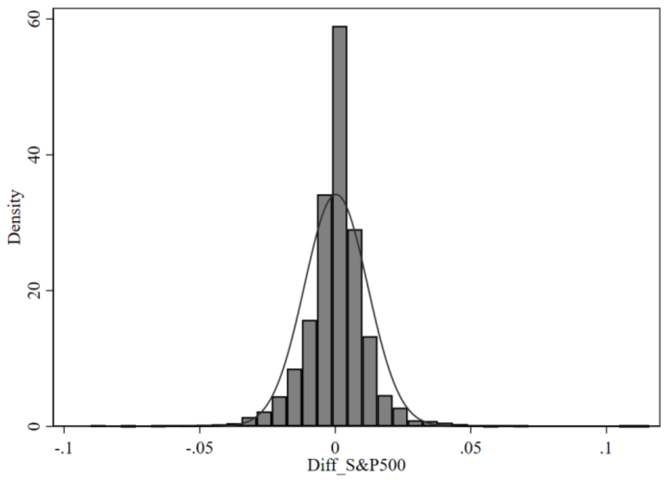

Figure 2.2: original distribution of S&P500 returns with a standard normal distribution line

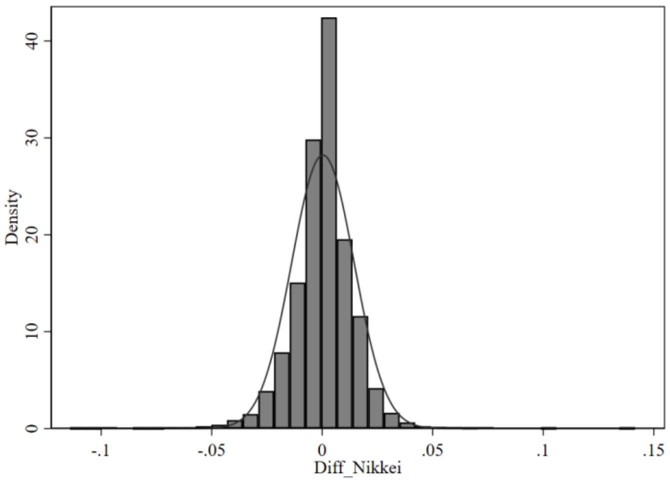

Figure 2.3: Original distribution of Nikkei 225 returns with a standard normal distribution line

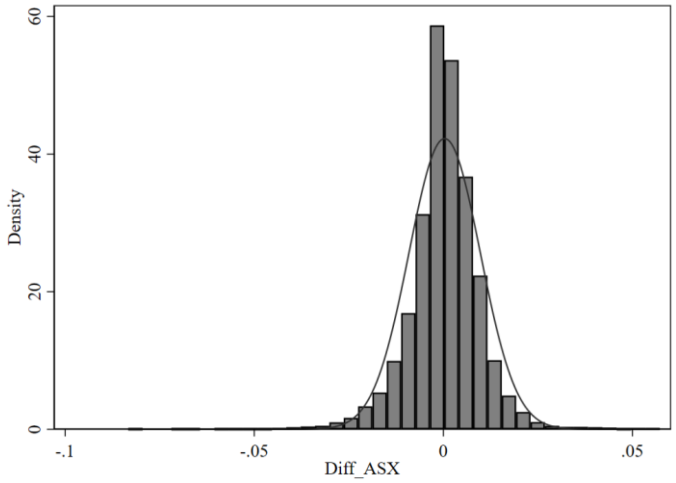

Figure 2.4: original distribution of ASX 300 returns with a standard normal distribution line

3. Winsorised returns

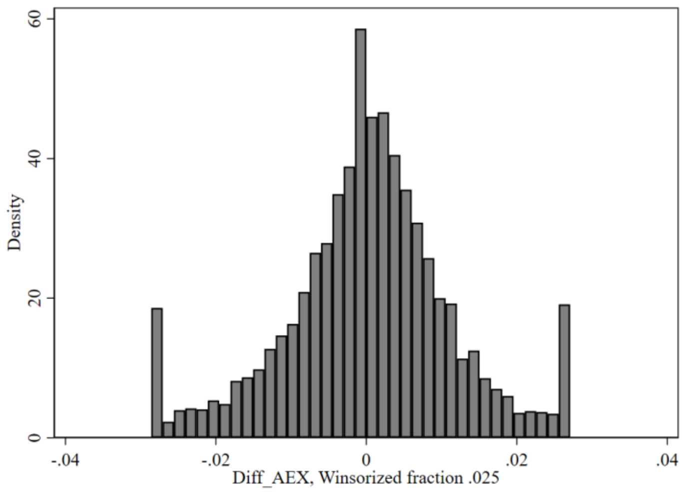

Figure 2.5: Winsorised distribution of AEX returns

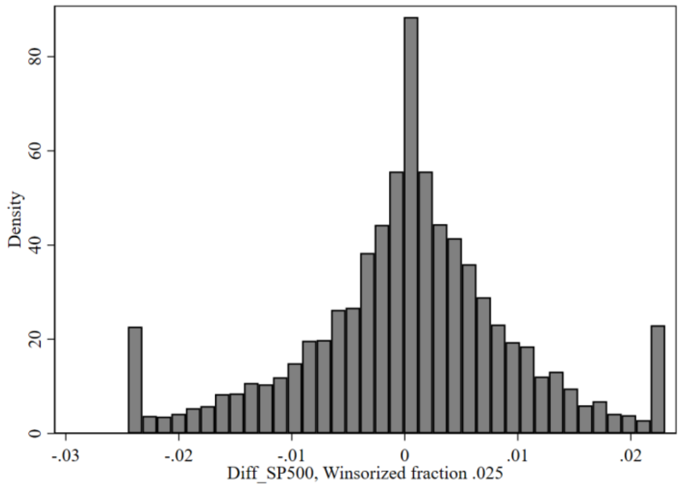

Figure 2.6: Winsorised distribution of S&P500 returns

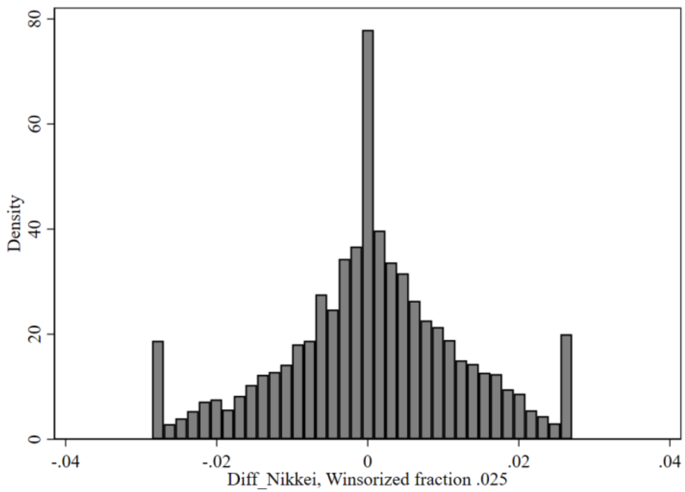

Figure 2.7: Winsorized distribution of Nikkei 225 returns

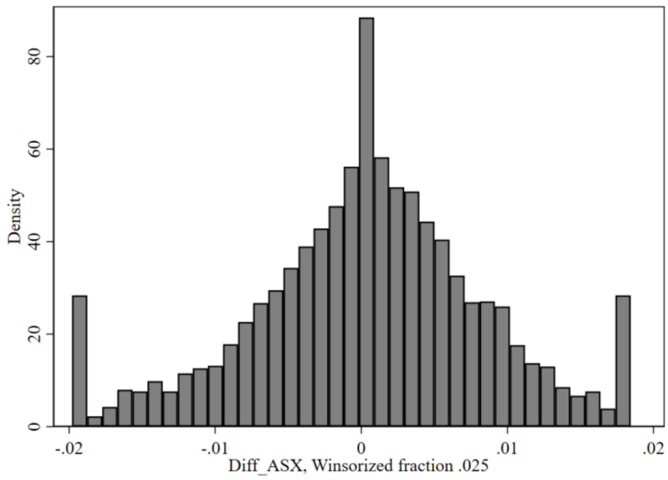

Figure 2.8: Winsorized distribution of ASX 300 returns