

Analysis of Seasonal Effects on Share Indices with Artificial Neural Networks

Masterarbeit

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2. Introduction

In recent decades, many studies have examined several different seasonal effects in stock markets, the so called calendar effects or anomalies. It can be observed recurring price trends in stock market indices for special events and such recurrent prices could be adapted to the future. In general, the hypothesis says that stock prices should fall before a special event, and after that event the stock prices should raise again. Previous studies have indicated unusually high returns through these anomalies. These effects include macroeconomic announcements like interest rates as well as temporal situations like exchange holidays. Some effects could be significantly confirmed and dated back to the 17th century. The studies are not limited to the American equity market or to other established markets, such as Europe. There have been also developing emerging markets in the studies, like the Arab stock market in Zarour (2007). Almost all empirical studies have documented a significant calendar effect. For instance, there is the *Day-of-the-week Effect*. This effect is discussed in French (1980), Smirlock and Starks (1986), Johnston, Kracaw and McConnel (1991) and Joshi and K. C. (2005). This Day-of-the-week Effect characterizes particular returns to individual days of the week. Furthermore, the macroeconomic effect is one famous effect. McQueen and Roley (1993), Bomfim (2001) and Goeij and Marquering (2006) have investigated the effect. Here, the major stock indices should rise before the macroeconomic announcement or rather result. Another well-known effect is the *Turn-Of-The-Month (TOTM) Effect*. It is discussed in Ariel (1987), Lakonishok and Smidt (1988), Hensel and Ziembra (1996) and Swinkels and van Vliet (2011). At the end of the month the prices of stock indices drop. The investors reposition themselves so that the stock prices rise again at the beginning of the month. The *Holiday Effect* is another much studied effect. Ariel (1987, 1990) and Swinkels and van Vliet (2011) have studied this effect. This Holiday Effect includes exchange holidays. Before the holiday the prices should fall and on the first trading after exchange holiday stock prices should rise again. Why all these seasonal effects occur and whether they continue to exist in the future is not analyzed or answered in this Master Thesis.

Since the 18th century, effects may level off in their extensiveness or disappear. According to Schiller (2000), many abnormalities vanish if they are known. For instance the so called *January Effect* disappeared for this reason. In January, Gultekin and Gultekin (1983) documented significantly high exchange returns. Many studies such as Keim (1983) and Roll (1983) substantiated this effect due to the phenomenon of size-effects. The January effect may occur due to the tax-loss selling, which are justified at the end of the fiscal year.

According to the *Efficient Market Hypothesis* (EMH) these anomalies, as appropriate investment strategies, should not exist within an efficient market. In this manner excess returns cannot be achieved with available information on the market. The EMH says that any information that has an impact on the stock is taken into account. Following the EMH patterns in the season or other recurring rules that generate an excess return should not exist in an efficient market, so Lo (2008). Yet there are strategies to generate excess returns. In this line patterns or anomalies are not present in the theory, but they exist in the real markets as has mentioned above. These anomalies produce excess returns and refute the EMH. Doubts about the EMH are confirmed by the fact that in the literature many seasonal effects have been studied and presented. These studies have examined the effects over various decades as well as different equity markets and they prove the occurrences of the patterns in reality. Although according to the theory, these effects should not exist, but there are indications.

Some seasonal effects are studied in this thesis and whether these effects are still statistically significant detectable. Six stock indices are investigated in order to identify anomalies. Additionally it is examined whether an effect can be seen at the Bund Future or Gold Index. These underlying assets are so called secure investment. A contrarian price trend could be observed, when the secure investments are liquidated to invest in stocks for the specific events. Almost all studies have examined seasonal effects with statistical models, but in the present study, these patterns are examined with the neural network simulator FAUN. For all statistically significant effects three trading strategies are developed. It is created a

realistic scenario including taxes and fees in order to test whether excess returns could be realized. If these excess returns can be realized, the performances are compared with a *Buy and Hold strategy* as benchmark strategy. The comparison has the purpose to make a statement about the performances of the trading strategies.

This Master Thesis has the following structure. After the previous abstract and the introduction follows the Chapter Literature overview (3.) that gives an overview of the effects that have already been analyzed in the past and are studied in this Master Thesis. The *Holiday*, *Turn-Of-The-Month*, *Federal Open Market Committee*, *IFO*, *U. S. Labor Market Data*, *Monday*, *Tuesday* and *Halloween Effects* are analyzed.

Chapter four contains the scientific *Research gaps*. It includes the differentiations from other studies and indicates the focus of this thesis, if the effects can be confirmed by artificial neural networks and whether a trading strategy can be developed in near realistic conditions.

In Chapter five the various tools, key figures and procedure are presented. The processing of the time series of individual stock indices is made (5.1.). For the time series six different indicators are presented (5.2.). In this section it is demonstrated that the closing prices of one underlying and one indicator form a basic dataset. Furthermore, the six datasets of each underlying are presented to examine each effect. In the next sections, the artificial neural networks (5.3.) and the neural network simulator FAUN (5.4.) are presented. The results of the investigation by FAUN are checked by a binomial test (5.5.). The following sections relate to the trade. The four trading strategies are explained and presented (5.6.). The results of the trading strategies are compared by key figures. In the last section of this chapter these key figures are explained (5.7.).

In the sixth chapter the exact procedures are illustrated. The exact FAUN settings are presented to investigate the effects (6.1.). In this section the expiration of the binomial tests is also demonstrated. The development and execution of each strategy is described (6.2.).

In the seventh chapter the results of the significance tests (7.1.) and the trading strategies (7.2.) are presented. It is considered which effects could be demonstrated, and which indicators could be detected the most effects. In the following section, the performances of the strategies are presented and compared graphically (7.3.). An analysis of the performances of the strategies is at the end of this section.

In chapter eight, recommendations are given to the strategies on the basis of comparisons and analysis of the effects of chapter seven. Subsequent the limitations (9.) of this thesis are explained. It is demonstrated where the limitations are in this investigation and whereby these are emerged.

The last chapter contains the conclusion as well as an outlook. The main results and points of this thesis are summarized. In the outlook section the points of trade strategies are presented that should be considered in subsequent studies.

10. Summary and Outlook

The aim of the present research work was to answer three questions. The first question was whether the exchange anomalies still exist. The neural network simulator FAUN was recognized these effects on the base of DAX, Euro Stoxx 50, S&P500, FTSE100, CAC40, Bovespa, Bund Future and Gold Index. Eight different exchange anomalies were examined: Holiday, Turn-Of-The-Month, FOMC, IFO, USLMD, Monday, Tuesday and Halloween Effect. The hypothesis was that in general before the effect day takes place stock prices fall and rise again on the day the effect occurs with the exception of the Monday Effect, where it was the other way around. Five indicators were still calculated on the base of each stock index to yield more accurate forecasts of the closing price after the event by FAUN. Used indicators were Double Moving Average, Moving Average Convergence/Divergence, Exponential Moving Average, 5-days and All Indicators. The forecasts by FAUN were examined by a binomial test. Twenty various stock index and indicator combination anomalies were examined statistically significant. The Monday Effect was identified seven times at DAX, S&P 500 and FTSE100. At DAX and CAC40 the Turn-Of-The-Month Effect and at DAX, S&P 500 and Bund Future the IFO Effect was confirmed. The Holiday Effect had been recognized three times at DAX and Gold Index. The FOMC Effect was seen twice at Euro Stoxx 50 and CAC40. The USLMD, Tuesday and Halloween Effect were not statistically significant. At the Tuesday Effect no pattern were found. There were only closing prices available, whereas it was likely that this effect was observed only in the morning. The Halloween Effect was not statistically significant. The reason could be the short observation period. Using all indicators eight hits reached which was the highest number of confirmations. Without indication had been four patterns and the second highest number. Finally, thirteen effects can be identified on the base of eight different indices, when the multiple confirmations were ignored. Although, after the efficient market hypothesis, such anomalies should not exist, nevertheless these were statistically significant confirmed. Even after more than 40 years, the effects could be proven.

The second question focused on whether the effects can be used by three trading strategies. A Momentum strategy was selected to trade. Furthermore, the FAUN forecast for a trading strategy was used and also a combination of the two. The closing price before the effect date was taken as entry and the position was closed after the respective effect. Optionally, the position was held for another day and sold only at the next day. For this purpose a fictional certificate was issued. In order to compare the strategies to the effects, a Buy and Hold strategy was used as a benchmark. At thirteen different time periods, the benchmark strategy showed twelve times a higher depot level in comparison to the other three strategies at the end of the trading period. Only 16 of 46 depots of the effect trading strategies had a higher depot level as the initial capital of € 50,000.00. The depot levels were not high, but rather just above the starting capital. The highest depot level reached € 53,547.53 at the Momentum strategy. In comparison, the highest depot level reached by the benchmark strategy. The depot level was € 77,179.77 at the end of the trading period. Only two of thirteen had a lower depot level as the initial capital at the end. The other three strategies on effects could not be recommended due to poor performance regarding the low depot level at the end.

The last question was whether so called safe investments are also affected by the effects. For this purpose the Bund Future and the Gold Index was examined. Based on the Bund Future the IFO Effect and based on the Gold Index the Holiday Effect was confirmed. The value of both depots remained stable at the start capital by each effect strategy. Effects could be detected in the safe investment, but these are not tradable for excess returns.

In future studies of the effects Open, High and Low prices should be included. The forecasts by FAUN should probably be better. The Tuesday Effect can be explicitly studied in detail. In addition, the trading volume and volatility should be incorporated in future studies to improve the quality of predictions. In addition, the effects of any reverse abnormalities need to be investigated. Especially with long observation periods, the time segments should be broken down into several smaller individual periods.

Furthermore, the Halloween Effect should be studied over a longer period. After a possibly significant confirmation of the Halloween Effect, it would be helpful to trade in this period as trading strategy. Another trading strategy could be a Buy and Hold strategy on the base of the Halloween Effect. Thereby the fees could be limited.

In further studies of the effects and trading strategies macroeconomic factors should also be taken into account. Interest rate decisions, Euro Dollar parity, inflation rate or the general mood of the economy based on consumer sentiment could affect the respective effects as well. These factors may increase the hit probability of trades, when they were taken into account.

Finally, it had to be noted that there were such effects and the Efficient Market Hypothesis had been refuted. But an excess return could not have been reached on the basis of these effects. At this point, the Efficient Market Hypothesis retained its validity.