

# Historical Evolution of Monthly Anomalies in International Stock Markets

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June 11, 2019

## Abstract

This paper is a comprehensive investigation of the evolution of various monthly anomalies (January effect, December effect, and the Mark Twain effect) in the US stock market for its entire history. This is done using various statistical techniques (average analysis, Student's t-test, ANOVA, the Mann-Whitney test) and a trading simulation approach). To confirm our results we extended the analysis to the UK, Japan, Canada, France, Switzerland, Germany and Italy stock markets. The results indicate that the January effect was most prevalent in the US and that the December effect and the Mark Twain effect were never prevalent in the US. This result was confirmed in other markets as well. The January effect was most prevalent in the middle of the 20<sup>th</sup> century but has since disappeared. Furthermore, the January effect provided exploitable profit opportunities. Our results are consistent and add to the existing literature through the use of a complete history of the US market. Overall, the US stock market is consistent with the Adaptive Market Hypothesis.

**Keywords:** Calendar Anomalies, Month of the Year Effect, Stock Market, Efficient Market Hypothesis, January Effect, December Effect, Mark Twain Effect.

**JEL Codes:** G12, C63

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# 1 Introduction

The Efficient Market Hypothesis (EMH) predicts that stock prices reflect all available information about the value of a firm, and therefore there is no possibility of economic profits (see [Fama \(1965\)](#) and [Fama \(1970\)](#)). However, [Rossi \(2015\)](#) observes that after years of investigation in all its forms (weak, semi-strong, and strong forms) and considerable controversy, in recent years scholars have been continuing to find evidence contradicting the EMH (for example see [Klock \(2014\)](#) and [Perez \(2018\)](#)). This is, however, not a recent realisation as others have shown that the predictions of the EMH are not absolute (see [Grossman & Stiglitz \(1980\)](#), [Shiller \(2000\)](#), [Shiller \(2003\)](#), and [Akerlof & Shiller \(2009\)](#)). Furthermore, [Rossi & Gunardi \(2018\)](#) contend that the calendar anomalies literature continues to be fragmented and therefore the study of calendar anomalies remains relevant.

To this end, [Plastun et al. \(2019\)](#) and [Urquhart & McGroarty \(2016\)](#), amongst others, focused on the evolution of calendar anomalies using data that spans over a century. For example, used data from 1900 to 2018 in the US stock market and found that the ‘golden age’ of calendar anomalies was in the middle of the 20th century. However, since the 1980s all calendar anomalies disappeared, which is consistent with the EMH. Whilst, [Urquhart & McGroarty \(2016\)](#) demonstrated that stock market return predictability varies over time and is related to the stock market conditions, thereby Adaptive Market Hypothesis in the S&P500, FTSE100, NIKKEI225 and the EURO STOXX 50. That is, the analogous behaviour of stock market returns varies over time is not omnipresent as suggested by the Efficient Market Hypothesis. Although questions around the evolution of the January effect specifically are not new, [Perez \(2018\)](#), [Gupta \(2017\)](#) and [Patel \(2016\)](#) continue to investigate the evolution of the January effect in advanced and emerging markets. Others such as [Ahmed & Boutheina \(2017\)](#) and [Gupta \(2017\)](#) focused on the evolution of other monthly anomalies such as the December effect and the Mark Twain effect.

This paper seeks to add to the existing monthly anomalies literature by using data from which covers the entire US stock market history and to confirm the US results by comparing with similar markets. This has not previously been done in the literature. Furthermore, it seeks to expand on the limited literature on the December effect and the Mark Twain effect in the US, whilst confirming the voluminous January effect literature. To achieve this we employ various statistical techniques (average analysis, Student’s t-test, ANOVA, the Mann-Whitney test) and a trading simulation approach. The trading simulation approach is unique to the literature in that it provides practical implications for the anomaly, that is, whether there was a possibility of exploitable profits from an anomaly. The layout of the paper is as follows. Section 2 describes the data and outlines the empirical methodology. Section 3 presents the US empirical results, and Section 4 offers some concluding remarks.

## 2 Literature Review

According to [Thaler \(1987\)](#) the first attempts to test the EMH examined short term correlations in stock prices, and when no evidence of serial correlation was found initially it was thought that stock prices followed a random walk. However, the work of [Rozeff & Kinney \(1976\)](#) found seasonal patterns in the New York Stock exchange over the period 1904 to 1974. In particular, this referred to January returns being on average 3.5 per cent, compared to 0.5 per cent in the other months. This is the most prominent of the monthly anomalies, that is, the January effect.

After [Rozeff & Kinney \(1976\)](#), others such as [Gultekin & Gultekin \(1983\)](#) found the January effect in 16 countries, [Ho \(1990\)](#) who found the January effect in six out of eight emerging Asian Pacific markets, and [Lakonishok & Smidt \(1988\)](#) who confirmed the January effect in the US followed. This continued initial wave of the confirmation of the January effect shifted focus in the literature towards an explanation for the January effect and to a certain extent the other forms of monthly anomalies such as the Mark Twain effect and the December effect.

[Roll \(1983\)](#) and [Keim \(1983\)](#), amongst others, attributed the existence of the January effect to the size effect (or the small-firm effect), including those that underperformed in the past ([De Bondt & Thaler \(1985\)](#)). Essentially the contention is that small firms in the processing of seeking to improve profitability, sell stocks at a capital loss in order to avoid taxation, otherwise known as tax loss selling hypothesis ([Wachtel \(1942\)](#)), and buy back these stocks in January, thereby increasing returns in that month. This is, however, not limited to small firms. In addition, the tax loss selling hypothesis is not limited to December tax years only. As shown by [Agrawal & Tandon \(1994\)](#) in most countries tax loss selling was confirmed with a December tax year, however, in the UK it was confirmed with a March tax year. [Choudhry \(2001\)](#) found strong evidence of the January effect prior to the first world war in the UK, US, and Germany despite the lack of tax treatment of capital gains in these countries during that period. This contradicted the tax loss selling hypothesis.

Various studies have cited the size effect as the main reason for the January effect. [Lakonishok & Smidt \(1988\)](#) confirmed the results of [Roll \(1983\)](#) in the US. Whilst [Bhabra et al. \(1999\)](#) studied the impact of the 1986 Tax Reform Act in the US on the tax loss selling and confirmed that tax loss selling shifted to November as a result. More recently, [Moller & Zilca \(2008\)](#), [Gu \(2003\)](#) found similar results.

Other explanations have been advanced for the existence of the January effect. [Haugen & Lakonishok \(1988\)](#) advanced the window dressing hypothesis which states that investors sell certain stocks at the end of the year in order to present more acceptable portfolio performance in year-end reports. [Stoll & Whaley \(1983\)](#) found that transaction costs in small firms and [Chang & Pinegar \(1990\)](#) found that seasonality in the risk premium explained the January effect. Lastly, [Kohers & Kohli \(1992\)](#) found that the

January effect was linked to the business cycle. Lastly, [Blume & Stambaugh \(1983\)](#) attributed the January effect to statistical bias.

The evolution of the January effect, and in general the various monthly anomalies, was investigated across the world. Post the initial wave of the confirmation of the January effect, more evidence from recent studies is mixed. Suggesting that the January effect has since disappeared in advanced markets (see [Marquering et al. \(2006\)](#) and [Perez \(2018\)](#)). For example, [Floros \(2008\)](#) found no evidence of the January effect in the Greek stock market, [Rossi & Gunardi \(2018\)](#) found no evidence of the January effect in advanced markets between 2001 and 2010, and [Giovanis \(2009\)](#) found no evidence of the January effect in 36 out of 55 stock markets. [Marrett & Worthington \(2011\)](#) found higher returns in April instead of January. [Mills et al. \(2000\)](#) found higher monthly returns in January and February in the Greek stock market.

However, others continue to find evidence of the January effect to varying degrees. [Patel \(2016\)](#) found evidence in the US and other markets using data from 1997 to 2014. Similarly, [Haug & Hirschey \(2006\)](#) found that the January effect was still prevalent in US equities, even in equally weighted small-cap stock returns. [Jacobsen et al. \(2005\)](#) also confirmed the January effect in the US. However, in addition, [Jacobsen et al. \(2005\)](#) studied the interaction of the January effect with the Halloween effect and found that unlike the January effect the Halloween effect was a market-wide phenomenon.

In emerging markets, for example, in the Indian stock market [Gupta \(2017\)](#) studied the January effect using 15 years worth of data and found no anomalous evidence. In the Tunisian stock market [Ahmed & Boutheina \(2017\)](#) also did not find evidence of the January effect but confirmed the month of the effect in August and April. [Balaban et al. \(1995\)](#) found evidence of the January effect in the Turkish stock market. [Alagidede & Panagiotidis \(2006\)](#) found evidence of an anomaly in April instead of January in Ghana. However, [Zhang & Li \(2006\)](#) in China found evidence of the January effect in the Chinese stock market.

Equally relevant for this study, the Mark Twain effect and December effect received less attention in the literature compared to the January effect. This is as these effects are less prominent than the January effect. Referring to higher than average returns in October as compared to other months, both [Ahmed & Boutheina \(2017\)](#), [Balaban et al. \(1995\)](#), and [Floros \(2008\)](#) did not find evidence of the Mark Twain effect in the Tunisian, Istanbul and Greek stock markets, respectively. Furthermore, [Rossi & Gunardi \(2018\)](#) did not find any significant evidence of the Mark Twain effect and December effect in Germany, France, Italy and Spain. However, [Norvaisiene et al. \(2015\)](#) found evidence of the Mark Twain effect in Estonia. [Agrawal & Tandon \(1994\)](#) found evidence of the December effect in an international study which excluded the US. [Parikh \(2009\)](#) and [Gupta \(2017\)](#) confirmed the December effect in the Indian stock market. No literature confirming Mark Twain effect or the December effect in the US was found suggesting that these have since disappeared ([Marquering et al. \(2006\)](#)) or may have never existed.

### 3 Data and Methodology

We use monthly data from the US, UK, Canadian, French, Germany, Italy, and Japanese stock markets. This data was sourced from the Global Financial Database<sup>1</sup>. The sample periods are summarised in Table 1 below. In order to explore the evolution of the various monthly anomalies (January effect, Mark Twain effect, December effect) we split overall period into a number of sub-periods. The length of each sub-period is 25 years. This explains why some data sets are do not end with 2018, but with 2017 or 2015. This allows for sufficient data sets for analysis with statistically significant results and at the same time to see the dynamics of the evolution.

The following hypotheses are tested in this research:

- $H_1$ : the various monthly anomalies are not a market myth or legend;
- $H_2$ : the various monthly anomalies evolve over time;
- $H_3$ : the various monthly anomalies can be exploited to get abnormal profits from trading in the stock markets.

Table 1: Data

Country	Stock Market	Sample Period
US	S&P 500 Index	1791-2015
UK	FTSE All Share Index	1693-2017
Canada	S&P/TSX 300 Composite Index	1915-2014
France	CAC All Tradable Index	1898-2018
Germany	CDAX Composite Index	1870-2018
Italy	Banca Commerciale Italiana Index	1905-2018
Japan	Nikkei 225	1914-2013
Switzerland	Switzerland Composite Stock Price Index	1916-2015

To confirm or reject these hypotheses we use average analysis, parametric tests (Students t-tests and ANOVA analysis), non-parametrical test (Mann-Whitney test), and the trading simulation approach. The average analysis provides preliminary evidence

<sup>1</sup>The data is available for download at <https://www.globalfinancialdata.com>

of differences in returns between the months of the year. Furthermore, both the parametric and non-parametric tests are carried out given evidence of fat tails and kurtosis in stock market return data. To this end, the null hypothesis ( $H_0$ ) in each case is that the data belong to the same population and a rejection of this null suggesting the presence of an anomaly. The Students t-tests are carried out under the same null hypothesis.

The tests are carried out at the 95% confidence level, and the degrees of freedom are  $N1$  ( $N = N_1 + N_2$ ). Returns are computed as follows:

$$R_t = \left( \frac{Close_t}{Close_{t-1}} - 1 \right) \times 100 \quad (1)$$

where  $R_t$  is the return on the  $t^{th}$  day in percentage,  $Close_t$  is the close price on the  $t^{th}$  day, and  $Close_{t-1}$  is the open price on the  $t - 1^{th}$  day.

When an anomaly is detected we examine whether it gives rise to exploitable profit opportunities by means of a trading simulation approach. Specifically, we use an algorithm based on the various monthly anomalies to replicate the behaviour of a trader who opens positions in the stock market and holds them for a certain period of time (for example, for the January effect the algorithm is: buy on the start of January and close this position at the end of January).

We use the following procedure to simulate the trading process. First we compute the percentage result of the deal ( $\%Result$ ):

$$\%Result = \frac{100 \times P_{open}}{P_{close}} \quad (2)$$

where  $P_{open}$  is the opening price, and  $P_{close}$  is the closing price.

The sum of results from each deal is the total financial result of trading. A strategy resulting positive total profits is defined as indicating an exploitable market anomaly. To ensure that the results we obtain are statistically different from the random trading we carry out t-tests on the results. Given that the sample size of the trading simulation results is less than a 100, the t-test is utilised instead of the z-test.

A t-test compares the means from two samples to test whether these means originate from the same population. In our case, the first is the average profit/loss factor of one trade applying the trading strategy, and the second is equal to zero because random trading (without transaction costs) should generate zero profit.

Therefore, the null hypothesis ( $H_0$ ) is that the means are equal in both samples and the alternative ( $H_1$ ) indicates that they are not. The t-tests are conducted at a 5 % level of significance. Failure to reject  $H_0$  implies that there are no advantages from exploiting the trading strategy being considered, whilst a rejection suggests that the adopted strategy can generate abnormal profits.

## 4 Results

Appendix A contains the US results. Appendix B contains supplementary results on the Canadian, French, German, Italian, Japanese, Swiss, and UK stock markets. In particular, the Canadian results are shown in both full and aggregated forms<sup>2</sup>. In order to fit all available results into one paper, for other countries aggregated results are used. The full results include an average analysis (Table 12 and Figure 3), detailed statements of the ANOVA analysis (Table 13), Mann-Whitney (Table 14) and t-tests (Table 15).

In terms of the January effect, the average analysis reveals that since 1866 returns in the stock market were higher than average in January (see Table 2). However, for the Mark Twain effect, the average analysis reveals that between 1816 and 1940 returns in October were higher than average. This trend has since reversed in the rest of the sample. Lastly, the average analysis revealed evidence of the December effect in the US between 1941 and 2015.

The January effect average analysis results to a large extent are supported by statistical tests (ANOVA, t-test, and Mann-Whitney test) which were all significant between 1891 and 1965. However, in recent times statistical tests have not confirmed the January effect. Statistical tests for both the Mark Twain effect and the December effect fail to confirm anomalies in returns. Given the confirmation of the January effect, we conduct a trading simulation to determine if this anomaly generated exploitable profits. As can be seen in Table 3, a trading strategy based on the January effect generated abnormal profits in the US stock market for over 100 years (between 1891 and 2015).

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<sup>2</sup>Please note that full results of all stock markets are available on request

Table 2: Overall results for the various monthly anomalies

Effect	Method	1791 - 1815	1816 - 1840	1841 - 1865	1866 - 1890	1891 - 1915	1916 - 1940	1941 - 1965	1966 - 1990	1991 - 2015
January effect	Average analysis	-	-	-	+	+	+	+	+	+
	ANOVA	-	-	-	-	+	+	+	-	-
	Students t-test	-	-	-	-	+	+	+	-	-
	Mann-Whitney test	-	-	-	-	+	+	+	-	-
Mark Twain effect	Overall	0	0	0	1	4	4	4	1	1
	Average analysis	-	+	+	+	+	+	-	-	+
	ANOVA	-	-	-	-	-	-	-	-	-
	Students t-test	-	-	-	-	-	-	-	-	-
	Mann-Whitney test	-	-	-	-	-	-	-	-	-
	Overall	0	1	1	1	1	1	0	0	1
December effect	Average analysis	+	-	+	-	-	-	+	+	+
	ANOVA	-	-	-	-	-	-	-	-	-
	Students t-test	-	-	-	-	-	-	-	-	-
	Mann-Whitney test	-	-	-	-	-	-	-	-	-
	Overall	1	0	1	0	0	0	1	1	1

Note: + means that the anomaly is present, and - means that it is not present. The Overall column simply counts the number of + with a higher number indicating stronger evidence of the anomaly



Table 3: Trading simulation results of the January effect

Period	Number of trades, units	Number of suc- cessful trades, units	Number of suc- cessful trades, %	Profit, %	Profit % per year	t-test	Result
1866-1890	25	14	56.0	18.65	1.9	1.4	failed
1891-1915	25	18	72.0	39.74	4.0	3.23	passed
1916-1940	25	15	60.0	42.56	4.3	3.17	passed
1941-1965	25	20	80.0	45.25	4.5	3.45	passed
1966-1990	25	17	68.0	42.72	4.3	2.45	passed
1991-2015	25	15	60.0	25.85	2.6	1.88	passed

Overall, our analysis reveals that the January effect remains prevalent in the US stock market. However, the Mark Twain effect and December effect were never prevalent in the US. These results are confirmed the average analysis, statistical tests, and the trading simulation. The results of the January effect are, therefore, inconsistent with the EMH.

#### 4.1 Robustness

The results of the US stock market are collaborated by the results of the Canadian, French, German, Italian, Japanese, Swiss, and UK stock markets. That is, in all these stock markets the January effect was prevalent but has since disappeared, and the Mark Twain and December effects were never prevalent with some exceptions. Specifically, the Mark Twain effect was prevalent in the UK between 1768 and 1792, and the December effect was prevalent in Canada between 1965 and 2014, and in the UK between 1993 and 2017. Lastly, the trading simulation approach results are also congruent with the US results, revealing that the January effect in the main generated exploitable profits. In recent years, however, this trend has begun to reverse in almost all these markets (see Tables 4-7).

Table 4: Overall results of the January effect

Period	Average Analysis	ANOVA	Students t-test	Mann-Whitney test	Overall
1915-1939	+	+	Canadian stock market +	+	4
1940-1964	+	+	+	+	4
1965-1989	+	-	-	-	1
1990-2014	-	-	-	-	0
1898-1922	+	-	French stock market -	-	1
1923-1947	+	-	-	-	1
1948-1972	+	+	+	+	4
1973-1997	+	-	-	+	2
1998-2018	+	-	-	-	1
1870-1894	-	-	German stock market -	-	0
1895-1919	+	+	+	-	3
1920-1944	+	+	+	+	4
1945-1969	+	-	+	-	2
1970-1994	+	-	-	-	1
1994-2018	+	-	-	-	1
1905-1929	+	-	Italian stock market -	-	1
1930-1954	+	-	-	-	1
1955-1979	+	+	+	-	3
1980-2004	+	+	+	-	3
2005-2018	+	-	-	-	1
1914-1938	+	+	Japanese stock market +	+	4
1939-1963	+	+	+	+	4
1964-1988	+	+	+	+	4
1989-2013	-	-	-	-	0
1916-1940	-	-	Swiss stock market -	-	0
1941-1965	+	+	+	+	4
1966-1990	+	+	+	-	3
1991-2015	+	-	-	-	1
1693 - 1717	-	-	UK stock market -	-	0
1718 - 1742	-	-	-	-	0
1743 - 1767	-	-	-	-	0
1768 - 1792	-	-	-	-	0
1793 - 1817	-	-	-	-	0
1818 - 1842	+	-	-	-	1
1843 - 1867	+	+	+	-	3
1868 - 1892	+	+	+	+	4
1893 - 1917	+	+	+	+	4
1918 - 1942	+	+	+	+	4
1943 - 1967	+	-	-	+	1
1968 - 1992	+	-	-	+	2
1993 - 2017	-	-	-	-	0

Note: + means the that anomaly is present, and - means that it is not present. The Overall column simply counts the number of + with a higher number indicating stronger evidence of the anomaly

Table 5: Overall results of the Mark-Twain effect

Period	Average Analysis	ANOVA	Students t-test	Mann-Whitney test	Overall
1915-1939	+	-	Canadian stock market	-	1
1940-1964	-	-	-	-	0
1965-1989	+	-	-	-	1
1990-2014	-	-	-	-	0
1898-1922	-	-	French stock market	-	0
1923-1947	-	-	-	-	0
1948-1972	+	-	-	+	2
1973-1997	+	-	-	-	1
1998-2018	-	-	-	-	0
1870-1894	+	-	German stock market	-	1
1895-1919	+	-	-	-	1
1920-1944	+	-	-	+	2
1945-1969	-	-	-	-	0
1970-1994	+	-	-	-	1
1994-2018	-	-	-	-	0
1905-1929	+	-	Italian stock market	+	2
1930-1954	-	-	-	-	0
1955-1979	+	-	-	-	1
1980-2004	-	-	-	-	0
2005-2018	-	-	-	-	0
1914-1938	+	-	Japanese stock market	-	1
1939-1963	+	-	-	-	1
1964-1988	+	-	-	-	1
1989-2013	+	-	-	-	1
1916-1940	+	-	Swiss stock market	+	2
1941-1965	+	+	+	-	3
1966-1990	-	-	-	-	0
1991-2015	-	-	-	-	0
1693 - 1717	+	-	UK stock market	+	2
1718 - 1742	+	-	-	+	2
1743 - 1767	+	+	+	+	4
1768 - 1792	+	+	+	+	4
1793 - 1817	-	-	-	-	0
1818 - 1842	+	-	-	-	1
1843 - 1867	+	-	-	-	1
1868 - 1892	-	-	-	-	0
1893 - 1917	+	-	-	-	1
1918 - 1942	-	-	-	-	0
1943 - 1967	-	-	-	-	0
1968 - 1992	+	-	-	-	1
1993 - 2017	-	-	-	+	1

Note: + means the that anomaly is present, and - means that it is not present. The Overall column simply counts the number of + with a higher number indicating stronger evidence of the anomaly

Table 6: Overall results of the December effect

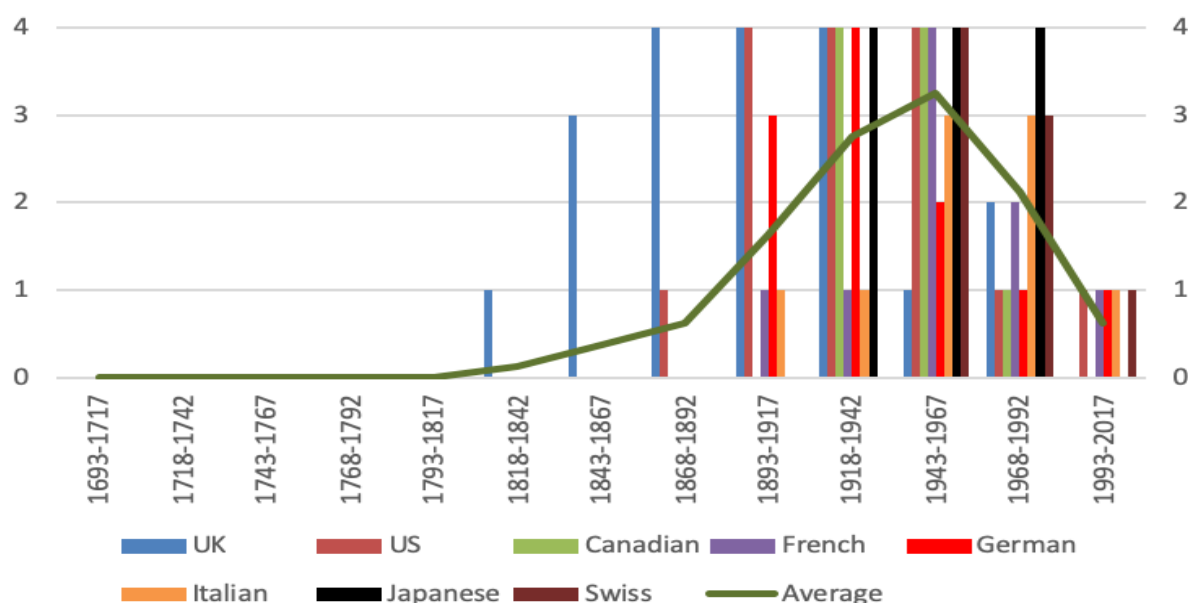
Period	Average Analysis	ANOVA	Students t-test	Mann-Whitney test	Overall
1915-1939	-	-	Canadian stock market	-	0
1940-1964	-	-	-	-	0
1965-1989	+	+	+	+	4
1990-2014	+	+	+	+	4
1898-1922	-	-	French stock market	-	0
1923-1947	-	-	-	-	1
1948-1972	+	-	-	-	1
1973-1997	+	-	-	-	1
1998-2018	+	-	-	-	1
1870-1894	+	-	German stock market	-	1
1895-1919	-	-	-	-	0
1920-1944	+	-	-	-	1
1945-1969	+	-	-	-	1
1970-1994	+	-	-	-	1
1994-2018	+	-	-	+	2
1905-1929	+	-	Italian stock market	-	1
1930-1954	+	-	-	-	1
1955-1979	-	-	-	-	0
1980-2004	+	-	-	-	1
2005-2018	+	-	-	-	1
1914-1938	-	-	Japanese stock market	-	0
1939-1963	+	-	-	-	1
1964-1988	+	-	-	-	1
1989-2013	+	-	-	-	1
1916-1940	+	-	Swiss stock market	-	1
1941-1965	+	-	-	-	1
1966-1990	+	+	+	+	4
1991-2015	+	-	-	-	1
1693 - 1717	+	-	UK stock market	-	1
1718 - 1742	+	+	+	-	3
1743 - 1767	+	-	-	-	1
1768 - 1792	+	-	-	+	2
1793 - 1817	+	-	-	-	1
1818 - 1842	+	-	+	-	4
1843 - 1867	+	+	-	+	1
1868 - 1892	+	-	-	-	1
1893 - 1917	+	-	-	-	1
1918 - 1942	-	-	-	-	0
1943 - 1967	-	-	-	-	1
1968 - 1992	+	-	-	-	1
1993 - 2017	+	+	+	+	4

Note: + means the that anomaly is present, and - means that it is not present. The Overall column simply counts the number of + with a higher number indicating stronger evidence of the anomaly

Table 7: Trading simulation results of the January effect

Period	Number of trades, units	Number of successful trades, units	Number of successful trades, %	Profit, %	Profit % per year	t-test	Result
<b>Canadian stock market</b>							
1965-1989	25	20	80.0	53.48	5.3	2.88	passed
1990-2014	25	21	84.0	51.46	5.1	3.92	passed
<b>French stock market</b>							
1898-1922	25	15	62.5	36.82	3.7	2.08	passed
1923-1947	25	16	64.0	82.07	8.2	2.08	passed
1948-1972	25	16	64.0	74.01	7.4	3.12	passed
1973-1997	25	18	72.0	71.23	7.1	2.32	passed
1998-2018	21	13	61.9	4.97	0.5	0.20	failed
<b>German stock market</b>							
1870-1894	25	10	40.0	-13.05	-1.3	-0.82	failed
1895-1919	25	15	60.0	28.47	2.8	2.70	passed
1920-1944	25	21	84.0	104.69	10.5	3.23	passed
1945-1969	25	17	68.0	50.84	5.1	2.91	passed
1970-1994	25	18	72.0	35.32	3.5	1.53	failed
1994-2018	24	16	66.7	10.63	1.1	0.36	failed
<b>Italian stock market</b>							
1905-1929	24	13	54.2	33.27	3.3	0.88	failed
1930-1954	24	15	62.5	36.82	3.7	2.08	passed
1955-1979	25	16	64.0	57.15	5.7	2.16	passed
1980-2004	25	18	72.0	119.23	11.9	3.42	passed
2005-2018	14	10	71.4	8.19	0.8	0.33	failed
<b>Japanese stock market</b>							
1914-1938	24	19	79.2	89.23	8.9	3.79	passed
1939-1963	25	18	72.0	167.14	16.7	2.48	passed
1964-1988	25	21	84.0	85.43	8.5	6.05	passed
1989-2013	25	14	56.0	-1.37	-0.1	-0.05	failed
<b>Swiss stock market</b>							
1916-1940	24	13	54.2	-16.30	-1.6	-0.48	failed
1941-1965	25	21	84.0	62.29	6.2	4.65	passed
1966-1990	25	17	68.0	62.24	6.2	2.51	passed
1991-2015	25	16	64.0	29.73	3.0	1.28	failed
<b>UK stock market</b>							
1818-1842	25	15	60.0	56.55	5.7	1.05	failed
1843-1867	25	16	64.0	32.04	3.2	2.63	passed
1868-1892	25	19	76.0	34.39	3.4	3.36	passed
1893-1917	25	18	72.0	30.11	3.0	4.80	passed
1918-1942	25	20	80.0	23.74	2.4	3.50	passed
1943-1967	25	17	68.0	21.07	2.1	1.39	failed
1968-1992	25	20	80.0	105.34	10.5	2.27	passed

Figure 1: Evolution of the January effect



Note: The scale is from 0 to 4, where 0 is total absence of anomaly and 4 is the most convincing presence of anomaly

Summarising all previous results in Figure 1 we conclude that the January effect appeared at the beginning of the 20<sup>th</sup> century and was most prevalent in the 1940s until the 1960s. However, the January effect has since disappeared with January returns in many cases are not positive, and when they are positive they do not differ statistically from the average returns in other months. Furthermore, it is now impossible to generate profits from trading based on this anomaly (at least with stable results which will differ from random).

## 5 Conclusion

This paper examined various monthly anomalies (January effect, December effect, and the Mark Twain effect) in the US over the entire history of the market using various methods (average analysis, the Student's t-test and ANOVA, Kruskal-Wallis and Mann-Whitney tests, and the trading simulation approach). This paper sought to investigate how these calendar anomalies evolved over time, to test whether stock markets were inefficient in the past and present, and could these inefficiencies be exploited for profit.

The results show that the January effect was the most prevalent of the three anomalies. That in fact, the December effect and the Mark Twain effect were never prevalent in the US. Furthermore, the January effect was most prevalent in the middle of the 20<sup>th</sup> century but has since disappeared. The January effect indeed created opportunities for market participants to profit. Combined with similar results from comparable stock

markets this confirms that the January effect existed in these markets and is not just a market legend. Therefore, this market behaviour is more consistent with the Adaptive Market Hypothesis (AMH) in that the US market has evolved from being inefficient to efficient.

Our results are consistent with the existing literature. The fact that a complete history of the various markets was used adds weight to the work of [Marquering et al. \(2006\)](#), [Perez \(2018\)](#) and [Rossi & Gunardi \(2018\)](#), amongst others, who in the main highlighted the disappearance of anomalies over time. Or in other words, that markets evolve to become more efficient. Furthermore, our results confirm the prominence of the January effect which has been a recurring theme in the literature (see [Patel \(2016\)](#), [Haugen & Lakonishok \(1988\)](#), [Jacobsen et al. \(2005\)](#), amongst others). Although this study did not directly test for the reasons behind the prominence of the January effect, there is no reason to doubt the key explanations in the literature (such as tax loss selling ([Wachtel \(1942\)](#)) and window dressing ([Haugen & Lakonishok \(1988\)](#))) given the congruency of our results to the literature.

However, given that recent evidence of the December effect was Canada and the Mark Twain effect in the UK, market efficiency from a practical perspective remains interesting. That is, opportunities to exploit these anomalies still exist. This is of interest to practitioners who can exploit these opportunities, but also to academics who can challenge the conventional wisdom that less efficient markets are only found in emerging countries.

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# Appendices

## A History of month of the year effect in the US stock market

Table 8: Average returns

Month	1791-1815	1816-1840	1841-1865	1866-1890	1891-1915	1916-1940	1941-1965	1966-1990	1991-2015
January	-0.44	-0.06	-1.47	0.75	1.59	1.70	1.81	1.71	1.03
February	-0.39	0.18	2.04	0.32	-0.18	0.18	0.07	0.60	0.72
March	0.17	0.10	1.45	-0.21	-0.31	-0.06	0.54	0.70	0.41
April	0.16	0.18	-0.45	-0.12	1.17	-1.26	1.05	1.06	1.29
May	0.02	0.18	1.31	0.13	-1.09	-0.48	0.80	0.09	1.13
June	0.41	0.83	0.36	-0.26	-0.35	-0.59	0.40	0.69	0.01
July	-0.29	-1.23	-1.06	0.56	-0.72	2.76	1.70	-0.28	0.24
August	0.19	0.72	0.33	0.65	1.43	2.05	0.36	0.01	-0.23
September	0.19	0.72	0.33	0.65	1.43	2.05	0.36	0.01	-0.23
October	0.19	-0.24	-0.65	-0.44	-0.25	-2.05	0.48	0.01	-0.19
November	-0.16	-0.88	0.01	-0.14	0.83	-0.81	0.67	-0.06	1.82
December	0.24	-0.05	0.73	0.00	-0.17	-1.64	1.18	0.74	1.29

Figure 2: Average returns

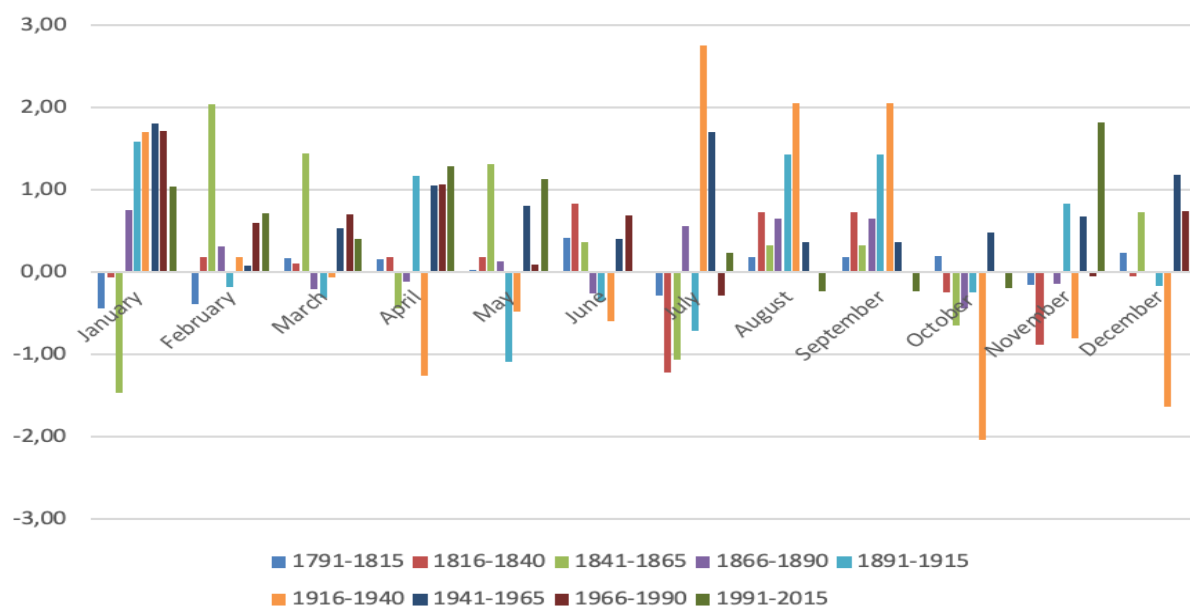


Table 9: ANOVA test of the month of the year effect

Month	1791-1815	1816-1840	1841-1865	1866-1890	1891-1915	1916-1940	1941-1965	1966-1990	1991-2015
January	not	not	not	not	confirmed	confirmed	confirmed	not	not
February	confirmed	confirmed	confirmed	confirmed	not	not	not	confirmed	confirmed
	not	not	confirmed	not				not	not
March	confirmed	confirmed	not	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed
	not	not		not	not	not	not	not	not
April	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed
	not	not	not	not	not	not	not	not	not
May	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed
	not	not	not	not	not	not	not	not	not
June	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed
	not	not	not	not	not	not	not	not	not
July	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed
	not	not	not	not	not	not	not	not	not
August	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed
	not	not	not	not	not	not	not	not	not
September	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed
	not	not	not	not	not	not	not	not	not
October	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed
	not	not	not	not	not	not	not	not	not
November	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed
	not	not	not	not	not	not	not	not	not
December	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed
	not	not	not	not	not	not	not	not	not

Table 10: T-test of the month of the year effect

Month	1791-1815	1816-1840	1841-1865	1866-1890	1891-1915	1916-1940	1941-1965	1966-1990	1991-2015
January	not	not	not	not	confirmed	confirmed	confirmed	not	not
February	confirmed	confirmed	confirmed	confirmed	not	not	not	confirmed	confirmed
	not	not	confirmed	not				not	not
March	confirmed	confirmed	not	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed
	not	not		not	not	not	not	not	not
April	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed
	not	not	not	not	not	not	not	not	not
May	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed
	not	not	not	not	not	not	not	not	not
June	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed
	not	not	not	not	not	not	not	not	not
July	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed
	not	not	not	not	not	not	not	not	not
August	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed
	not	not	not	not	not	not	not	not	not
September	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed
	not	not	not	not	not	not	not	not	not
October	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed
	not	not	not	not	not	not	not	not	not
November	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed
	not	not	not	not	not	not	not	not	not
December	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed
	not	not	not	not	not	not	not	not	not

Table 11: Mann-Whitney test of the month of the year effect

Month	1791-1815	1816-1840	1841-1865	1866-1890	1891-1915	1916-1940	1941-1965	1966-1990	1991-2015
January	not	not	confirmed	not	confirmed	confirmed	confirmed	not	not
February	confirmed	confirmed	confirmed	confirmed	not	not	not	confirmed	confirmed
March	not	not	not	not	confirmed	confirmed	confirmed	not	not
April	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed
May	not	not	not	not	not	not	not	not	not
June	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed
July	not	confirmed	not	not	not	confirmed	not	not	not
August	confirmed	not	confirmed	confirmed	confirmed	not	confirmed	confirmed	confirmed
September	not	not	not	not	not	confirmed	not	not	not
October	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed
November	not	not	not	not	not	not	not	not	not
December	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed

## B Supplementary Appendices

### B.1 History of month of the year effect in the Canadian stock market (full results)

Table 12: Average returns

Month	1915-1939	1940-1964	1965-1989	1990-2014
January	2.48	1.84	2.59	0.57
February	1.10	-0.23	0.67	0.74
March	-0.61	0.40	0.33	0.54
April	-0.16	1.08	0.37	0.63
May	-0.95	-0.14	-0.39	1.59
June	-0.80	-0.07	-0.20	-0.72
July	1.37	1.32	0.96	0.62
August	0.92	0.31	0.91	-0.34
September	0.92	0.31	0.91	-0.34
October	-1.20	-0.31	-2.02	0.58
November	0.20	0.83	1.69	0.52
December	-0.38	1.18	2.14	2.06

Figure 3: Average returns

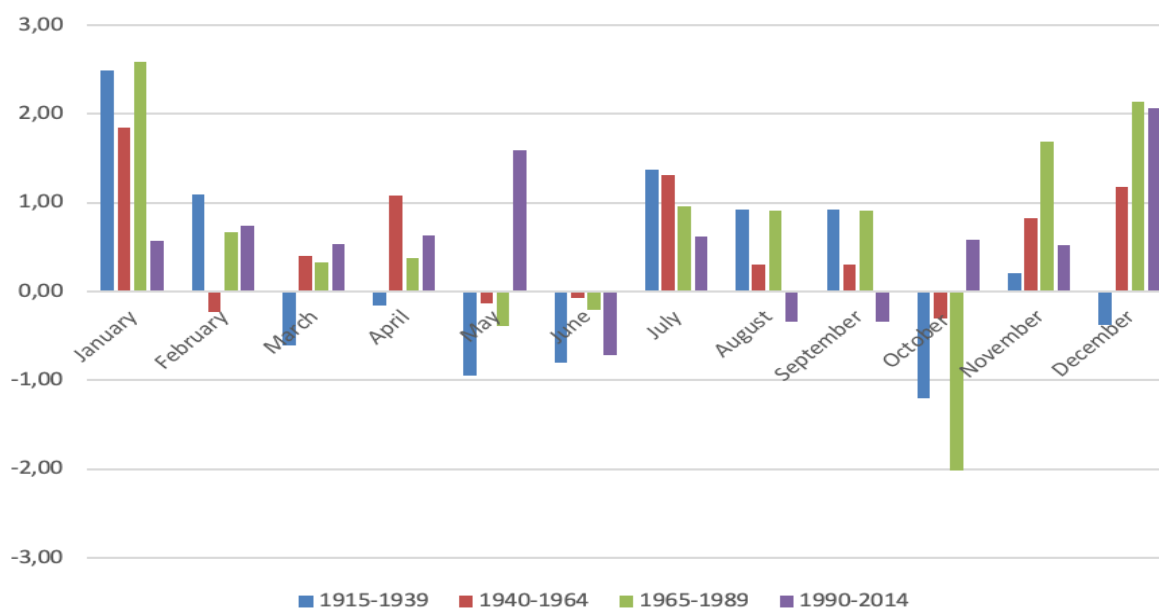


Table 13: ANOVA test of the month of the year effect

Parameter	All	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1915-1939													
F	0.91	10.32	1.72	1.36	0.15	0.43	0.69	1.69	0.58	0.03	1.04	0.00	0.45
p-value	0.59	0.00	0.20	0.25	0.70	0.52	0.41	0.20	0.45	0.86	0.31	0.99	0.51
F critical	1.55	4.04	4.04	4.04	4.04	4.04	4.04	4.04	4.04	4.04	4.04	4.04	4.04
Null hypothesis	not rejected	rejected	not rejected	not rejected	not rejected	not rejected	not rejected	not rejected	not rejected	not rejected	not rejected	not rejected	not rejected
Anomaly	not confirmed	confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
Anova multiplier	0.59	2.55	0.43	0.34	0.04	0.11	0.17	0.42	0.14	0.01	0.26	0.00	0.11
1940-1964													
F	0.88	4.92	1.06	0.04	0.79	0.45	0.34	1.56	0.06	0.76	1.77	0.25	1.25
p-value	0.63	0.03	0.31	0.85	0.38	0.51	0.56	0.22	0.81	0.39	0.19	0.62	0.27
F critical	1.55	4.04	4.04	4.04	4.04	4.04	4.04	4.04	4.04	4.04	4.04	4.04	4.04
Null hypothesis	not rejected	rejected	not rejected	not rejected	not rejected	not rejected	not rejected	not rejected	not rejected	not rejected	not rejected	not rejected	not rejected
Anomaly	not confirmed	confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
Anova multiplier	0.57	1.22	0.26	0.01	0.20	0.11	0.08	0.38	0.01	0.19	0.44	0.06	0.31
1965-1989													
F	1.64	3.48	0.06	0.03	0.03	1.60	0.39	0.34	0.15	2.88	3.88	1.60	4.87
p-value	0.03	0.07	0.81	0.86	0.86	0.21	0.54	0.56	0.70	0.10	0.05	0.21	0.03
F critical	1.55	4.04	4.04	4.04	4.04	4.04	4.04	4.04	4.04	4.04	4.04	4.04	4.04
Null hypothesis	not rejected	rejected	not rejected	not rejected	not rejected	not rejected	not rejected	not rejected	not rejected	not rejected	not rejected	not rejected	not rejected
Anomaly	not confirmed	confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
Anova multiplier	1.06	0.86	0.01	0.01	0.01	0.40	0.10	0.08	0.04	0.71	0.96	0.40	1.21
1990-2014													
F	1.10	0.04	0.11	0.02	0.08	2.38	2.43	0.07	0.54	4.03	0.02	0.01	8.52
p-value	0.35	0.85	0.74	0.89	0.78	0.13	0.13	0.79	0.47	0.05	0.02	0.92	0.01
F critical	1.55	4.04	4.04	4.04	4.04	4.04	4.04	4.04	4.04	4.04	4.04	4.04	4.04
Null hypothesis	not rejected	rejected	not rejected	not rejected	not rejected	not rejected	not rejected	not rejected	not rejected	not rejected	not rejected	not rejected	not rejected
Anomaly	not confirmed	confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
Anova multiplier	0.71	0.01	0.03	0.01	0.02	0.59	0.60	0.02	0.13	1.00	0.00	0.00	2.11

Table 14: Mann-Whitney test of the month of the year effect

Parameter	All	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1915-1939													
Adjusted H	20.15	8.87	1.52	0.53	0.14	0.13	2.38	0.62	0.01	0.96	0.03	0.04	0.33
d.f.	11.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P value	0.04	0.00	0.22	0.47	0.71	0.72	0.12	0.43	0.92	0.33	0.85	0.84	0.57
Null hypothesis	rejected	rejected	not	not	not	not	not	not	not	not	not	not	not
Anomaly	confirmed	confirmed	rejected	rejected	rejected	confirmed	rejected	rejected	rejected	rejected	rejected	rejected	rejected
			confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed
1940-1964													
Adjusted H	10.92	4.11	1.29	0.68	0.06	0.24	0.00	1.92	0.47	0.03	0.35	1.62	1.87
d.f.	11.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P value	0.45	0.04	0.26	0.41	0.81	0.62	0.98	0.17	0.49	0.87	0.55	0.20	0.17
Null hypothesis	not	rejected	not	not	not	not	not	not	not	not	not	not	not
Anomaly	not	confirmed	rejected	rejected	rejected	confirmed	rejected	rejected	rejected	rejected	rejected	rejected	rejected
	confirmed		confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed
1965-1989													
Adjusted H	16.73	2.20	0.26	0.00	0.50	0.40	0.23	0.04	0.13	2.32	3.36	2.75	5.38
d.f.	11.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P value	0.12	0.14	0.61	0.95	0.48	0.53	0.63	0.84	0.72	0.13	0.07	0.10	0.02
Null hypothesis	not	not	not	not	not	not	not	not	not	not	not	not	not
Anomaly	not	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected
	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed
1990-2014													
Adjusted H	13.68	0.40	1.00	0.00	0.06	2.88	2.32	1.04	0.00	0.92	0.85	0.56	11.20
d.f.	11.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P value	0.25	0.53	0.32	0.99	0.81	0.09	0.13	0.31	0.98	0.34	0.36	0.46	0.00
Null hypothesis	not	not	not	not	not	not	not	not	not	not	not	not	not
Anomaly	not	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected
	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed



Table 15: T-test of the month of the year effect

Month	aver	month sigma	aver	excl-month sigma	t-test	Null hypothesis	Anomaly
1915-1939							
January	-0.02	2.17	2.48	3.23	3.79	rejected	confirmed
February	0.11	2.16	1.10	3.08	1.57	not rejected	not confirmed
March	0.27	2.23	-0.61	3.04	-1.41	not rejected	not confirmed
April	0.23	2.06	-0.16	4.52	-0.43	not rejected	not confirmed
May	0.29	1.76	-0.95	9.34	-0.66	not rejected	not confirmed
June	0.06	2.15	-0.80	4.72	-0.90	not rejected	not confirmed
July	0.08	2.33	1.37	4.38	1.45	not rejected	not confirmed
August	0.12	2.37	0.92	4.68	0.84	not rejected	not confirmed
September	0.17	2.16	0.92	4.68	0.80	not rejected	not confirmed
October	0.31	2.07	-1.20	7.12	-1.06	not rejected	not confirmed
November	0.19	2.19	0.20	5.68	0.01	not rejected	not confirmed
December	0.24	2.14	-0.38	4.09	-0.75	not rejected	not confirmed
1940-1964							
January	0.37	1.32	1.84	3.04	2.40	rejected	confirmed
February	0.56	1.27	-0.23	3.59	-1.08	not rejected	not confirmed
March	0.50	1.39	0.40	2.43	-0.21	not rejected	not confirmed
April	0.44	1.30	1.08	3.36	0.95	not rejected	not confirmed
May	0.55	1.18	-0.14	5.00	-0.69	not rejected	not confirmed
June	0.41	1.27	-0.07	3.94	-0.61	not rejected	not confirmed
July	0.42	1.42	1.32	3.32	1.34	not rejected	not confirmed
August	0.51	1.35	0.31	3.84	-0.26	not rejected	not confirmed
September	0.56	1.30	0.31	3.84	-0.33	not rejected	not confirmed
October	0.56	1.31	-0.31	3.01	-1.44	not rejected	not confirmed
November	0.46	1.47	0.83	3.35	0.55	not rejected	not confirmed
December	0.43	1.26	1.18	3.13	1.19	not rejected	not confirmed
1965-1989							
January	0.32	1.29	2.59	5.93	1.90	not rejected	not confirmed
February	0.50	1.32	0.67	3.30	0.26	not rejected	not confirmed
March	0.53	1.46	0.33	5.38	-0.18	not rejected	not confirmed
April	0.53	1.12	0.37	4.12	-0.19	not rejected	not confirmed
May	0.59	1.17	-0.39	3.71	-1.32	not rejected	not confirmed
June	0.38	1.33	-0.20	4.48	-0.65	not rejected	not confirmed
July	0.47	1.37	0.96	3.93	0.62	not rejected	not confirmed
August	0.48	1.21	0.91	5.53	0.40	not rejected	not confirmed
September	0.64	1.23	0.91	5.53	0.25	not rejected	not confirmed
October	0.74	1.66	-2.02	6.81	-2.02	not rejected	not confirmed
November	0.41	1.22	1.69	4.92	1.30	not rejected	not confirmed
December	0.36	1.35	2.14	3.78	2.33	rejected	confirmed
1990-2014							
January	0.42	1.48	0.57	3.57	0.20	not rejected	not confirmed
February	0.41	1.58	0.74	4.74	0.34	not rejected	not confirmed
March	0.43	1.43	0.54	3.57	0.15	not rejected	not confirmed
April	0.42	1.45	0.63	3.52	0.30	not rejected	not confirmed
May	0.33	1.57	1.59	3.78	1.66	not rejected	not confirmed
June	0.54	1.51	-0.72	3.74	-1.67	not rejected	not confirmed
July	0.42	1.36	0.62	3.53	0.29	not rejected	not confirmed
August	0.51	1.47	-0.34	5.55	-0.76	not rejected	not confirmed
September	0.62	1.22	-0.34	5.55	-0.86	not rejected	not confirmed
October	0.42	1.37	0.58	5.75	0.14	not rejected	not confirmed
November	0.43	1.49	0.52	4.27	0.11	not rejected	not confirmed
December	0.29	1.42	2.06	2.68	3.26	rejected	confirmed

## B.2 History of month of the year effect in the Canadian stock market (aggregated results)

Table 16: Average returns

Month	1915-1939	1940-1964	1965-1989	1990-2014
January	2.48	1.84	2.59	0.57
February	1.10	-0.23	0.67	0.74
March	-0.61	0.40	0.33	0.54
April	-0.16	1.08	0.37	0.63
May	-0.95	-0.14	-0.39	1.59
June	-0.80	-0.07	-0.20	-0.72
July	1.37	1.32	0.96	0.62
August	0.92	0.31	0.91	-0.34
September	0.92	0.31	0.91	-0.34
October	-1.20	-0.31	-2.02	0.58
November	0.20	0.83	1.69	0.52
December	-0.38	1.18	2.14	2.06

Figure 4: Average returns

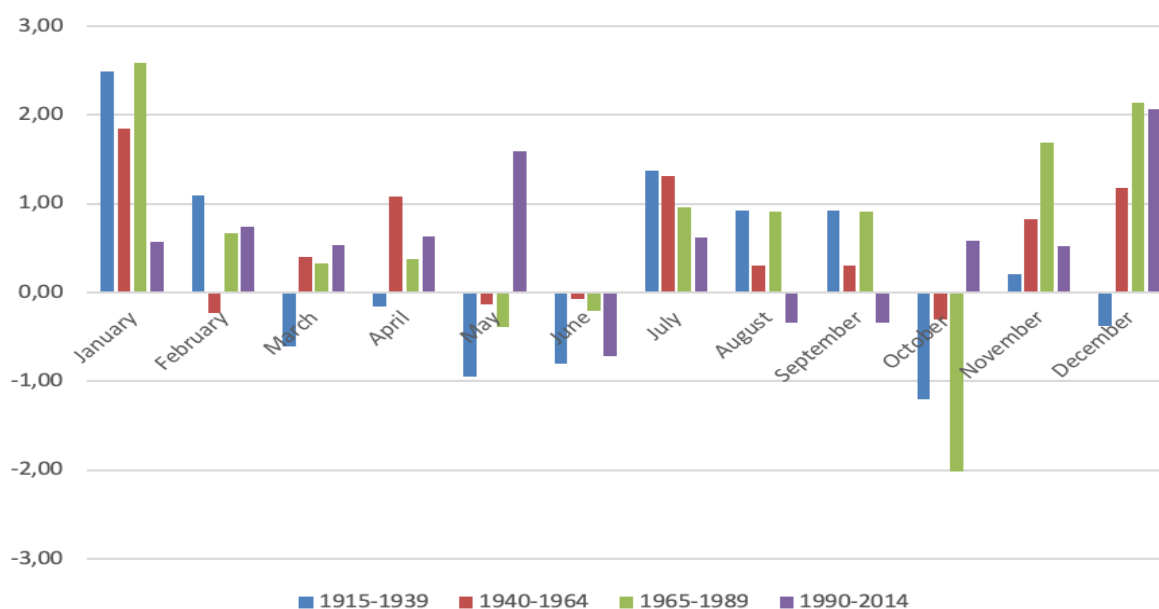


Table 17: ANOVA test of the month of the year effect

Month	1915-1939	1940-1964	1965-1989	1990-2014
January	confirmed	confirmed	not confirmed	not confirmed
February	not confirmed	not confirmed	not confirmed	not confirmed
March	not confirmed	not confirmed	not confirmed	not confirmed
April	not confirmed	not confirmed	not confirmed	not confirmed
May	not confirmed	not confirmed	not confirmed	not confirmed
June	not confirmed	not confirmed	not confirmed	not confirmed
July	not confirmed	not confirmed	not confirmed	not confirmed
August	not confirmed	not confirmed	not confirmed	not confirmed
September	not confirmed	not confirmed	not confirmed	not confirmed
October	not confirmed	not confirmed	not confirmed	not confirmed
November	not confirmed	not confirmed	not confirmed	not confirmed
December	not confirmed	not confirmed	confirmed	confirmed

Table 18: Mann-Whitney test of the month of the year effect

Month	1915-1939	1940-1964	1965-1989	1990-2014
January	confirmed	confirmed	not confirmed	not confirmed
February	not confirmed	not confirmed	not confirmed	not confirmed
March	not confirmed	not confirmed	not confirmed	not confirmed
April	not confirmed	not confirmed	not confirmed	not confirmed
May	not confirmed	not confirmed	not confirmed	not confirmed
June	not confirmed	not confirmed	not confirmed	not confirmed
July	not confirmed	not confirmed	not confirmed	not confirmed
August	not confirmed	not confirmed	not confirmed	not confirmed
September	not confirmed	not confirmed	not confirmed	not confirmed
October	not confirmed	not confirmed	not confirmed	not confirmed
November	not confirmed	not confirmed	not confirmed	not confirmed
December	not confirmed	not confirmed	confirmed	confirmed

Table 19: T-test of the month of the year effect

Month	1915-1939	1940-1964	1965-1989	1990-2014
January	confirmed	confirmed	not confirmed	not confirmed
February	not confirmed	not confirmed	not confirmed	not confirmed
March	not confirmed	not confirmed	not confirmed	not confirmed
April	not confirmed	not confirmed	not confirmed	not confirmed
May	not confirmed	not confirmed	not confirmed	not confirmed
June	not confirmed	not confirmed	not confirmed	not confirmed
July	not confirmed	not confirmed	not confirmed	not confirmed
August	not confirmed	not confirmed	not confirmed	not confirmed
September	not confirmed	not confirmed	not confirmed	not confirmed
October	not confirmed	not confirmed	not confirmed	not confirmed
November	not confirmed	not confirmed	not confirmed	not confirmed
December	not confirmed	not confirmed	confirmed	confirmed

## B.3 History of month of the year effect in the French stock market

Table 20: Average returns

Month	1898-1922	1923-1947	1948-1972	1973-1997	1998-2018
January	1.47	3.28	2.96	2.85	0.24
February	0.50	0.95	0.53	1.99	0.22
March	0.38	-0.73	0.62	1.91	1.55
April	0.22	0.69	1.14	2.73	2.19
May	-0.52	-1.12	-0.70	-0.84	0.32
June	-1.43	0.29	-1.64	-1.84	-1.71
July	0.49	0.18	1.31	0.90	0.16
August	1.69	2.77	2.95	0.96	-1.16
September	1.69	2.77	2.95	0.96	-1.16
October	-0.29	0.89	-0.70	-1.31	2.26
November	0.38	0.21	-0.57	0.73	1.01
December	-0.32	2.26	0.64	1.27	1.27

Figure 5: Average returns

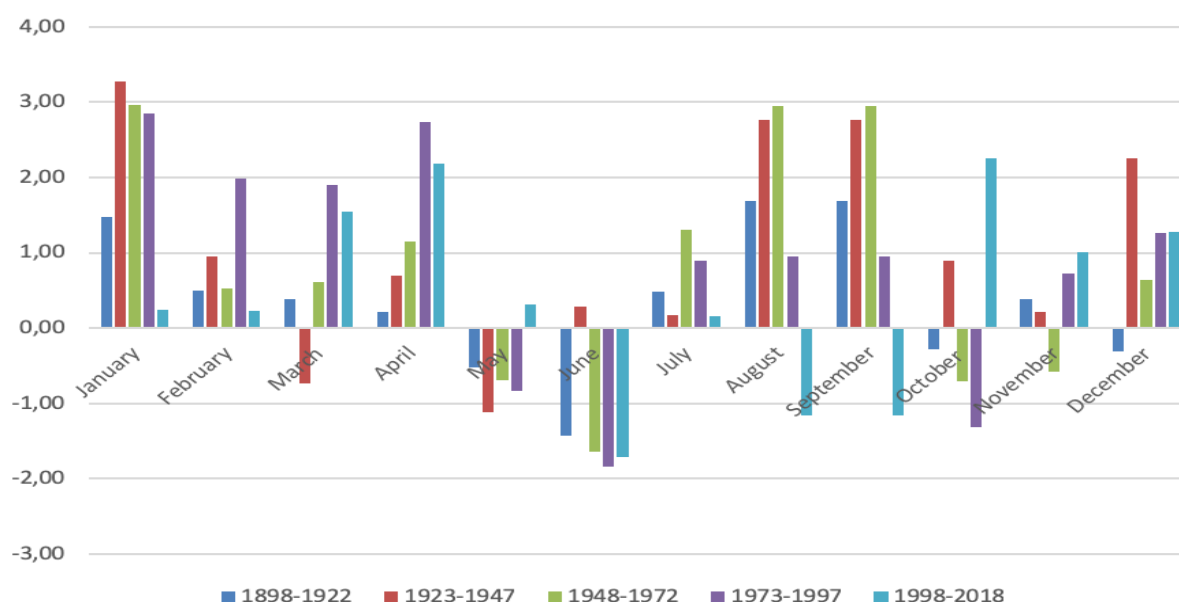


Table 21: ANOVA test of the month of the year effect

Month	1898-1922	1923-1947	1948-1972	1973-1997	1998-2018
January	not confirmed	not confirmed	confirmed	not confirmed	not confirmed
February	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
March	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
April	not confirmed	not confirmed	not confirmed	confirmed	not confirmed
May	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
June	confirmed	not confirmed	confirmed	confirmed	confirmed
July	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
August	confirmed	not confirmed	confirmed	not confirmed	not confirmed
September	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
October	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
November	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
December	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed

Table 22: T-test of the month of the year effect

Month	1898-1922	1923-1947	1948-1972	1973-1997	1998-2018
January	not confirmed	not confirmed	confirmed	not confirmed	not confirmed
February	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
March	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
April	not confirmed	not confirmed	not confirmed	confirmed	confirmed
May	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
June	confirmed	not confirmed	confirmed	confirmed	confirmed
July	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
August	confirmed	not confirmed	confirmed	not confirmed	not confirmed
September	confirmed	not confirmed	confirmed	not confirmed	not confirmed
October	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
November	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
December	confirmed	not confirmed	not confirmed	not confirmed	not confirmed

Table 23: Mann-Whitney test of the month of the year effect

Month	1898-1922	1923-1947	1948-1972	1973-1997	1998-2018
January	not confirmed	not confirmed	confirmed	confirmed	not confirmed
February	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
March	not confirmed	confirmed	not confirmed	not confirmed	not confirmed
April	not confirmed	not confirmed	not confirmed	confirmed	confirmed
May	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
June	confirmed	not confirmed	confirmed	confirmed	not confirmed
July	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
August	confirmed	not confirmed	confirmed	not confirmed	not confirmed
September	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
October	not confirmed	not confirmed	confirmed	not confirmed	not confirmed
November	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
December	confirmed	not confirmed	not confirmed	not confirmed	not confirmed

## B.4 History of month of the year effect in the German stock market

Table 24: Average returns

Month	1870-1894	1895-1919	1920-1944	1945-1969	1970-1994	1994-2018
January	-0.52	1.14	4.19	2.03	1.41	0.44
February	0.72	0.38	1.17	0.31	1.32	0.43
March	0.24	-0.47	-0.11	-0.60	1.63	0.73
April	-0.61	-0.47	1.22	1.37	0.54	2.21
May	-0.44	0.08	-2.02	-0.21	-1.72	-0.09
June	0.10	-0.52	1.49	0.57	0.43	-0.36
July	-0.07	-0.83	-0.44	-5.10	0.81	0.83
August	2.52	0.02	-2.89	2.41	0.28	-2.48
September	2.52	0.02	-2.89	2.41	0.28	-2.48
October	-0.72	-1.14	-1.64	1.25	-0.08	1.94
November	-1.31	-2.36	0.20	1.67	0.03	2.00
December	1.17	-1.49	2.53	1.02	1.11	1.76

Figure 6: Average returns

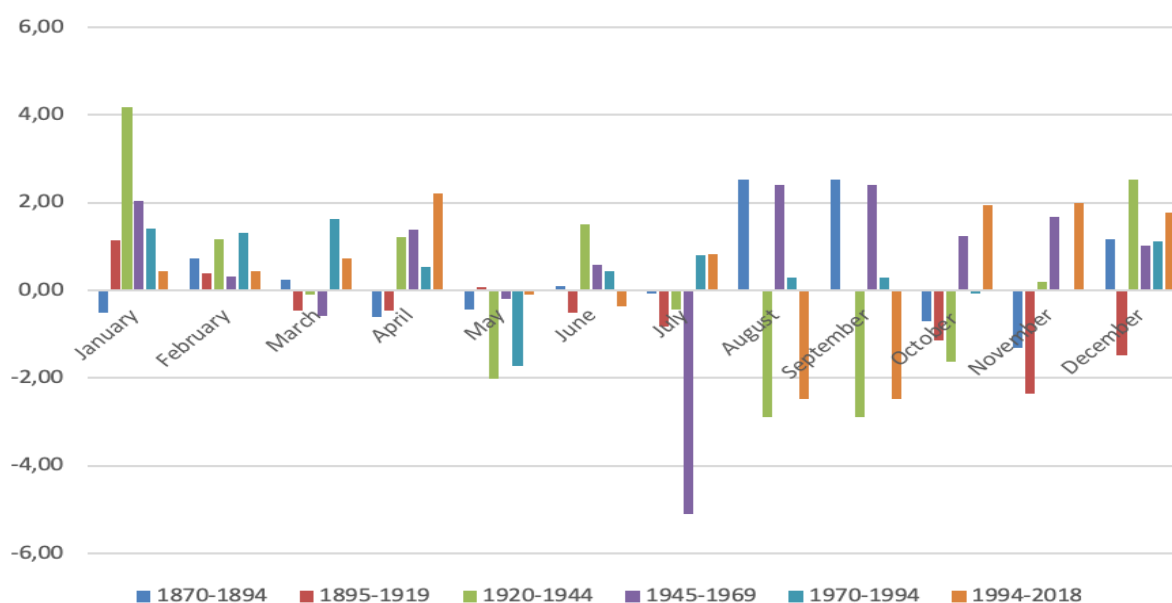


Table 25: ANOVA test of the month of the year effect

Month	1870-1894	1895-1919	1920-1944	1945-1969	1970-1994	1994-2018
January	not confirmed	confirmed	confirmed	not confirmed	not confirmed	not confirmed
February	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
March	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
April	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	confirmed
May	not confirmed	not confirmed	not confirmed	not confirmed	confirmed	not confirmed
June	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
July	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
August	confirmed	not confirmed	not confirmed	not confirmed	not confirmed	confirmed
September	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	confirmed
October	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
November	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	confirmed
December	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed

Table 26: T-test of the month of the year effect

Month	1870-1894	1895-1919	1920-1944	1945-1969	1970-1994	1994-2018
January	not confirmed	confirmed	confirmed	confirmed	not confirmed	not confirmed
February	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
March	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
April	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
May	not confirmed	not confirmed	not confirmed	not confirmed	confirmed	not confirmed
June	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
July	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
August	confirmed	not confirmed	not confirmed	not confirmed	not confirmed	confirmed
September	confirmed	not confirmed	not confirmed	not confirmed	not confirmed	confirmed
October	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
November	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
December	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed

Table 27: Mann-Whitney test of the month of the year effect

Month	1870-1894	1895-1919	1920-1944	1945-1969	1970-1994	1994-2018
January	not confirmed	not confirmed	confirmed	not confirmed	not confirmed	not confirmed
February	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
March	not confirmed	not confirmed	not confirmed	confirmed	not confirmed	not confirmed
April	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
May	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
June	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
July	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
August	confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
September	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
October	not confirmed	not confirmed	confirmed	not confirmed	not confirmed	not confirmed
November	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	confirmed
December	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	confirmed

## B.5 History of month of the year effect in the Italian stock market

Table 28: Average returns

Month	1905-1929	1930-1954	1955-1979	1980-2004	2005-2018
January	1.33	1.50	2.29	4.77	0.59
February	1.49	0.53	0.78	2.75	-0.93
March	-1.46	-0.14	-0.34	1.84	1.45
April	-0.79	1.63	-0.04	2.44	2.38
May	0.20	2.77	-1.09	-0.84	-1.55
June	-1.69	-0.10	-0.25	-1.77	-3.70
July	0.01	0.10	-0.37	0.85	1.28
August	0.74	3.62	2.38	0.56	-0.59
September	0.74	3.62	2.38	0.56	-0.59
October	-1.58	0.16	-1.12	0.52	0.14
November	0.23	0.37	-0.11	1.49	-1.41
December	0.74	2.96	-0.44	1.92	1.04

Figure 7: Average returns

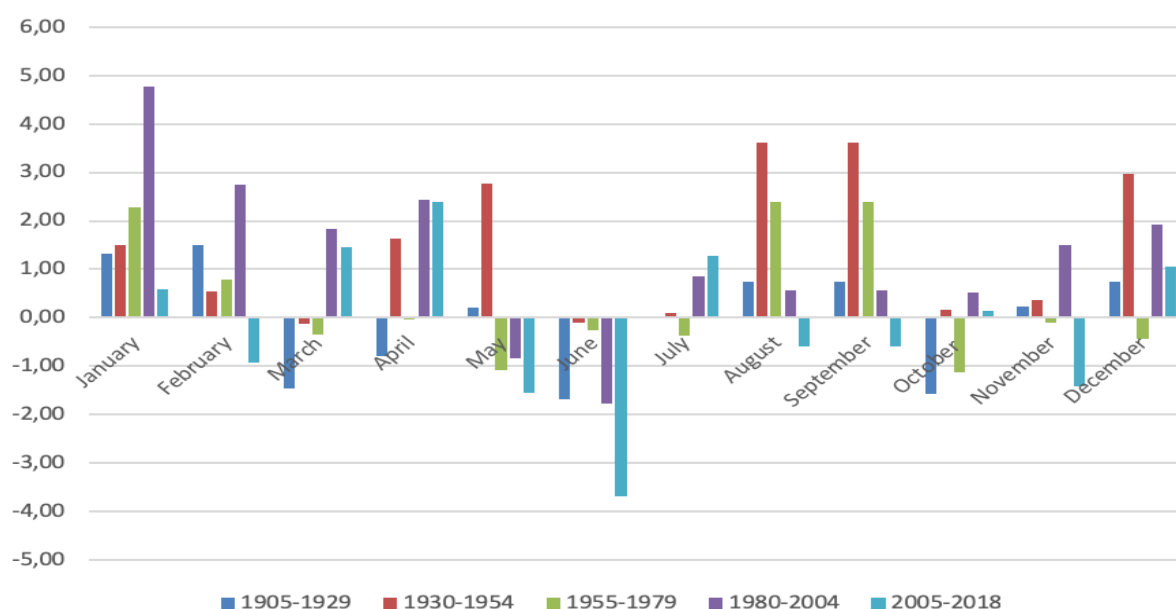


Table 29: ANOVA test of the month of the year effect

Month	1905-1929	1930-1954	1955-1979	1980-2004	2005-2018
January	not confirmed	not confirmed	confirmed	confirmed	not confirmed
February	confirmed	not confirmed	not confirmed	not confirmed	not confirmed
March	confirmed	not confirmed	not confirmed	not confirmed	not confirmed
April	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
May	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
June	not confirmed	not confirmed	not confirmed	not confirmed	confirmed
July	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
August	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
September	not confirmed	not confirmed	not confirmed	confirmed	not confirmed
October	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
November	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
December	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed



Table 30: T-test of the month of the year effect

Month	1905-1929	1930-1954	1955-1979	1980-2004	2005-2018
January	not confirmed	not confirmed	confirmed	confirmed	not confirmed
February	confirmed	not confirmed	not confirmed	not confirmed	not confirmed
March	confirmed	not confirmed	not confirmed	not confirmed	confirmed
April	not confirmed	not confirmed	not confirmed	not confirmed	confirmed
May	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
June	not confirmed	not confirmed	not confirmed	not confirmed	confirmed
July	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
August	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
September	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
October	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
November	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
December	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed

Table 31: Mann-Whitney test of the month of the year effect

Month	1905-1929	1930-1954	1955-1979	1980-2004	2005-2018
January	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
February	confirmed	not confirmed	not confirmed	not confirmed	not confirmed
March	confirmed	confirmed	not confirmed	not confirmed	not confirmed
April	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
May	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
June	not confirmed	not confirmed	not confirmed	not confirmed	confirmed
July	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
August	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
September	not confirmed	not confirmed	not confirmed	confirmed	not confirmed
October	confirmed	not confirmed	not confirmed	not confirmed	not confirmed
November	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
December	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed

## B.6 History of month of the year effect in the Japanese stock market

Table 32: Average returns

Month	1914-1938	1939-1963	1964-1988	1989-2013
January	3.72	6.69	3.42	-0.05
February	1.31	1.41	1.02	0.39
March	-1.86	0.66	2.57	0.35
April	-2.28	1.82	0.82	1.35
May	-0.18	0.26	0.44	-0.55
June	-1.73	0.33	1.51	-0.73
July	0.92	0.47	-0.23	-0.34
August	0.57	2.10	0.36	-1.88
September	0.57	2.10	0.36	-1.88
October	-1.46	-0.53	-0.07	-1.00
November	1.55	1.08	1.06	0.16
December	1.10	0.44	1.89	1.62

Figure 8: Average returns

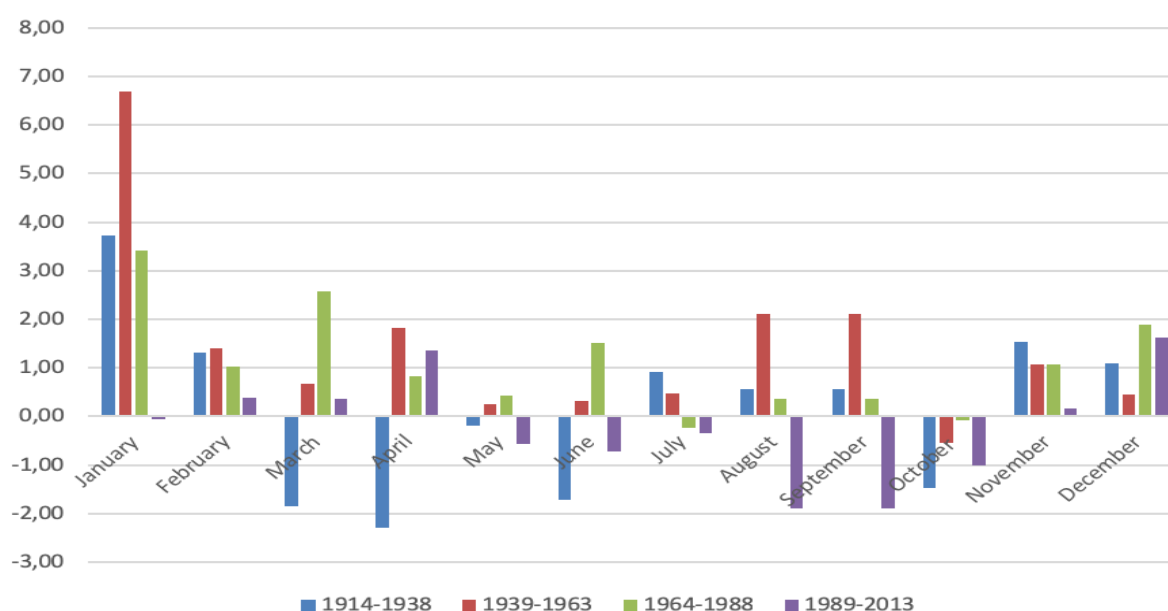


Table 33: ANOVA test of the month of the year effect

Month	1914-1938	1939-1963	1964-1988	1989-2013
January	confirmed	confirmed	confirmed	not confirmed
February	not confirmed	not confirmed	not confirmed	not confirmed
March	confirmed	not confirmed	not confirmed	not confirmed
April	not confirmed	not confirmed	not confirmed	not confirmed
May	not confirmed	not confirmed	not confirmed	not confirmed
June	not confirmed	not confirmed	not confirmed	not confirmed
July	not confirmed	not confirmed	not confirmed	not confirmed
August	not confirmed	not confirmed	not confirmed	not confirmed
September	not confirmed	not confirmed	not confirmed	not confirmed
October	not confirmed	not confirmed	not confirmed	not confirmed
November	not confirmed	not confirmed	not confirmed	not confirmed
December	not confirmed	not confirmed	not confirmed	not confirmed

Table 34: T-test of the month of the year effect

Month	1914-1938	1939-1963	1964-1988	1989-2013
January	confirmed	confirmed	confirmed	not confirmed
February	not confirmed	not confirmed	not confirmed	not confirmed
March	confirmed	not confirmed	not confirmed	not confirmed
April	not confirmed	not confirmed	not confirmed	not confirmed
May	not confirmed	not confirmed	not confirmed	not confirmed
June	not confirmed	not confirmed	not confirmed	not confirmed
July	not confirmed	not confirmed	confirmed	not confirmed
August	not confirmed	not confirmed	not confirmed	not confirmed
September	not confirmed	not confirmed	not confirmed	not confirmed
October	not confirmed	not confirmed	not confirmed	not confirmed
November	not confirmed	not confirmed	not confirmed	not confirmed
December	not confirmed	not confirmed	not confirmed	not confirmed

Table 35: Mann-Whitney test of the month of the year effect

Month	1914-1938	1939-1963	1964-1988	1989-2013
January	confirmed	confirmed	confirmed	not confirmed
February	not confirmed	not confirmed	not confirmed	not confirmed
March	confirmed	not confirmed	not confirmed	not confirmed
April	not confirmed	not confirmed	not confirmed	not confirmed
May	not confirmed	not confirmed	not confirmed	not confirmed
June	not confirmed	not confirmed	not confirmed	not confirmed
July	not confirmed	not confirmed	confirmed	not confirmed
August	not confirmed	not confirmed	not confirmed	not confirmed
September	not confirmed	not confirmed	not confirmed	not confirmed
October	not confirmed	not confirmed	not confirmed	not confirmed
November	not confirmed	not confirmed	not confirmed	not confirmed
December	not confirmed	not confirmed	not confirmed	confirmed

## B.7 History of month of the year effect in the Swiss stock market

Table 36: Average returns

Month	1916-1940	1941-1965	1966-1990	1991-2015
January	-0.65	2.49	2.49	1.19
February	0.21	-0.44	-0.51	0.61
March	-0.85	-0.90	0.32	1.07
April	0.36	1.12	0.06	1.54
May	-0.41	-0.66	-1.04	0.15
June	-0.43	-0.07	0.57	-0.07
July	-0.19	1.56	0.44	0.10
August	1.85	2.13	0.58	-0.71
September	1.85	2.13	0.58	-0.71
October	-2.25	-1.12	0.06	1.43
November	0.70	0.95	-0.04	0.95
December	1.14	0.88	1.79	1.17

Figure 9: Average returns



Table 37: ANOVA test of the month of the year effect

Month	1916-1940	1941-1965	1966-1990	1991-2015
January	not confirmed	confirmed	confirmed	not confirmed
February	not confirmed	not confirmed	not confirmed	not confirmed
March	not confirmed	confirmed	not confirmed	not confirmed
April	not confirmed	not confirmed	not confirmed	not confirmed
May	not confirmed	not confirmed	not confirmed	not confirmed
June	not confirmed	not confirmed	not confirmed	not confirmed
July	not confirmed	not confirmed	not confirmed	not confirmed
August	confirmed	not confirmed	not confirmed	not confirmed
September	not confirmed	not confirmed	not confirmed	not confirmed
October	not confirmed	confirmed	not confirmed	not confirmed
November	not confirmed	not confirmed	not confirmed	not confirmed
December	not confirmed	not confirmed	confirmed	not confirmed

Table 38: T-test of the month of the year effect

Month	1916-1940	1941-1965	1966-1990	1991-2015
January	not confirmed	confirmed	confirmed	not confirmed
February	not confirmed	not confirmed	not confirmed	not confirmed
March	not confirmed	confirmed	not confirmed	not confirmed
April	not confirmed	not confirmed	not confirmed	not confirmed
May	not confirmed	not confirmed	not confirmed	not confirmed
June	not confirmed	not confirmed	not confirmed	not confirmed
July	not confirmed	not confirmed	not confirmed	not confirmed
August	confirmed	confirmed	not confirmed	not confirmed
September	confirmed	confirmed	not confirmed	not confirmed
October	not confirmed	confirmed	not confirmed	not confirmed
November	not confirmed	not confirmed	not confirmed	not confirmed
December	not confirmed	not confirmed	confirmed	not confirmed

Table 39: Mann-Whitney test of the month of the year effect

Month	1916-1940	1941-1965	1966-1990	1991-2015
January	not confirmed	confirmed	not confirmed	not confirmed
February	not confirmed	not confirmed	not confirmed	not confirmed
March	not confirmed	confirmed	not confirmed	not confirmed
April	not confirmed	not confirmed	not confirmed	not confirmed
May	not confirmed	not confirmed	not confirmed	not confirmed
June	not confirmed	not confirmed	not confirmed	not confirmed
July	not confirmed	not confirmed	not confirmed	not confirmed
August	confirmed	confirmed	not confirmed	not confirmed
September	not confirmed	not confirmed	not confirmed	not confirmed
October	confirmed	not confirmed	not confirmed	not confirmed
November	not confirmed	not confirmed	not confirmed	not confirmed
December	not confirmed	not confirmed	confirmed	not confirmed

## B.8 History of month of the year effect in the UK stock market

Figure 10: Average returns

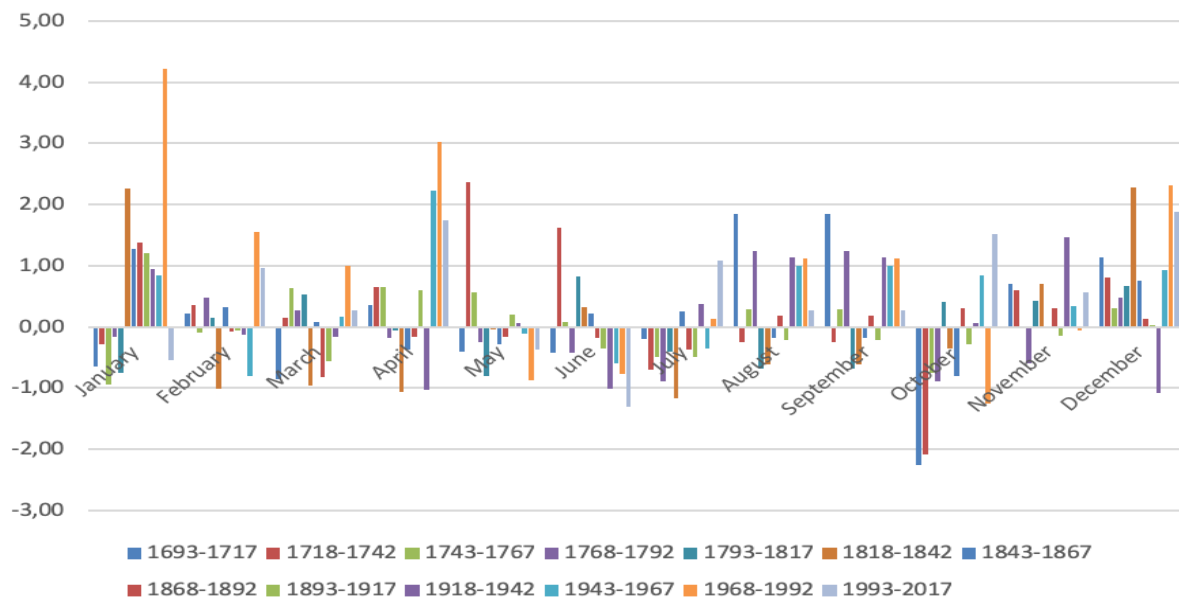


Table 40: Average returns

Month	1693-1717	1718-1742	1743-1767	1768-1792	1793-1817	1818-1842	1843-1867	1868-1892	1893-1917	1918-1942	1943-1967	1968-1992	1993-2017
January	-0.65	-0.29	-0.94	-0.16	-0.75	2.26	1.28	1.38	1.20	0.95	0.84	4.21	-0.54
February	0.21	0.36	-0.09	0.48	0.15	-1.02	0.32	-0.07	-0.06	-0.12	-0.80	1.55	0.97
March	-0.85	0.15	0.64	0.26	0.54	-0.96	0.08	-0.83	-0.56	-0.17	0.18	1.00	0.28
April	0.36	0.66	0.64	-0.18	-0.06	-1.06	-0.38	-0.17	0.60	-1.02	2.22	3.02	1.74
May	-0.41	2.36	0.57	-0.25	-0.81	-0.04	-0.29	-0.16	0.21	0.06	-0.11	-0.88	-0.38
June	-0.43	1.62	0.08	-0.42	0.82	0.32	0.22	-0.19	-0.36	-1.01	-0.60	-0.77	-1.30
July	-0.19	-0.70	-0.49	-0.89	-0.41	-1.16	0.25	-0.38	-0.50	0.37	-0.35	0.14	1.08
August	1.85	-0.24	0.30	1.25	-0.69	-0.62	-0.18	0.19	-0.21	1.13	1.00	1.12	0.27
September	1.85	-0.24	0.30	1.25	-0.69	-0.62	-0.18	0.19	-0.21	1.13	1.00	1.12	0.27
October	-2.25	-2.08	-0.75	-0.89	0.41	-0.35	-0.81	0.30	-0.29	0.07	0.85	-1.24	1.51
November	0.70	0.61	-0.02	-0.60	0.42	0.70	-0.02	0.31	-0.14	1.47	0.34	-0.06	0.56
December	1.14	0.81	0.30	0.48	0.67	2.29	0.76	0.13	0.04	-1.08	0.92	2.32	1.88

Table 41: ANOVA test of the month of the year effect

Month	1693-1717	1718-1742	1743-1767	1768-1792	1793-1817	1818-1842	1843-1867	1868-1892	1893-1917	1918-1942	1943-1967	1968-1992	1993-2017
January	not confirmed	not confirmed	confirmed	not confirmed	not confirmed	not confirmed	confirmed	confirmed	confirmed	confirmed	not confirmed	not confirmed	not confirmed
February	confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
March	not confirmed	not confirmed	confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
April	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
May	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
June	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
July	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
August	confirmed	not confirmed	confirmed	confirmed	confirmed	not confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed
September	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
October	not confirmed	not confirmed	confirmed	confirmed	confirmed	not confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed
November	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
December	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed



Table 42: T-test of the month of the year effect

Month	1693-1717	1718-1742	1743-1767	1768-1792	1793-1817	1818-1842	1843-1867	1868-1892	1893-1917	1918-1942	1943-1967	1968-1992	1993-2017
January	not confirmed	not confirmed	confirmed	not confirmed	not confirmed	not confirmed	confirmed	confirmed	confirmed	confirmed	not confirmed	not confirmed	not confirmed
February	confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
March	not confirmed	not confirmed	confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
April	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
May	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
June	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
July	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
August	confirmed	not confirmed	confirmed	confirmed	confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
September	confirmed	not confirmed	not confirmed	confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
October	not confirmed	not confirmed	confirmed	confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
November	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
December	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed

Table 43: Mann-Whitney test of the month of the year effect

Month	1693-1717	1718-1742	1743-1767	1768-1792	1793-1817	1818-1842	1843-1867	1868-1892	1893-1917	1918-1942	1943-1967	1968-1992	1993-2017
January	not confirmed	not confirmed	confirmed	not confirmed	not confirmed	not confirmed	not confirmed	confirmed	confirmed	confirmed	not confirmed	confirmed	not confirmed
February	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
March	not confirmed	not confirmed	confirmed	confirmed	not confirmed	not confirmed	not confirmed	confirmed	confirmed	confirmed	not confirmed	not confirmed	not confirmed
April	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
May	not confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	not confirmed	not confirmed	not confirmed
June	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
July	not confirmed	not confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	not confirmed	not confirmed	not confirmed
August	confirmed	not confirmed	not confirmed	confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	confirmed	confirmed	confirmed
September	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
October	confirmed	confirmed	confirmed	confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
November	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
December	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed	not confirmed
	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed	confirmed