Effect of interest rate changes on stocks:
Is the Icelandic market efficient?

Júni, 2017

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Yfirlýsing um heilindi í rannsóknarvinnu

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Abstract

The aim of this study was to analyze the effects of interest rate changes on stocks and to examine Icelandic stock market efficiency between 2009 and 2017. The study employed a constant mean return model and a market model to estimate expected returns. In addition, a linear regression analysis was employed to estimate the effects that unanticipated interest rate changes have on stock prices. The results demonstrate that anticipated interest rate changes do not affect stock prices on the announcement day. However, unanticipated interest rate changes have a statistically significant effect on stock returns on the announcement day. The findings of the study indicate that the Icelandic stock market is efficient when incorporating interest rate changes, suggesting semi-strong market efficiency.
Preface

This Bachelor thesis is a thesis part of a B.Sc. degree in Business Administration at the Reykjavik University. The thesis accounts for 12 ECTS and was written during the period from December 2016 until May 2017. First and foremost, we would like to thank our instructor Dr. Stefan Wendt for his great advice and guidance during the bachelor thesis. We would also like to thank Landsbankinn hf. for providing us with data on interest rate changes during the research period.
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1. Introduction

Monetary policy is a set of objectives that a central authority, usually a central bank, sets to attempt to influence macroeconomic factors such as inflation, employment and the real output of an economy. By using the interest rate, the supply of money and the currency board, the central bank tries to ensure price stability and economic growth. Therefore, monetary policy decisions tend to affect the broader financial markets, for example, the bond market, the foreign exchange market and the stock market. Monetary policy is generally categorized as expansionary or contractionary. Low interest rates, increases in consumer spending and higher earnings for companies, are usually a sign of expansionary monetary policy. In contrast, contractionary policy is usually associated with high interest rates, less consumer spending and a reduction in investment. Patelis (1997) demonstrates that monetary policy is a significant predictor of asset returns in the United States. He argues that there is a relationship between U.S. monetary policy variables and future excess stock returns. Ioannidis & Kontonikas (2008) argue that stock market returns tend to be higher during periods of expansionary- and lower during contractionary monetary policy. Thus, market participants tend to keep account of monetary policy decisions and macroeconomic news.

Interest rate decisions made by the central authority represent new macroeconomic information for market participants. Changes in interest rates can affect stock prices in two ways: First, by having an effect on the discount rate which market participants use to calculate the present value of firms’ future cash flows and second, by influencing expectations of companies’ future performances. The first effect is due to a change in the risk free-rate, which affects the required return for firms. The second effect is due to changes in overall economic variables and the cost of borrowing funds in the market. These changes affect the estimated future cash flow market participants use to estimate the present value of a firm (Lobo, 2008; Bernanke & Kuttner, 2005; Ioannids & Kontinikas, 2008; Chen, Mohan & Steiner, 1999).

In this Bachelor thesis, we analyze the effect of interest rate announcements on stocks in Iceland between 2009 and 2017 and how efficiently Icelandic market participants incorporate interest rate changes. The period between 2009 and 2017 within the Icelandic context is particularly interesting. During the financial crisis that started in 2007, the Icelandic stock market lost over 92% of its value within four months (financial.thomsonreuters.com, 2017). Trading in the Icelandic stock markets was suspended for several days in October of 2008. When markets reopened on the 14th of October 2008, the
Icelandic index OMX 15 had fallen to 678.4 compared to 3004.6 when it closed the week before and 9016 at its peak in July 2007 (see figure 1). In the aftermath of the financial collapse the Icelandic stock market consisted of only five companies compared to 30 companies before the crash in 2007 (Nasdaqomxnordic.com, 2017).

During the crisis, the economy went through severe difficulties, the main interest rate was set to an all-time high of 18% to cope with the extreme inflation caused by the plunge of the Icelandic Krona (www.cb.is, 2017) and in November 2008, capital controls were established. The capital controls limited the outflow of local currency significantly to attempt to stabilize the Icelandic Krona. Subsequently, foreign investors could not withdraw their funds at any given moment and therefore chose to invest elsewhere. The introduction of capital controls reduced liquidity in the Icelandic market drastically. As shown in figure 1 the turnover shrunk significantly because free flow of investments was limited.

![Figure 1. Icelandic OMXI development and daily turnover since 2007. (Source: Nasdaqomxnordic.com)](image)

However, Iceland was able to recover quickly and the economy picked up again in 2011. The Icelandic stock exchange reinvigorated in late 2011 when Hagar hf. was the first company to go public since the economic crisis in 2008. Since 2011, twelve other companies underwent their IPO and were listed on the Icelandic stock exchange (OMXI). Currently there are 17 companies listed on OMXI. Due to capital controls, the Icelandic financial market became somewhat secluded from the rest of the financial world. Although this lead to a quick recovery, this may have significantly reduced market efficiency during that period. (Graham, Peltomaki, Sturludóttir, 2015).
With low activity of foreign investors in the Icelandic stock market, pension funds began to hold an increasing amount of Icelandic stocks. Icelandic regulation prohibits each pension from owning more than 15% of outstanding shares of any given company (althingi.is, 2017). They hold stocks both directly and indirectly through mutual funds. Currently pension funds own the majority of stocks traded on the Icelandic stock exchange. This results in lower liquidity since Icelandic pension funds trade infrequently and in addition, capital controls interfere with the possibility of foreign investments. Therefore the question arises whether the Icelandic market is inefficient when incorporating new information such as interest rate changes.

In Iceland, the Monetary Policy Committee (MPC) takes monetary policy decisions on behalf of the Central Bank of Iceland. The MPC is required to meet at least eight times per year and publish their interest rate decision before the opening of the market (www.cb.is, 2017). The main interest rate instrument for the MPC in Iceland was a simple average of the current account rate and maximum rate on 28-day certificates of deposit up until the 21st of May 2014 when it changed to the 7-day term deposit rate. The interest rate changes for both rates are the same throughout the entire research period.

In this thesis, we use an event study approach to analyze the effects of interest rate changes on Icelandic stock prices between 2009 and 2017. Further we test if market participants incorporate interest rate changes efficiently. We divide the event study into two different periods: The estimation window and the event window. In the estimation window, we use two different methods to estimate expected returns. First, we use constant mean of daily returns to estimate an expected return. Second, we derive the expected return using a market model, which adjust for a market wide effect of interest rate changes. In the event window, we compare expected returns to actual returns. The difference between expected returns and actual returns is denoted as abnormal return that results from interest rate changes.

Interest rate announcements can affect the stock market through two channels, the pre-announcement effect or “the calm before the storm” and the announcement effect itself or “the storm” (Jones et al, 1998). Rigbon and Sack (2003) show that volatility increased in the U.S stock market after interest rate announcements as market participants incorporate the interest rate change within their pricing models. If an announcement effect exists, changes in stock prices should be statistically significant as market participants react to interest rate announcements by integrating the information into their pricing model.
However, analysing the effect of interest rate announcements on the stock market is complex. Stock market participants might correctly anticipate interest rate changes and adjust their portfolios accordingly. If market participants predict interest rate changes to the full extent, interest rate announcements provide no new information. Therefore, interest rate changes should not have any significant effect on stock prices when the announcement is made public, resulting in no significant abnormal returns. In contrast, if interest rate announcements deviate from market expectations they provide new information for market participants and interest rate announcements should have a significant effect on stock prices. As participants incorporate the interest rate decisions into their pricing models we should be able to measure significant abnormal returns. According to the efficient market hypothesis (Fama, 1970) an efficient market should immediately reflect unanticipated interest rate changes as market participants incorporate all available and relevant information to their pricing models.

To investigate whether the Icelandic stock market incorporates unanticipated interest rate changes in an efficient manner, we examine the cumulative abnormal returns within the event window. We then conduct a linear regression analysis to estimate the effect unanticipated interest rate changes have on stock prices.

Getting a better insight into the impact of interest rate changes on equity prices is essential for investors, portfolio managers, pension fund managers as well as policy makers. To obtain quantitative estimates of the effects of interest rate changes can improve the understanding of asset allocation, portfolio management and risk management. For Icelandic policy makers it is essential to know how their decisions affect the broader financial markets and how investors react to these decisions. Even though many studies have been published on the subject of interest rate effects on stock prices as well as market efficiency, most of it has been focused on larger markets such as the United States. Our work contributes to existing studies by examining the effect in a smaller, illiquid market with entry barriers. The study provides practical implications for investors since it shows how efficiently market participants incorporate information into their valuation models. Portfolio managers need to have an estimate on the effects that interest rate changes have on their portfolios should they not anticipate them correctly and for investors it is important to know if market pricing is efficient or whether arbitrage opportunities exist.

Our bachelor thesis is structured as follows: we begin with an overview of related literature about market efficiency, the economic effects of monetary policy on stock prices and the effects of interest rate announcements on stock prices (section 2), followed by
presentation of the data used in the study (section 3). The next two sections cover the methodology of our research (section 4), followed by the empirical results (section 5). Finally, we present our discussion and conclusions (section 6).
2. Related Literature

2.1. Efficient market hypothesis

Eugene F. Fama first came up with the concept of market efficiency in his Ph.D. thesis (1965). In his thesis, he analyses the behavior of stock market prices in the short-term to refute the concept of technical stock analysis, which uses past price patterns of stocks to anticipate future price movements. Ultimately, he comes up with the market efficiency hypothesis, which states that stock prices should reflect all publicly available information.

Along with the efficient market hypothesis, it is important to talk about the random walk theory. The random walk theory states that stock prices follow an unpredictable pattern and therefore cannot be foreseen through an analysis of past behavior. This random walk usually occurs around an asset’s real or intrinsic value. Although a stock’s intrinsic value can change at any given time, it should only do so in response to new and unforeseen information on a company’s business.

Eugene F. Fama (1965, p.56) describes market efficiency as “a market where there are a large number of rational profit-maximizers actively competing, with each trying to predict future market values of individual securities, and where important current information is almost freely available to all participants.” Further, the hypothesis implies that an efficient market immediately prices in new information. In a subsequent paper titled efficient capital markets (Fama, 1970), he introduces three forms of market efficiency. These forms are weak-form efficiency, semi-strong form efficiency and strong form efficiency. The type of market efficiency depends on distribution of information among market participants. Other research has shown that the efficiency of a market can change over time. Chung and Hradil (2008) link this in large part to liquidity. Even though they do not talk about a shift from weak-form efficiency to semi-strong form efficiency, they argue that within these forms efficiency can vary a great deal.

Bodie, Kane and Marcus (2014) define the three forms of market efficiency more detailed than Fama. They describe them as follows:

**Weak-form efficiency** assumes that stock prices reflect all data that can be acquired through analysis of past performance, trading data, and interest rates. Weak-form efficiency assumes that an analysis of the market trend is pointless. Past performance of stocks is publicly available and cheap to obtain, the weak form assumes that if investors could predict future stock prices from past performance, they would learn how to use buy and sell signals
and act on them. As market participants become aware of buy and sell signals, the signals would lose their value and result in immediate price changes. However, investors can earn excess profits by analyzing financial statements and economic trends.

**Semi-strong form efficiency** assumes that stock prices already reflect all publicly available information. In addition to information drawn from stocks’ past performance and trading data from assets, the semi-strong form includes information drawn from fundamental data on a firm’s business practices, management performance, financial statements and outlooks of overall performance and growth.

**Strong-form efficiency** asserts that the stock price reflects all available information available to both the public and company insiders. Hence it would be impossible to gain an excess return from undisclosed information (insider trading), since such information does in theory not exist.

These theories illustrate that the forms of market efficiency distinguish themselves through the distribution of information. One can therefore argue that information is the most valuable asset in finance, especially in the context of market efficiency. However, acquiring information is costly and time consuming, which means that analyzing it should yield an excessive return. Therefore, market participants only acquire information until the marginal cost of additional information exceeds the return of that information (Grossman Stieglitz, 1980). Investors use the information acquired in different financial models to derive the intrinsic value of company shares \((PV)\). The most widely used models are discounted cash flow models (DCF), which state that a stock’s intrinsic value is equal to the present value of future cash flows discounted with an appropriate required return \((R)\) as can be seen in formula (1). The discount rate reflects economic effects such as the current interest rate. Consequently, changes in the interest rate have a direct but inverse effect on stock prices.

\[
P V = \left( \frac{CF_1}{(1+R)^1} + \frac{CF_2}{(1+R)^2} + \cdots + \frac{CF_t}{(1+R)^t} \right) + \frac{CF_{t+1}}{(R-g)} \quad (2.1)
\]

Where:

- \(PV\) = Intrinsic value of the stock
- \(CF_t\) = Cash flow at time \(t\)
- \(R\) = Required return
- \(g\) = Expected growth rate
One of the most common ways to determine the required return (R) is the capital asset pricing model (CAPM). Changes in interest rates affect the risk-free rate used in the capital asset pricing model, which derives an expected (normal) return of an asset (Swiney, 1986). In an efficient market an asset price reflects all available information, changes therefore only occur when new information is uncovered and analysts update their valuation models. Nissim & Penman (2003) support this, as they found that changes in interest rates are positively related to earnings, but that the change in earnings is usually not sufficient to account for the change in investors’ required returns. This means that the net effect of interest rate increases on equity values is negative for financial firms. For most non-financial firms the interest rate changes only affect the net interest expense directly. Nissim and Penman observe a positive relationship between the effects of interest rate changes on revenue and operating expense and since interest rate changes also effect the discount rate market participants use to value equity, they conclude that even though interest rate changes have a net positive effect on revenue this effect is not sufficient to offset the change in required returns.

Market efficiency can be limited by numerous factors such as time of adjustment, transaction and information cost, number of market participants and other regulations. When these assumptions do not hold and markets are inefficient, investors can earn excessive returns without taking on much risk. The fundamentals of efficient markets may not always be fulfilled and especially smaller markets may have problems fulfilling all assumptions. (Langevoort, 1992)

In Iceland, the stock market could especially be prone to inefficiency due to low liquidity in the market and entry barriers for foreign investors. One study made on the Icelandic market examines the effect of capital controls on market efficiency and concludes that when compared to other Nordic markets, the Icelandic market is not considered weak form efficient. However, when analyzed separately, the study shows that market efficiency increased in Iceland after the implementation of capital controls. (Graham, Peltonaki, Sturludottir, 2015). These findings contrast many empirical studies showing that an increase in liquidity leads to an increase in market efficiency (e.g. Chung & Hrazdil, 2008; Chorida, Roll & Subrahmanyam, 2008). Further studies from the United States show that deregulation of financial markets leads to an increase in market efficiency (Ataullah, Cockerill, & Le, 2004; Bae, Ozoguz, Tan & Wirjanto, 2012). However, the United States is one of the most developed and most regulated financial market in the world, which is why we cannot translate these findings directly to financial markets of emerging countries such as Iceland. Sturludottir’s findings could therefore have an important implication for our study.
2.2. Economic effect

One of the three main tools for implementing monetary policy is the discount rate of the central bank. The discount rate is the interest rate that commercial banks face for short-term loans. Waud (1970) argues that interest rate changes set the future course for the economy since they affect expectations of both businesses and financial institutions. They do so by changing future cash flows through an increase or decrease in the rate at which businesses are able to borrow funds.

Jensen and Johnson (1995) investigate stock market performance between 1962 and 1991. They show that stock market returns are significantly greater following periods of expansionary monetary policy than during contractionary monetary policy. Periods of expansionary policy also show less volatility than periods of contractionary monetary policy. By classifying monetary policy into five categories: strongly anti-inflationary, anti-inflationary, natural, pro-growth and strongly pro-growth, Thorbecke (1994) argues that a one-unit increase in these categories (e.g. a change from neutral to pro-growth) increases industry stock returns by an average of 0.83% per month. The findings of these studies are consistent with the notion that monetary policy affects the stock market. This suggests that market participants should monitor macroeconomic news and view them as relevant information.

Thorbecke (1996) examines how stock returns react to monetary policy shocks. He analyzes the effect of monetary policy changes on 22 industries over the years 1953-1990. Using VAR estimations, he observes that one standard deviation rise in the federal fund rate decreases nominal stock returns by an average of -0.80% per month. Ioannidis and Kontonikas (2008) analyzes the impact of monetary policy on stock prices. They find a correlation between contractionary monetary environment and declining stock returns. Their sample included 13 OECD countries over the period from 1972 to 2002. By regressing nominal stock returns against changes in short-term interest rates, they find that ten of the 13 countries within the sample have a statistically significant negative coefficient, which indicates a relationship between higher interest rates and lower nominal stock returns. After adjusting nominal stock returns for dividend payments, the strong negative relationship between them is not affected. The coefficient for 11 of the 13 countries is negative and statistically significant at p<0.1. They also analyze whether the relationship identified in nominal stock returns is present in real returns. They observe that seven out of the 13 countries in the sample have a substantial difference in actual returns, statistically significant...
at p<0.01. Overall, ten out of the 13 countries display a statistically significant relationship between changes in interest rates and stock returns. Overall, the findings of these studies imply that interest rate changes do affect the stock market over time.

Ioannidis and Kontonikas (2008) also analyze whether expected stock returns are changing over time and if they are to some extend predictable. Using monetary conditions as data, the results show that these monetary conditions directly relate to investors required returns. If the central bank chooses to follow expansionary policies when economic conditions are weak, then investors may require higher rates of return to invest in the stock market. Overall, the findings show that for the countries under observation 80% exhibit declines in stock market value during periods where the central bank follows a contractionary monetary policy. This suggests that contractionary and expansionary monetary policy have a statistically significant effect on both required returns and actual returns.

A recent study investigated the coherence between changes in interest rates and stock prices on the European market. Ferrer, Bolós and Benítez (2016) use stock returns of ten European countries (Germany, the UK, France, Italy, Spain, the Netherlands, Finland, Ireland, Portugal and Greece) between January 1993 and December 2012 to find a relationship in time-frequency space. They find that the relationship between interest rate changes and stock returns differs significantly between countries as well as over time. They find the highest correlation in the United Kingdom followed by larger European countries such as Germany, France, the Netherlands and Spain. In smaller countries, the correlation between interest rate changes and equity returns was much less. They further find that the correlation between interest rate changes and stock returns is strongest for a time horizon of between one and two years.

Bjørnland (2009) showed that interest rate changes have a significant effect on stock prices in both the short-run and the long-run. In agreement with other studies, these data show that interest rate surprises explain only a minimal percentage of stock returns on the days of interest rate announcements. He argues that stock prices respond to interest rate changes with a noteworthy delay rather than immediately. This assertion however contradicts Famas’ efficient market theory, which states that in an efficient market stock prices reflect all publicly available information. His theory is further strengthened by research of Lastrapes (1998) and Rapach (2001).
2.3. Announcement effect

An event study from Thorbecke (1994) supports that there is a relationship between signals of changes in monetary policy and stock prices. He uses a sample of newspaper articles where policy induced changes are referenced. Thorbecke applies a regression model where the independent variables are the Dow Jones Industrial Average and the Dow Jones Composite Average; his dependent variables are news of the federal funds rate changes. He observes a statistically significant relationship between news of expansionary (contractionary) policy and increases (decreases) in the stock indexes. This supports the notion that news about changes in interest rates are an event that impacts future cash flows as well as discount factors used to calculate cash flows to their present value.

Waud (1970) analyzes the public interpretation of the announcement effect regarding interest changes made by the Fed. Participants in financial markets will always have expectations about future cash flows and economic trends. He questions if an announcement effect exists for interest rate changes since market participants often correctly anticipate them and therefore changes withhold no new information. He uses interest rate changes from the New York Fed to find existence of an alleged announcement effect. Further, he interprets the announcement effect as “an effect that alters the expectations of businessmen, financial institutions, and other economic actors about the future course of the economy”. (p. 232) He finds that the estimated mean residual on the first trading day after the interest rate announcement is significantly negative for interest increases and significantly positive for interest rate decreases. This implies that there is an effect associated with interest rate decisions and that these decisions contain information that give an indication on future economic conditions.

Bernanke and Kuttner (2005) examine the reaction of equity prices to changes in the target federal fund rate. They measure the impact of Federal Reserve policy on the stock market with an event study approach by calculating the market’s reaction to the federal funds rate changes on the day of change. Their sample consists of 131 Federal Open Market Committee (FOMC) meetings from 1994 to 2002. They conduct a regression analysis where they analyze the effect of interest rate changes on stock returns. Their result is that an increase of 1% in the fund rate results in a 0.61% decrease in stock returns. However, these results are small and not statistically significant. They argue that an explanation for these results might be the fact that asset markets are forward looking and likely to incorporate all available information about anticipated future interest rate changes. They attempt to isolate
unanticipated interest rate changes that might generate a market response by analyzing changes in the price of the 30-day Federal Funds futures. They conduct a regression using an additional determinant that denotes unanticipated interest rate changes. Their results show that a 1% surprise interest rate change implies a 4.68% change in 1-day return. These results are statistically significant although only explaining 17% of the variance of equity prices on event days. Bernanke and Kuttner also find that equity returns are, on average, 10% more volatile on FOMC announcement days than on non-event days.

Bomfim (2003) examines the pre-announcement and news effect on stock returns and studies volatility in the context of monetary policy decisions. His sample includes daily data of stock returns from 1989 to 1998 and data on the Federal Reserve’s policy meeting dates as well as data on the target federal fund rates. The event study framework he applies differs from the traditional event-study approach in several ways. He explicitly models the time-varying nature of market volatility and allows for policy effects on both the level and variance of returns. He uses all daily observations on stock returns, not just returns that correspond to days of policy announcements. Using the conditional mean of daily stock returns, he argues that expectations of near-term interest rate changes have a negative and statistically significant effect on stock returns. He estimates that for each basis point increase in the expected average daily value of the funds rate, daily stock returns decrease by 0.04% in the following month. He also analyses the conditional mean of the variance for FOMC meeting days. His results suggest that volatility is unusually high on FOMC meeting days, but finds no statistically significant effects on volatility on days before or after the meeting.

Lobo (2008) examines adjustments of stock prices around interest rate announcements. His results suggest that interest rate announcements have significant effects on stock returns. He observes that risk aversion increases before the announcement, suggesting that the announcement conveys new information to the stock market.

Chen, Mohan and Stener (1999) examined the effect of discount rate changes on equity returns, market volatility and trading volume. They found a negative correlation of equity returns with announcements of discount rate changes. Using a series of regressions, they conclude that on average stock returns decrease by 0.5% for every 10 basis point increase in the discount rate. All above-mentioned studies propose that stock markets incorporate monetary policy changes.
3. Data

To conduct our research, we combine data from three sources. We use closing prices of Icelandic stocks derived from Thompson Reuters Eikon DataStream, actual changes in the central bank’s main interest rate and data on anticipated interest rate changes published by the Icelandic bank Landsbankinn hf. Published interest rates from Landsbankinn are available to all investors at no cost. The research period starts in January 2009 and stands until February 2017. We subdivide the period into smaller windows of 250 days to estimate expected returns up until 3 days before the actual event of each interest rate announcement.

Except for one recently listed stock, our data set consists of the entire population of stocks listed on the Icelandic stock exchange during the research period. We exclude Skeljungur from the dataset because it was listed in late 2016 and we are not able to collect enough data points to estimate an expected return. Table 1 shows that only five companies are listed for the entire research period and twelve companies went public during that period.
Table 1

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<td>Tryggingarmiðstöðin</td>
<td>08.05.2013</td>
<td>TM</td>
</tr>
<tr>
<td>Vátryggingafélag Íslands</td>
<td>24.04.2013</td>
<td>VIS</td>
</tr>
<tr>
<td>Voðafone Ísland</td>
<td>18.12.2012</td>
<td>VOICE</td>
</tr>
</tbody>
</table>

Notes. This table shows the dates at which each company underwent its initial public offering. The companies listed on the Icelandic stock exchange for the entire period are marked accordingly. In the right cell, the ticker symbol under which companies are listed is shown. (Source: thomsonreuters.com)

It is of concern that only five companies are listed on the stock exchange for the entire research period because it might lead to difficulties when we collect data points as over half of all interest rate changes happen before 2012. Nevertheless, the Icelandic market is small and we are using the entire population of interest rate changes as well as all stocks with sufficient data points.

Within our research period, 22 interest rate changes affected the five companies listed the entire time. This resulted in 110 data points for these companies. In addition to that, we collected 56 data points for changes that affect companies that went public during our research period. One problem in the study is that there might be other events, such as
company related news that affect stock prices on or around the day of interest rate announcements and impair our results. We exclude extreme outliers that are unlikely a result of the interest rate changes. Overall, we exclude 22 observations. We excluded these outliers based on daily abnormal returns.

The period in which historical data is collected is between January 29th 2009 and the latest interest rate announcement unaffected by lifted capital controls, February 8th 2017. During that period, the MPC published 56 interest rate announcements. Of these announcements, 12 were to decrease interest rates, 10 were to increase interest rates and the remaining 34 times the MPC announced no change on the main interest rate. Of all interest rate changes two were for 1%, two for 0.75%, and nine for 0.5% and 0.25% respectively. Interest rate changes further demonstrate a cycling character. Early in the research period, we see eight interest rate decreases followed by seven interest rate increases. After a long period of no changes, the cycle picks up towards the end of our research period.

Interest rate decreases happen in three windows. Most decreases happen early in the period as a direct consequence of the financial crisis of 2008 where interest rates spiked up to 18%. The MPC announced further decreases in late 2014 as well as late 2016. Increases in interest rates happen in two phases. The first in 2011 and 2012, and the second in 2015. Figure 2 shows development of the Icelandic stock index OMXI 8 with all interest rate changes occurring in the research period.

**Figure 2.** OMXI 8 Iceland and interest rate changes during the research period.
When examining market efficiency, the net effect of changes in the main interest rate on stock prices is of particular importance. As mentioned earlier, anticipated interest rate changes may already be included in stock prices before the announcement is made public it is therefore necessary to differentiate between anticipated and unanticipated interest rate changes. Bernanke and Kuttner (2005) use forward rates to measure market participant’s anticipations of interest rate changes. Unfortunately, a futures market does not exist in Iceland, which is why we use economic estimates provided by the Icelandic bank Landsbankinn hf. We break interest rate changes up into three categories: Positive changes, neutral and negative changes. A positive (negative) change occurs when the economic estimate is lower (higher) than the actual change in the main interest rate. To categorize the events, we calculated the net effect of each announcement as:

$$\Delta \text{ actual change} - \Delta \text{ anticipated change} \ (3.1)$$

If this results in a number larger (less) than zero, we categorize the change as positive (negative). If Landsbankinn anticipates the interest rate change correctly, we categorize the event as neutral. Table 2 shows the differences in anticipated and actual interest rate changes during the research period as well as magnitude of the difference.

Table 2

<table>
<thead>
<tr>
<th>Positive change</th>
<th>Negative change</th>
</tr>
</thead>
<tbody>
<tr>
<td>05.05.2010 (+0.25)</td>
<td>18.08.2010 (-0.50)</td>
</tr>
<tr>
<td>22.09.2010 (+0.25)</td>
<td>03.11.2010 (-0.25)</td>
</tr>
<tr>
<td>02.02.2011 (+0.75)</td>
<td>08.12.2010 (-0.25)</td>
</tr>
<tr>
<td>17.08.2011 (+0.25)</td>
<td>03.10.2012 (-0.25)</td>
</tr>
<tr>
<td>21.05.2014 (+0.25)</td>
<td>05.11.2014 (-0.25)</td>
</tr>
<tr>
<td>18.03.2015 (+0.25)</td>
<td>24.08.2016 (-0.50)</td>
</tr>
<tr>
<td>04.11.2015 (+0.25)</td>
<td>14.12.2016 (-0.25)</td>
</tr>
</tbody>
</table>

Notes. The left column of the table shows dates of positive interest rate surprises and the corresponding size of the surprise. The left side shows dates of negative interest rate surprises and corresponding sizes.
4. Methodology

4.1. Event study

In this section, we specify the methods used to examine the effect of interest rate changes on Icelandic stocks and describe the tests used in the analysis. As mentioned above, market participants usually incorporate all available information into their pricing models. Thus, anticipated interest rate changes should have no impact on stock market returns on announcement days. In our study, interest rate changes are subdivided into correctly anticipated (neutral effect) and unanticipated changes to be able to measure the effect of interest rate surprises. We divide these interest rate surprises further into two categories, positive effect and negative effect.

The efficient market hypothesis assumes that stock prices reflect all available information, which is why we also analyze if the Icelandic stock market reacts efficiently to unexpected changes in the central bank’s main interest rate. To test for market efficiency we conducted an event study. During the event study, we followed MacKinlays (1997) methodology. To determine if changes in stock prices are immediate when the monetary Policy Committee (MPC) publishes unanticipated interest rate changes, we examine stock prices for a short period before and after the interest rate announcement to measure abnormal returns. Strength of event studies is that it shows how immediate market participants incorporate new information into stock prices. It also has the power to display exaggerated movements in the stock market resulting from unanticipated interest rate changes.

We segmented our event study into two parts: The estimation window and the event window.

For our estimation window, we considered two options. The first option was to use the periods between interest rate changes. This has the advantage that returns in the estimation window would be independent of interest rate changes. However, this option was disregarded because estimation periods are very inconsistent and not of substantial length, reaching from only 15 days to about 40 days. We would not be able to come up with a uniform estimate for all periods.

We decided on a second option, which is to choose periods that have the same length and more data points to estimate expected returns. In that option, we use an estimation window of 250 trading days before the event window, which roughly equals one trading year before the interest rate announcement. Although each estimation window includes multiple interest rate changes it is a tradeoff we must work with. In addition to that, one year gives
sufficient time to account for volatility caused by different interest rate changes and other events that might have significant impacts on expected returns. The estimation window ends three days prior to the interest rate announcement. During this 250-day window, we estimate the constant mean return of daily stock returns as well as expected returns using a linear regression model. Even though these two periods have trade-offs, no other options with fewer downsides presented themselves.

The **event window** includes three days before and after the actual event of interest rate announcements. We formulate the event window for interest announcements so it takes into account both a possible pre-announcement effect and announcement effect. If interest rate changes are unanticipated, an efficient market should incorporate the new information rapidly.

![Figure 3. Event study methodology.](image)

In an efficient market, significant price changes should only be the result of new, unforeseen information. We test how changes in the main interest rate made by the Icelandic central bank affect stock prices of companies listed on the stock exchange. We compare the actual return of stock prices to expected returns if no event had taken place. The difference between expected return and actual return is the abnormal return and is denoted by $AR_{i,t}$.

To examine unanticipated interest rate changes, we determine the abnormal return of firm $i$, at time $t$. The abnormal return is essential to measure the significance of the event. We define abnormal return by the difference between actual return observed in the market and the expected return:

$$AR_{i,t} = r_{i,t} - E[r_{i,t}] \quad (4.1)$$
Where:

\[ AR_{i,t}: \text{the abnormal return of firm i at time t} \]

\[ r_{i,t}: \text{actual return of firm i at time t observed in the market} \]

\[ E[r_{i,t}]: \text{expected return of firm i at time t} \]

We calculate the actual return on a daily basis as:

\[ r_{i,t} = \ln \left( \frac{P_{i,t}}{P_{i,t-1}} \right) \quad (4.2) \]

Abnormal returns equaling zero indicate that the interest rate announcement does not affect stock returns. If, however the abnormal return does not equal zero we can say that the interest rate change affected stock returns during the event window. We expect abnormal returns to be positive (negative) and significant on the event day as well as the following three days, where unanticipated interest rate changes are categorized as negative (positive). To analyze market efficiency further, we calculate the cumulative abnormal return (CAR) within the event window:

\[ CAR = \sum_{t_s}^{t_e} AR_{i,t} \]

The CAR shows effects of interest rate announcements over multiple days in the event window. If CARs are significant over longer periods it indicates that the market is inefficient in incorporating new information contained in unanticipated interest rate changes. Furthermore, if the market is inefficient it should result in CAR in days following the interest rate announcement due to market participants incorporating the announcement within their pricing models. Due to low liquidity in Iceland, we expect CAR to be significant over the event window and in the days following the interest rate announcement.

To estimate the expected return of firm \( i \), at time \( t \) we use two alternatives, the constant mean model and the market model approach.
4.2. Constant mean return model

To analyze whether announcements of interest rate changes impact stock returns we calculate the mean daily return over the estimation window and compare it to the actual daily return in the event window. For this approach, we use the constant mean return model:

\[ r_{i,t} = \mu_i + \epsilon_{i,t} \quad (4.3) \]

Where \( r_{i,t} \) denotes the continuously compounded return on firm \( i \) at time \( t \). The term \( \mu_i \) represents the expected return for firm \( i \) and \( \epsilon_{i,t} \) denotes the random error term of firm \( i \) at time \( t \). Furthermore, we assume that the error term is normally distributed, has a mean of zero and a constant variance:

\[ E[\epsilon_{i,t}] = 0 \]
\[ var(\epsilon_{i,t}) = \sigma_i^2 \]

We estimate the expected return of firm \( i \) at time \( t \) using the arithmetic mean of estimation window returns:

\[ \mu_i = \frac{1}{N_i} \sum_{t_1}^{T_0} r_{i,t} \]

Where, \( N_i \) denotes the number of actual returns over the estimation period for firm \( i \).

This model implies that the firm’s actual return \( (r_{i,t}) \) is equal to the expected return \( (\mu_i) \) plus the error term \( (\epsilon_{i,t}) \). As stated above, the error term is a random variable with a mean of zero and a constant variance. Further, we assume that the mean return over the estimation window should be approximately equal to the actual return over the event window and thus abnormal returns should equal zero. This implies that the error term \( (\epsilon_{i,t}) \) can be interpreted as a price change because of an unanticipated interest rate change between time \( T_1 \) and time \( T_2 \).

On event days where unanticipated interest rate changes occur, we expect the error term to deviate from zero. If an announcement effect is present, new information reflected in
the surprise element of the interest rate announcement should result in significant abnormal returns. On event days where unanticipated interest changes categorize as negative we expect abnormal returns to be positive. In contrast, when unanticipated interest rate changes classify as positive, we expect abnormal returns to be negative. Additionally, we expect abnormal returns to differ between events where interest rate changes are unanticipated and those where the announcement is correctly anticipated.

4.3. Market model

The constant mean model does not account for any market-wide changes in the event window that are unrelated to the event itself but might still have an impact on stock returns. Thus, we use the market model approach based on the one-factor market model by Sharpe (1964) and Lintner (1965) to account for any systematic risk during the event window. We calculate expected returns with the following market model:

\[ E[r_{i,t}] = \alpha_i + \beta_i r_{m,t} + \epsilon_{i,t} \] (4.4)

Where:

- \( E[r_{i,t}] \): Expected return of firm \( i \) at time \( t \)
- \( \alpha_i \): Constant return component
- \( \beta_i \): Slope of regression line
- \( r_{m,t} \): Return on the market at time \( t \)
- \( \epsilon_{i,t} \): Error term

We assume that the error term is normally distributed, has a mean of zero and a constant variance:

\[ E[\epsilon_{i,t}] = 0 \text{ and, } \]
\[ var(\epsilon_{i,t}) = \sigma_i^2 \]

We conduct linear regressions for each firm \( i \), in each estimation window \( (T_0 - T_1) \) to estimate the alpha \( (\alpha_i) \) and the coefficient \( (\beta_i) \). To calculate the expected return \( (r_{i,t}) \) over the event window \( (T_1 - T_2) \) we combine the values of \( \alpha_i \) and \( \beta_i \), estimated in the regression to find the expected return.
Thus, we can rearrange formula 4.1:

\[ AR_{i,t} = r_{i,t} - (\alpha_i + \beta_1 r_{m,t} + \epsilon_{i,t}) \]  

(4.5)

The error term \((\epsilon_{i,t})\) is interpreted as the return deviation resulting from unanticipated interest rate changes. We expect the unanticipated interest rate changes to affect the error term, resulting in significant abnormal returns. We anticipate the abnormal returns to be positive on events where net anticipation of market participants exceeds the actual change of the MPC. In contrast, the abnormal returns should be negative when the unanticipated interest rate change classifies as positive. Furthermore, we expect a significant deviation between abnormal returns of unanticipated and anticipated interest rate changes.

4.4. Testing for significance

When analysing interest rate changes, we focus on the performance of the estimated residuals around interest rate increases separately from the performance of those around interest rate decreases. We analyse these events separately to account for the case that interest rate increases have different market expectations than interest rate decreases. We pool together all abnormal returns within each category (positive, negative and neutral) and calculate the average abnormal return for each category:

\[ \overline{AR} = \frac{1}{N} \sum_{t=1}^{T} AR_{i,t} \]

Where, \(N\) denotes the number of abnormal returns within each category.

We define outliers with the signed score of standard deviations. If a data points standardized score is higher than 3.5, we define it as an outlier and exclude it from the data set:

\[ \left| \frac{AR_{i,t} - \overline{AR}}{\sigma_{AR_t}} \right| > 3.5 \]
Where,

\[ \sigma_{AR_t} = \text{the standard deviation of abnormal returns} \]

To test for statistical significance of abnormal returns we conduct a t-test for each subsample (neutral, negative and positive) on each day in the event window:

\[ t_{AR_k} = \frac{AR_{lt}}{\frac{s_{AR_{lt}}}{\sqrt{N}}} \]

We calculate the variance for abnormal returns during the event window by:

\[ s^2_{AR_k} = \frac{1}{N-1} \sum_{t=0}^{T_1} (AR_{lt} - \bar{AR}_t)^2 \]

Where, \( N \) stands for the number of abnormal returns during the event window. The standard deviation is defined by the square root of the variance:

\[ S_{AR_t} = \sqrt{\frac{1}{N-1} \sum_{t=0}^{T_1} (AR_{lt} - \bar{AR}_t)^2} \]

We examine the significance of the CAR using the t-statistic defined by:

\[ t_{CAR_k} = \frac{CAR_k}{\frac{s_{CAR_k}}{\sqrt{N}}} \]

Where the variance is defined as:

\[ s^2_{CAR_k} = (T_2 - T_1) \sum_{i=1}^{N} (s^2_{AR_{lt}}) \]

And the standard deviation is defined as the square root of the variance:

\[ S_{CAR_k} = \sqrt{(T_2 - T_1) \sum_{i=1}^{N} (s^2_{AR_{lt}})} \]
To examine if abnormal returns differ between event windows where interest rate changes are anticipated and unanticipated we test the samples of positive effects and negative against neutral ones:

\[ t_k = \frac{(\bar{AR}_{t,k} - \bar{AR}_{t,neutral}) - (\bar{AR}_{t,k} - \bar{AR}_{t,neutral})}{\sqrt{\frac{s^2_k}{N_k} + \frac{s^2_{neutral}}{N_{neutral}}}} \]

Where \( k \) denotes either the positive or the negative subsample.

### 4.5. Regression analysis

As previously mentioned, it is essential to differentiate between anticipated and unanticipated interest rate changes. Following Bernanke and Kuttner (2005) we introduce a variable to denote unanticipated interest rate changes. To examine the relation between interest rate changes and stock prices we apply the following regression model:

\[ AR = \beta_0 + \beta_1 \Delta i_t^u + \varepsilon_t \quad (4.6) \]

Where:

- \( AR \): Abnormal return of stocks.
- \( \beta_1 \): Coefficient of unanticipated interest rate changes.
- \( \Delta i_t^u \): Unanticipated interest rate change
- \( \varepsilon_t \): Error term.

This analysis gives us a measure on how market participants respond to unanticipated interest rate changes. If an announcement effect exists within the Icelandic market, the coefficient for unanticipated interest rate changes should be significant and negative. To analyze market efficiency within the interest rate context we apply the regression to the three days following the announcement. In addition, we regress the cumulative abnormal returns for the 3-day period after the announcement day on unanticipated interest rate changes. If the market is inefficient when it comes to incorporate unanticipated interest rate changes, the coefficient should be negative and significant.
5. Empirical results

5.1. Constant mean return model

We present the results for the first part of the event study where we analyze abnormal returns (AR) as well as cumulative abnormal returns (CAR) in tables 3 to 10.

Table 3

Abnormal returns in the event window of events categorized as negative interest rate changes calculated with the constant mean return model.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>St. Dev</th>
<th>Observations</th>
<th>t-Statistic</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>AR (-3)</td>
<td>-0.308% ***</td>
<td>0.006</td>
<td>62</td>
<td>-3.898</td>
<td>0.000</td>
</tr>
<tr>
<td>AR (-2)</td>
<td>-0.142%</td>
<td>0.009</td>
<td>62</td>
<td>-1.185</td>
<td>0.241</td>
</tr>
<tr>
<td>AR (-1)</td>
<td>-0.093%</td>
<td>0.011</td>
<td>62</td>
<td>-0.657</td>
<td>0.514</td>
</tr>
<tr>
<td>AR (0)</td>
<td>1.076% ***</td>
<td>0.018</td>
<td>61</td>
<td>4.732</td>
<td>0.000</td>
</tr>
<tr>
<td>AR (1)</td>
<td>-0.223%</td>
<td>0.014</td>
<td>61</td>
<td>-1.232</td>
<td>0.223</td>
</tr>
<tr>
<td>AR (2)</td>
<td>0.032%</td>
<td>0.013</td>
<td>61</td>
<td>0.191</td>
<td>0.849</td>
</tr>
<tr>
<td>AR (3)</td>
<td>-0.207%</td>
<td>0.012</td>
<td>61</td>
<td>-1.319</td>
<td>0.192</td>
</tr>
</tbody>
</table>

Notes. *Significant at the 10-percent level; **significant at the 5-percent level; ***significant at the 1-percent level. Based on two-tailed non-parametric t-test.

This table shows the mean abnormal returns for negative interest rate surprises. The abnormal returns are calculated using expected returns derived with the constant mean return model. Abnormal returns are calculated for each day in the event window.

Table 3 presents the mean abnormal return (AR) and corresponding t-values from the seven interest rate announcements that are categorized as negative. We test the mean value of abnormal returns on each day within the event window against zero.

As expected, the AR is positive and significantly different from zero on the announcement day. Abnormal returns are evident on the day of the unanticipated interest rate changes, supporting the existence of an announcement effect. The results are also consistent with the implied economic notion that interest rate changes are inversely related to stock prices. As the expectations of market participants exceed the actual interest rate change, the unanticipated interest rate change is a net interest rate decrease. As market participants incorporate the new information into their pricing models stock prices increase.

Contrary to our expectations, the mean values on days following the interest rate announcement are close to zero and not statistically significant. It is interesting that the mean value of abnormal returns is not always positive on days following the event day. An explanation could be that market participants over-adjust their portfolio on the event day. Market participants might have different opinions on how much the unanticipated interest rate change affects the market and adjust their portfolios differently. All days within the event
window prior to the day of announcement display a negative $\bar{AR}$ although it is only statistically significant for AR (0) and AR (-3). A likely explanation might be portfolio adjustments of market participants as they incorporate interest rate expectations to their pricing models. To analyze the efficiency of the market further it is essential to evaluate the cumulate abnormal returns.

**Table 4**

Cumulative abnormal returns in the event window of events categorized as negative interest rate changes calculated with the constant mean return model.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>St. Dev</th>
<th>Observations</th>
<th>t-Statistic</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAR(-3,-1)</td>
<td>-0.543%***</td>
<td>0.011</td>
<td>62</td>
<td>-3.754</td>
<td>0.000</td>
</tr>
<tr>
<td>CAR (-3,3)</td>
<td>0.468%</td>
<td>0.030</td>
<td>62</td>
<td>1.234</td>
<td>0.222</td>
</tr>
<tr>
<td>CAR (-2,2)</td>
<td>0.573%</td>
<td>0.029</td>
<td>62</td>
<td>1.576</td>
<td>0.120</td>
</tr>
<tr>
<td>CAR (-1,1)</td>
<td>0.746%**</td>
<td>0.024</td>
<td>62</td>
<td>2.424</td>
<td>0.018</td>
</tr>
<tr>
<td>CAR (1,3)</td>
<td>-0.048%</td>
<td>0.022</td>
<td>62</td>
<td>-0.175</td>
<td>0.861</td>
</tr>
<tr>
<td>Negative - neutral</td>
<td>0.746%*</td>
<td>0.024</td>
<td>62</td>
<td>1.933</td>
<td>0.057</td>
</tr>
</tbody>
</table>

Notes. *Significant at the 10-percent level; **significant at the 5-percent level; ***significant at the 1-percent level. Based on two-tale non-parametric t-test.

This table shows the mean cumulative abnormal returns for negative interest rate surprises. The abnormal returns are calculated using expected returns derived with the constant mean return model. The event window is from three days before until three days after interest rate announcements. The last row compares negative interest rate surprises to anticipated interest rate changes.

Table 4 presents the mean value of cumulative abnormal returns ($\bar{CAR}$) and a comparison between net negative interest rate changes and correctly anticipated announcements. We test the mean value of cumulative abnormal returns against zero in rows one through five and in row six we test negative and neutral $\bar{CAR}$($-1,1$) against each other.

The mean value for cumulative abnormal returns for the three-day period from one day prior to one day after (-1,1) the event is positive and statistically different from zero within the 95% confidence level, which is in line with our expectations. However, the mean value of the cumulative abnormal returns for the days after the announcement (1,3) is negative and does not significantly deviate from zero. These results are in contrast with our expectations as we expected the low liquidity of the Icelandic market to affect how efficiently market participant incorporate the unanticipated interest rate changes. The market appears to adapt quickly to the information obtained from the unanticipated component of the announcement. These results suggest a semi-strong form of market efficiency in the context of interest rate changes.
We fail to reject the hypothesis that mean values of cumulative abnormal returns for negative and neutral effect are the same at the 5% confidence level. However, the results are significant within the 10% confidence level implying that the unanticipated element of the interest change affects abnormal returns over the event window.

Table 5
Abnormal returns in the event window of events categorized as positive interest rate changes calculated with the constant mean return model.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>St. Dev</th>
<th>Observations</th>
<th>t-Statistic</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>AR (-3)</td>
<td>0.018%</td>
<td>0.015</td>
<td>54</td>
<td>0.089</td>
<td>0.929</td>
</tr>
<tr>
<td>AR (-2)</td>
<td>-0.039%</td>
<td>0.018</td>
<td>56</td>
<td>-0.164</td>
<td>0.870</td>
</tr>
<tr>
<td>AR (-1)</td>
<td>-0.227%</td>
<td>0.014</td>
<td>56</td>
<td>-1.192</td>
<td>0.238</td>
</tr>
<tr>
<td>AR (0)</td>
<td>-0.765%***</td>
<td>0.016</td>
<td>55</td>
<td>-3.482</td>
<td>0.001</td>
</tr>
<tr>
<td>AR (1)</td>
<td>-0.040%</td>
<td>0.013</td>
<td>55</td>
<td>-0.225</td>
<td>0.823</td>
</tr>
<tr>
<td>AR (2)</td>
<td>-0.276%</td>
<td>0.014</td>
<td>56</td>
<td>-1.467</td>
<td>0.148</td>
</tr>
<tr>
<td>AR (3)</td>
<td>-0.195%*</td>
<td>0.008</td>
<td>55</td>
<td>-1.904</td>
<td>0.062</td>
</tr>
</tbody>
</table>

Notes. *Significant at the 10-percent level; **significant at the 5-percent level; ***significant at the 1-percent level. Based on two-tail non-parametric t-test.

This table shows the mean abnormal returns for positive interest rate surprises. The abnormal returns are calculated using expected returns derived with the constant mean return model. Abnormal returns are calculated for each day in the event window.

Table 5 presents the mean value of abnormal returns (\(\bar{AR}\)) and their corresponding t-values for all the examined abnormal returns within the event window where interest rate announcements comprised a positive surprise. We test the mean values of abnormal returns on each day within the event window against zero.

As hypothesized, the \(\bar{AR}\) on the day of unanticipated interest rate changes is negative and significantly deviates from zero. These results further verify the presence of an announcement effect as market participants integrate the surprise element of the announcement into their pricing models. These results are again consistent with other studies that show an inverse relationship between interest rate changes and stock prices.

As expected, the mean values of the abnormal returns are negative on all days in the event window. A likely explanation for these results is that market participants might be inefficient when incorporating unanticipated interest rate changes. However, the mean values are close to zero and only statistically significant on the third day after the announcement. To examine the efficiency of the market when it comes to positive interest rate surprises, we need to examine the cumulative abnormal returns as well.
Table 6

Cumulative abnormal returns in the event window of events categorized as positive interest rate changes calculated with the constant return model.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>St. Dev</th>
<th>Observations</th>
<th>t-Statistic</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$CAR(-3,-1)$</td>
<td>-0.249%</td>
<td>0.026</td>
<td>56</td>
<td>-0.727</td>
<td>0.470</td>
</tr>
<tr>
<td>$CAR(-3,3)$</td>
<td>-0.572%</td>
<td>0.035</td>
<td>56</td>
<td>-1.239</td>
<td>0.221</td>
</tr>
<tr>
<td>$CAR(-2,2)$</td>
<td>-0.780%*</td>
<td>0.030</td>
<td>56</td>
<td>-1.943</td>
<td>0.057</td>
</tr>
<tr>
<td>$CAR(-1,1)$</td>
<td>-1.017%***</td>
<td>0.023</td>
<td>56</td>
<td>-3.322</td>
<td>0.002</td>
</tr>
<tr>
<td>$CAR(1,3)$</td>
<td>0.428%</td>
<td>0.022</td>
<td>56</td>
<td>1.436</td>
<td>0.157</td>
</tr>
<tr>
<td>Positive - Neutral</td>
<td>-1.017%***</td>
<td>0.023</td>
<td>56</td>
<td>-3.463</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Notes. *Significant at the 10-percent level; **significant at the 5-percent level; ***significant at the 1-percent level. Based on two-tale non-parametric t-test.

This table shows the mean cumulative abnormal returns for positive interest rate surprises. The abnormal returns are calculated using expected returns derived with the constant mean return model. The event window is from three days before until three days after interest rate announcements. The last row compares mean stock returns during positive interest rate surprises to stock returns during anticipated interest rate changes.

Table 6 presents the mean value of cumulative abnormal returns ($\overline{CAR}$) and a comparison between positive and neutral subsamples. We test the mean value of the cumulative abnormal returns against zero in rows one to five. In row six we test the positive $\overline{CAR}$ against the neutral $\overline{CAR}$ for the period from one day prior to one day after the interest rate announcement (-1,1).

As anticipated, the mean value of all periods containing the event day is negative although only $\overline{CAR}$ (-1,1) and $\overline{CAR}$ (-2,2) are statistically significant. However, the results differ from our expectation since the mean value of cumulative abnormal returns for the three-day period after the announcement (1,3) is positive and not statistically different from zero. These results suggest that market participants in the Icelandic market efficiently incorporate interest rate changes into their pricing models. Overall, the results further substantiate the claim that the Icelandic market is semi-strong efficient within the interest rate context.

These results show that $\overline{CAR}$ (-1,1) for positive and neutral effects are different from each other with a statistical significant at p<0.01. This is consistent with our hypothesis that unanticipated interest rate changes affect abnormal returns of stocks.
Table 7

Abnormal returns in the event window of interest rate changes categorized as neutral and calculated with the constant return model.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>St. Dev</th>
<th>Observations</th>
<th>t-Statistic</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>AR (-3)</td>
<td>0.051%</td>
<td>0.013</td>
<td>362</td>
<td>0.755</td>
<td>0.451</td>
</tr>
<tr>
<td>AR (-2)</td>
<td>0.024%</td>
<td>0.013</td>
<td>363</td>
<td>0.354</td>
<td>0.724</td>
</tr>
<tr>
<td>AR (-1)</td>
<td>0.230%***</td>
<td>0.014</td>
<td>362</td>
<td>3.044</td>
<td>0.003</td>
</tr>
<tr>
<td>AR (0)</td>
<td>0.043%</td>
<td>0.013</td>
<td>361</td>
<td>0.641</td>
<td>0.522</td>
</tr>
<tr>
<td>AR (1)</td>
<td>-0.160%</td>
<td>0.013</td>
<td>361</td>
<td>-2.382</td>
<td>0.018</td>
</tr>
<tr>
<td>AR (2)</td>
<td>-0.055%</td>
<td>0.013</td>
<td>362</td>
<td>-0.825</td>
<td>0.400</td>
</tr>
<tr>
<td>AR (3)</td>
<td>-0.238%***</td>
<td>0.012</td>
<td>364</td>
<td>-3.859</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Notes. *Significant at the 10-percent level; **significant at the 5-percent level; ***significant at the 1-percent level. Based on two-tale non-parametric t-test.

This table shows the mean abnormal returns for the neutral category. The abnormal returns are calculated using expected returns derived with the constant mean return model. The event window is from three days before until three days after interest rate announcements. Abnormal returns are calculated for each day.

Table 7 presents the mean value of abnormal returns (\(\overline{AR}\)) and corresponding t-values from the 42 interest rate announcements that are categorized as neutral. We test the mean values of abnormal returns on each day within the event window against zero.

As expected, the mean values are close to zero and show no evidence of an announcement effect on the event day. As market participants anticipate interest rate changes correctly, they have already incorporated their estimate within their pricing models. The results also support the notion that anticipated interest changes do not affect abnormal returns.

On the day before the interest rate announcement, we observe a positive \(\overline{AR}\) that is significantly different from zero. A likely explanation is that market participants are adjusting their pricing models in accordance to their expectations for the upcoming interest rate change. The third day after the interest rate change, we also observe a negative \(\overline{AR}\) significantly different from zero. An explanation for this might be over-adjustment from portfolio managers of the interest rate change the day before.
Table 8

Cumulative abnormal returns in the event window of interest rate changes categorized as neutral and calculated with the constant return model.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>St. Dev</th>
<th>Observations</th>
<th>t-Statistic</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAR (-3,-1)</td>
<td>-0.304%***</td>
<td>0.022</td>
<td>364</td>
<td>-2.692</td>
<td>0.007</td>
</tr>
<tr>
<td>CAR (-3,3)</td>
<td>0.411%**</td>
<td>0.032</td>
<td>364</td>
<td>2.484</td>
<td>0.013</td>
</tr>
<tr>
<td>CAR (-2,2)</td>
<td>0.191%</td>
<td>0.029</td>
<td>364</td>
<td>1.277</td>
<td>0.203</td>
</tr>
<tr>
<td>CAR (-1,1)</td>
<td>0.113%</td>
<td>0.022</td>
<td>364</td>
<td>1.001</td>
<td>0.317</td>
</tr>
<tr>
<td>CAR (1,3)</td>
<td>0.065%</td>
<td>0.022</td>
<td>364</td>
<td>0.567</td>
<td>0.569</td>
</tr>
</tbody>
</table>

Notes. *Significant at the 10-percent level; **significant at the 5-percent level; ***significant at the 1-percent level. Based on two-tailed non-parametric t-test.

This table shows the mean cumulative abnormal returns for neutral interest rate changes. The abnormal returns are calculated using expected returns derived with the constant mean return model. The event window is from three days before until three days after interest rate announcements. The last two rows compare mean stock returns during positive and negative interest rate surprises to stock returns during anticipated interest rate changes.

Table 8 presents the mean cumulative abnormal returns (CAR) and its corresponding t-values for all examined firms during announcements where interest rate changes are correctly anticipated. We test the mean values of cumulative abnormal returns on each day within the event window against zero.

As expected, the cumulative abnormal returns are close to zero and all windows containing the announcement are statistically insignificant. However, the CAR on days before the announcement significantly deviates from zero. An explanation might be portfolio adjustments as investors estimate the possible interest rate change or react to other market wide events. The CAR over the entire event window displays a positive value that is statistically different from zero at p<0.05. Because shorter periods that contain the event day display a mean value close to zero a likely explanation for the significant results for the CAR (-3,3) are other market wide events unrelated to the interest rate change that affect stock returns.
Table 9

Comparison of abnormal returns between effects on the event day.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>St. Dev</th>
<th>Observations</th>
<th>t-Statistic</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative effect - AR (0)</td>
<td>1.076%***</td>
<td>0.0178</td>
<td>61</td>
<td>4.359</td>
<td>0.001</td>
</tr>
<tr>
<td>Positive effect - AR (0)</td>
<td>-0.765%***</td>
<td>0.0163</td>
<td>55</td>
<td>-3.518</td>
<td>0.001</td>
</tr>
<tr>
<td>Neutral effect - AR (0)</td>
<td>0.043%</td>
<td>0.0127</td>
<td>361</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes. *Significant at the 10-percent level; **significant at the 5-percent level; ***significant at the 1-percent level. Based on two-tale non-parametric t-test.

This table compares abnormal returns during positive and negative interest rate surprises to returns during expected interest rate changes. The abnormal returns are calculated using expected returns derived with the constant mean return model. The comparison is for the event day only.

Table 9 presents the results of a comparison between abnormal returns of events where interest rate changes are unanticipated and events where interest rate changes are anticipated correctly. As expected, both subsamples (negative and positive) display statistically significant differences in the mean value of abnormal returns compared to the mean of events within neutral. These results further verify the announcement effect that appears when interest rate changes are unanticipated.

5.2. Market model

The results for the second part of the event study where we analyze abnormal returns (AR) as well as cumulative abnormal returns (CAR) based on the market model are presented in table 10 to table 17.

Table 10

Abnormal returns in the event window of events categorized as negative interest rate changes calculated with the market model.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>St. Dev</th>
<th>Observations</th>
<th>t-Statistic</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>AR(-3)</td>
<td>-0.083%</td>
<td>0.018</td>
<td>56</td>
<td>-0.338</td>
<td>0.737</td>
</tr>
<tr>
<td>AR(-2)</td>
<td>0.068%</td>
<td>0.013</td>
<td>61</td>
<td>0.409</td>
<td>0.684</td>
</tr>
<tr>
<td>AR(-1)</td>
<td>-0.185%</td>
<td>0.014</td>
<td>61</td>
<td>-1.014</td>
<td>0.315</td>
</tr>
<tr>
<td>AR(0)</td>
<td>1.112%***</td>
<td>0.018</td>
<td>61</td>
<td>4.943</td>
<td>0.001</td>
</tr>
<tr>
<td>AR(1)</td>
<td>-0.052%</td>
<td>0.011</td>
<td>62</td>
<td>-0.358</td>
<td>0.721</td>
</tr>
<tr>
<td>AR(2)</td>
<td>-0.101%</td>
<td>0.010</td>
<td>62</td>
<td>-0.835</td>
<td>0.407</td>
</tr>
<tr>
<td>AR(3)</td>
<td>-0.267%***</td>
<td>0.006</td>
<td>62</td>
<td>-3.326</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Notes. *Significant at the 10-percent level; **significant at the 5-percent level; ***significant at the 1-percent level. Based on two-tale non-parametric t-test.

This table shows the mean abnormal returns for negative interest rate surprises. The abnormal returns are calculated with expected returns derived from the market model. Abnormal returns are calculated for each day in the event window.
Table 10 presents the mean abnormal return (\(\overline{AR}\)) and corresponding t-values from the seven interest rate announcements where interest rate changes are categorized as negative. We test the mean values of abnormal returns on each day within the event window against zero.

Again, we observe positive \(\overline{AR}\) significantly different from zero on the announcement day. These results are consistent with former results obtained with the constant mean model and substantiate the existence of an announcement. The results remain consistent with economic theory that interest rate changes affect stock prices inversely. As with the constant mean model, the mean value on days following the announcement are close to zero and not statistically significant. These results give additional support for the notion that the market is efficient when incorporating unanticipated interest rate changes. To evaluate market efficiency more thoroughly we examine the \(\overline{CAR}\)s for events that are categorized as negative.

Table 11
Cumulative abnormal returns in the event window of events categorized as negative interest rate changes calculated with the market model.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>St.Dev</th>
<th>Observations</th>
<th>t-Statistic</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAR(-3,-1)</td>
<td>-0.283%</td>
<td>0.023</td>
<td>62</td>
<td>-0.970</td>
<td>0.336</td>
</tr>
<tr>
<td>CAR(-3,3)</td>
<td>0.391%</td>
<td>0.031</td>
<td>62</td>
<td>1.012</td>
<td>0.316</td>
</tr>
<tr>
<td>CAR(-2,2)</td>
<td>0.826%**</td>
<td>0.028</td>
<td>62</td>
<td>2.319</td>
<td>0.024</td>
</tr>
<tr>
<td>CAR(-1,1)</td>
<td>0.860%***</td>
<td>0.024</td>
<td>62</td>
<td>2.781</td>
<td>0.007</td>
</tr>
<tr>
<td>CAR(1,3)</td>
<td>-0.419%**</td>
<td>0.013</td>
<td>62</td>
<td>-2.629</td>
<td>0.011</td>
</tr>
<tr>
<td>Negative CAR(-1,1)</td>
<td>0.8603%**</td>
<td>0.02436</td>
<td>62</td>
<td>2.5123</td>
<td>0.0140</td>
</tr>
</tbody>
</table>

Notes. *Significant at the 10-percent level; **significant at the 5-percent level; ***significant at the 1-percent level. Based on two-tail non-parametric t-test.
This table shows the mean cumulative abnormal returns for negative interest rate surprises. The abnormal returns are calculated with expected returns derived from the market model. The event window is from three days before until three days after interest rate announcements. The last row compares negative interest rate surprises to anticipated interest rate changes.

Table 11 presents the mean cumulative abnormal (\(\overline{CAR}\)) and corresponding t-values for all negative interest rate surprises. The last row presents the results from a comparison of \(\overline{CAR}\) of events that have negative interest rate surprises and \(\overline{CAR}\) for events with correctly anticipated interest rate changes. We test the mean values of cumulative abnormal returns on each day within the event window against zero. We observe \(\overline{CAR}\)s statistically significant for three out of the five periods examined. Consistent with the constant mean model the \(\overline{CAR}\) for the three-day period from one day prior to one day after the interest rate announcement (-1,1)
is positive and different from zero at p<0.01. This further supports our claim that unanticipated interest rate changes reflect new information for market participants to incorporate to their pricing models.

However, for the three-day period following the interest rate announcement we observe a negative ĈAR that is significantly different from zero. This is not in line with our expectations that market participants are inefficient when incorporating unanticipated interest rate changes. The results suggest that market participants overreact to the initial interest rate change and adjust their portfolios in the following days. Even though these results are inconsistent with the constant mean model they still substantiate the argument for semi-strong market efficiency when analyzing the effects of interest rate changes. The findings from analyzing negative interest rate surprises suggest that Icelandic market participants incorporate interest rate changes for the most part on the announcement day, but could also suggest that some adjusted their portfolios at a later stage. Another explanation might be increased noise in the returns from other events independent of interest rate changes.

Our findings for the comparison are significant at p<0.05 and indicate that there is a significant difference between cumulative abnormal return of anticipated and unanticipated interest rate changes within the negative category. These results suggest that unanticipated interest rate changes significantly affect abnormal returns in the one-day period around the interest rate announcement (-1,1).

Table 12

<table>
<thead>
<tr>
<th>Event Window</th>
<th>Mean</th>
<th>St. Dev</th>
<th>Observations</th>
<th>t-Statistic</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>AR(-3)</td>
<td>-0.242%**</td>
<td>0.008</td>
<td>55</td>
<td>-2.317</td>
<td>0.024</td>
</tr>
<tr>
<td>AR(-2)</td>
<td>-0.319%*</td>
<td>0.014</td>
<td>56</td>
<td>-1.693</td>
<td>0.096</td>
</tr>
<tr>
<td>AR(-1)</td>
<td>-0.084%</td>
<td>0.014</td>
<td>55</td>
<td>-0.454</td>
<td>0.652</td>
</tr>
<tr>
<td>AR(0)</td>
<td>-0.788%***</td>
<td>0.016</td>
<td>55</td>
<td>-3.582</td>
<td>0.001</td>
</tr>
<tr>
<td>AR(1)</td>
<td>-0.270%</td>
<td>0.014</td>
<td>56</td>
<td>-1.443</td>
<td>0.155</td>
</tr>
<tr>
<td>AR(2)</td>
<td>-0.083%</td>
<td>0.018</td>
<td>56</td>
<td>-0.338</td>
<td>0.737</td>
</tr>
<tr>
<td>AR(3)</td>
<td>-0.027%</td>
<td>0.014</td>
<td>54</td>
<td>-0.141</td>
<td>0.889</td>
</tr>
</tbody>
</table>

Notes. *Significant at the 10-percent level; **significant at the 5-percent level; ***significant at the 1-percent level. Based on two-tale non-parametric t-test.

This table shows the mean abnormal returns for positive interest rate surprises. The abnormal returns are calculated with expected returns derived from the market model. Abnormal returns are calculated for each day in the event window.
Table 12 presents the mean abnormal returns ($AR$) and corresponding t-values for all the examined abnormal returns within the event window where interest rate announcements had a positive effect. We test the mean abnormal returns of all seven interest rate announcements with a negative effect against zero.

The mean abnormal return for all observations is negative and statistically significant on three occasions. In line with our expectations, the $AR$ is negative and significantly deviates from zero on the day of unanticipated interest rate changes. On days following the announcement, we observe negative $AR$s although close to zero and not statistically significant. These results are against our expectations as we hypothesized that market participants might be inefficient in incorporating new information.

Three days before the interest rate announcement, we observe a deviation from zero significant at $p<0.05$ and two days before the announcement we observe a deviation significant at $p<0.1$. As mentioned earlier, a likely explanation for these values are portfolio adjustments in advance of the announcement. These results further indicate that the announcement effect exists and that unexpected interest rate changes influence stock returns significantly. To analyze market efficiency more precisely, we examine cumulative abnormal returns over the event period.

<table>
<thead>
<tr>
<th>Event Window</th>
<th>Mean</th>
<th>St. Dev</th>
<th>Observations</th>
<th>t-Statistic</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAR(-3,-1)</td>
<td>-0.639%</td>
<td>0.023</td>
<td>56</td>
<td>-2.136</td>
<td>0.037</td>
</tr>
<tr>
<td>CAR(-3,3)</td>
<td>-1.792%</td>
<td>0.037</td>
<td>56</td>
<td>-3.637</td>
<td>0.001</td>
</tr>
<tr>
<td>CAR(-2,2)</td>
<td>-1.528%</td>
<td>0.033</td>
<td>56</td>
<td>-3.492</td>
<td>0.001</td>
</tr>
<tr>
<td>CAR(-1,1)</td>
<td>-1.126%</td>
<td>0.023</td>
<td>56</td>
<td>-3.637</td>
<td>0.001</td>
</tr>
<tr>
<td>CAR(1,3)</td>
<td>-0.379%</td>
<td>0.026</td>
<td>56</td>
<td>-1.107</td>
<td>0.273</td>
</tr>
<tr>
<td>Positive CAR(1,-1)</td>
<td>-1.1259%***</td>
<td>0.02316</td>
<td>56</td>
<td>-3.487</td>
<td>0.0008</td>
</tr>
</tbody>
</table>

Table 13

Cumulative abnormal returns in the event window of events categorized as positive interest rate changes calculated with the market model.  

Table 13 presents the mean cumulative abnormal returns ($CAR$) and its corresponding t-values for all examined firms during event windows with where interest rate changes are
categorized as positive. The last row presents the results from a comparison of $\overline{CAR}$ of events that have positive interest rate surprises and $\overline{CAR}$ for events with correctly anticipated interest rate changes. We test the mean values of cumulative abnormal returns on each day within the event window against zero.

The $\overline{CAR}$ is statistically significant for all periods that include the announcement day, further supporting the notion that unanticipated interest rate changes affect abnormal returns over time. It is interesting to see that the $\overline{CAR}$ (-3,3) is substantially larger than the $\overline{CAR}$ (-1,1). Contrary to the constant mean model, the $\overline{CAR}$ is negative over the three-day period following the announcement, although not statistically significant. Thus, the results provide little support for our claim that the Icelandic market is inefficient. Our findings for the comparison are significant at $p<0.01$ and indicate that there is a significant difference between cumulative abnormal return of anticipated and unanticipated interest rate changes within the positive category. These results suggest that unanticipated interest rate changes significantly affect abnormal returns in the one-day period around the interest rate announcement (-1,1).
Abnormal returns in the event window of events categorized as neutral interest rate changes calculated with the market model.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>St. Dev</th>
<th>Observations</th>
<th>t-Statistic</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>AR(-3)</td>
<td>-0.225%***</td>
<td>0.0118</td>
<td>323</td>
<td>-3.422</td>
<td>0.001</td>
</tr>
<tr>
<td>AR(-2)</td>
<td>-0.078%</td>
<td>0.0122</td>
<td>321</td>
<td>-1.137</td>
<td>0.256</td>
</tr>
<tr>
<td>AR(-1)</td>
<td>-0.159%**</td>
<td>0.0126</td>
<td>321</td>
<td>-2.249</td>
<td>0.025</td>
</tr>
<tr>
<td>AR(0)</td>
<td>0.063%</td>
<td>0.0125</td>
<td>320</td>
<td>0.905</td>
<td>0.366</td>
</tr>
<tr>
<td>AR(1)</td>
<td>0.125%</td>
<td>0.0142</td>
<td>321</td>
<td>1.573</td>
<td>0.117</td>
</tr>
<tr>
<td>AR(2)</td>
<td>0.063%</td>
<td>0.0125</td>
<td>322</td>
<td>0.909</td>
<td>0.364</td>
</tr>
<tr>
<td>AR(3)</td>
<td>-0.004%</td>
<td>0.0131</td>
<td>321</td>
<td>-0.047</td>
<td>0.963</td>
</tr>
</tbody>
</table>

Notes. *Significant at the 10-percent level; **significant at the 5-percent level; ***significant at the 1-percent level. Based on two-tale non-parametric t-test.

This table shows the mean abnormal returns for neutral interest rate changes. The abnormal returns are calculated with expected returns derived from the market model. Abnormal returns are calculated for each day in the event window.

Table 14 presents mean abnormal returns (\(\overline{AR}\)) and corresponding t-values from the 42 interest rate announcements in the neutral category. We test the mean values of abnormal returns on each day within the event window against zero.

For neutral effect announcements, the mean values are close to zero and does not significantly differ from zero on the day of interest rate announcements. Providing more support for our claim that anticipated interest rate changes do not result in any announcement effect on stock returns.

Three days before the announcement \(\overline{AR}\) deviates from zero, with the deviation being significant at p<0.01. 1 day before the announcement \(\overline{AR}\) significantly deviated from zero at p<0.05. However, these deviations are small and likely explained by different expectations of the size of the interest rate change.
Table 15

Cumulative abnormal returns in the event window of events categorized as neutral interest rate changes calculated with the market model.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>St. Dev</th>
<th>Observations</th>
<th>t-Statistic</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAR(-3,-1)</td>
<td>-0.395%***</td>
<td>0.0302</td>
<td>323</td>
<td>-2.352</td>
<td>0.019</td>
</tr>
<tr>
<td>CAR(-3,3)</td>
<td>-0.214%</td>
<td>0.0317</td>
<td>323</td>
<td>-1.212</td>
<td>0.226</td>
</tr>
<tr>
<td>CAR(-2,2)</td>
<td>0.015%</td>
<td>0.0284</td>
<td>323</td>
<td>0.094</td>
<td>0.925</td>
</tr>
<tr>
<td>CAR(-1,1)</td>
<td>0.029%</td>
<td>0.0211</td>
<td>323</td>
<td>0.245</td>
<td>0.806</td>
</tr>
<tr>
<td>CAR(1,3)</td>
<td>0.183%</td>
<td>0.0217</td>
<td>323</td>
<td>1.523</td>
<td>0.129</td>
</tr>
</tbody>
</table>

Notes. *Significant at the 10-percent level; **significant at the 5-percent level; ***significant at the 1-percent level. Based on two-tale non-parametric t-test.

This table shows the mean cumulative abnormal returns for neutral interest rate changes. The abnormal returns are calculated with expected returns derived from the market model. Abnormal The event window is from three days before until three days after interest rate announcements. The last two rows compare positive and negative interest rate surprises to anticipated interest rate changes.

Table 15 presents the mean cumulative abnormal returns (\(CAR\)) and corresponding t-values for interest rate changes that are correctly anticipated by market participants. We test the mean values of cumulative abnormal returns on each day within the event window against zero.

None of the tested periods containing the interest rate announcement displays a significant deviation from zero, substantiating the argument that anticipated interest rate changes do not affect stock returns. The results from this table indicate that portfolios have been adjusted accordingly in advance of interest rate changes and therefore no abnormal returns can be measured in the event window.
Table 16

Comparison of abnormal returns between effects on the event day calculated with the market model.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>St. Dev</th>
<th>Observations</th>
<th>t-Statistic</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive AR(0)</td>
<td>-0.788%***</td>
<td>0.016</td>
<td>55</td>
<td>-3.688</td>
<td>0.001</td>
</tr>
<tr>
<td>Negative AR(0)</td>
<td>1.112%***</td>
<td>0.018</td>
<td>61</td>
<td>4.453</td>
<td>0.001</td>
</tr>
<tr>
<td>Neutral AR(0)</td>
<td>0.063%</td>
<td>0.013</td>
<td>320</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes. *Significant at the 10-percent level; **significant at the 5-percent level; ***significant at the 1-percent level. Based on two-tale non-parametric t-test.

This table compares abnormal returns during positive and negative interest rate surprises to returns during expected interest rate changes. The abnormal returns are calculated using expected returns derived from the market model. The comparison is done for the event day only.

Table 16 presents the results of a comparison between abnormal returns of events where interest rate changes are unanticipated and events where interest rate changes are anticipated correctly. We tested the mean abnormal returns of both positive and negative categories against neutral. The deviation found is significant at p<0.01. This suggests that there is a significant difference in stock returns between correctly anticipated and unanticipated interest rate changes. As expected, these results provide further evidence for the presence of an announcement effect.
5.3. Regression analysis

Table 17

Regression analysis of abnormal returns on and after days of interest rate surprises where abnormal returns are estimated with the constant mean return model.

<table>
<thead>
<tr>
<th></th>
<th>Intercept</th>
<th>Coefficients</th>
<th>t-Statistic</th>
<th>Observations</th>
<th>R squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>AR (0)</td>
<td>0.001</td>
<td>-3.172***</td>
<td>-7.192</td>
<td>118</td>
<td>0.31027</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.441)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AR(1)</td>
<td>-0.001</td>
<td>0.183</td>
<td>0.487</td>
<td>118</td>
<td>0.00206</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.375)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AR (2)</td>
<td>0.001</td>
<td>0.204</td>
<td>0.554</td>
<td>118</td>
<td>0.00264</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.369)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AR (3)</td>
<td>0.002</td>
<td>-0.130</td>
<td>-0.468</td>
<td>118</td>
<td>0.00189</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.278)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAR (1,3)</td>
<td>0.002</td>
<td>-0.250</td>
<td>0.926</td>
<td>118</td>
<td>0.00153</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.593)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes. *Significant at the 10-percent level; **significant at the 5-percent level; ***significant at the 1-percent level. Based on two-tale non-parametric t-test.

This table shows the results of the regression analysis where abnormal returns are calculated using expected returns obtained by the constant mean return model. Brackets show the standard error of the coefficient.

Table 17 presents the results from the regression analysis using abnormal return obtained by the constant mean return model. As expected, the coefficient on the event day is negative and statistically significant. On announcement days, we observe that unanticipated interest rate changes significantly affect abnormal returns as market participants incorporate the new information obtained from the interest rate announcement. The coefficient implies that for every 1% of unanticipated interest rate change abnormal returns change by approximately 3.2%. Furthermore, unanticipated interest rate changes seem to explain around 31% of the variance of abnormal returns on the day of the announcement. The results provide additional evidence for the existence of an announcement effect on stock prices.

In contrast with our predictions, we see that the coefficient for unanticipated interest rate changes is insignificant and close to zero on days following the announcement. In addition, the variable appears to explain little to nothing of the variance. Likewise, the cumulative abnormal returns for the three-day period after the announcement (1,3) seem to be unaffected by the unanticipated interest rate change. The results further suggest that market participants are efficient when incorporating interest rate surprises, as prices adjust on the day of the announcement.
Table 18

Regression analysis of abnormal returns on and after days of interest rate surprises where abnormal returns are estimated with the market model.

<table>
<thead>
<tr>
<th></th>
<th>Intercept</th>
<th>Coefficients</th>
<th>t-Statistic</th>
<th>Observations</th>
<th>R squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>AR (0)</td>
<td>0.001</td>
<td>-3.199***</td>
<td>-7.129</td>
<td>118</td>
<td>0.3083</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.449)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AR (1)</td>
<td>-0.002</td>
<td>-0.234</td>
<td>-0.676</td>
<td>118</td>
<td>0.0039</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.347)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AR (2)</td>
<td>-0.001</td>
<td>0.386</td>
<td>0.991</td>
<td>118</td>
<td>0.0084</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.390)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AR (3)</td>
<td>-0.001</td>
<td>0.343</td>
<td>1.153</td>
<td>118</td>
<td>0.0115</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.298)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAR(1,3)</td>
<td>-0.003</td>
<td>0.473</td>
<td>0.867</td>
<td>118</td>
<td>0.00643</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.546)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes. *Significant at the 10-percent level; **significant at the 5-percent level; ***significant at the 1-percent level. Based on two-tail non-parametric t-test.

This table shows the results of the regression analysis where abnormal returns are calculated using expected returns obtained by the market model. Brackets show the standard error of the coefficient.

Table 18 presents the results from the regression analysis using abnormal returns obtained with the market model. It is interesting to see that the results are almost identical to those obtained when using expected returns from the constant mean return model.

As hypothesized, the coefficient on the event day is negative and statistically significant substantiating the argument for an announcement effect. The coefficient implies that for every 1% deviation from anticipated interest rate changes abnormal returns change by approximately 3.2%. It is intriguing to see that the coefficient is positive on day 1 and day 3 after the announcement, however it is not significant and explains close to none of the variance.

Again, we see that on days following the announcement the coefficient is close to zero and the interest rate change explains a very low fraction of the variance.
6. Discussion and conclusion

In our thesis, we analyzed the effects of interest rates on stock prices and examined whether market participants are efficient in incorporating interest rate changes. During our study we follow the event study approach used in similar studies that have been made on other markets. (Bae, 1990; Bernanke & Kuttner, 2005; Bomfim, 2003; Ioannidis, & Kontonikas; Thorbecke, 1997) We hypothesized that interest rate announcements, where the market has incorrectly anticipated the interest rate changes, would result in an announcement effect. As market participants incorporate the new information to their pricing models, stock prices adjust accordingly.

Our findings show that an announcement effect is present on event days where interest rate changes where unanticipated. For both the negative and the positive categories, abnormal returns are different from zero and statistically significant at p<0.01. In contrast, on event days where market participants correctly anticipate interest rate changes the abnormal returns are insignificant and not statistically different from zero. When comparing the positive and negative subsamples to the neutral one the results are very clear. The mean values of abnormal returns within the positive and negative categories where different from neutral ones, statistically significant within p<0.01. These results confirm our notion that an announcement effect is only evident when interest rate changes are unanticipated. The results are consistent whether applying the constant mean model or the market model. A regression analysis of unanticipated interest rate changes confirms these findings. The regression analysis shows a statistically significant relationship between abnormal returns and unanticipated interest rate changes. Through our analysis, we find that for every 1% of unanticipated interest rate change abnormal returns change by approximately 3.2% on the day of the announcement. The results are practically identical whether we use the expected returns derived from the constant return model or the market model. These findings are consistent with studies made by Bernanke & Kuttner (2005) and Chen, Mohan and Stener (1999) as they estimate that 1% change in unanticipated interest rate affect stock returns by 4.68% and 5% respectively.

In addition, we expected market participants to be inefficient when incorporating the information. Those expectations arose because during the research period the Icelandic stock market had entry barriers in the form of capital controls. After the introduction of capital controls foreign investors were less inclined to invest in Iceland, as they could not easily withdraw their funds. Due to low foreign investments, institutional investors became the
main stockholders in Iceland. Because of a low number of foreign investors and the fact that institutional investors who often trade infrequently hold the majority of stock, liquidity decreased in the market. Due to these factors, we anticipated market efficiency to reduce significantly.

Contrary to our expectations, the findings show that the Icelandic market incorporates interest rate changes efficiently. Abnormal returns on days following unanticipated interest rate changes do not significantly deviate from zero. It is interesting to see that in days following the announcement, stock returns move in opposite direction to returns on the event day. For interest rate announcements categorized as negative, stock returns in days following the announcement are negative. The results for cumulative abnormal returns in the three-day period following the announcements are small and not statistically different from zero. The regression analysis displayed no relation between unanticipated interest rate changes and abnormal returns on the three days following the announcement, whether looking at individual days or the cumulative sum over the period. The results are not significant and explain a very low fraction of the variance of the abnormal returns. This came as a surprise since we expected low liquidity having a significant impact on market efficiency. Our findings are in line with Sturludóttirs (2015) study which concluded that capital controls had no significant effect on capital controls in Iceland. Market participants incorporate the new information conveyed with the unanticipated interest rate change rapidly, suggesting a semi-strong form of market efficiency since stock prices are quick to reflect all publicly available information. The implications of the results are independent of method we use to calculate the expected return, though displaying slightly stronger results when estimated with the market model.

Even though our findings are consistent with other studies it is limited by several factors. In total, the research period contains 16 companies. However, only five companies are listed on the stock exchange for the entire research period. This results in a relatively small data set with few observations. This limitation is inevitable when analyzing the Icelandic market.

During our analysis, we use Landsbankinn’s prediction for interest rate changes as an estimate for the expectations of market participants. These predictions are not always in line with estimates published by other market analysts. Nevertheless, Landsbankinn’s predictions are the only estimates that are freely available to all market participants over the entire research period. Other studies use more advanced estimates as future and forward rates. However, these measures are not available within the Icelandic context.
In our study, we use the constant mean return and the market model to estimate expected returns during the event window. For our estimation window we use the same 250 day period for all interest rate changes. This method however includes other interest rate changes made within the estimation window, which might skew the estimation since interest rate changes displayed a cycling character. An alternative is to have an estimation window between interest changes. We disregarded the alternative approach since periods between interest rate changes are not uniform and often too short to obtain reliable data. The models we use to estimate expected returns are rather simple and do not account for many variables. It would however be possible to use other models that take into account more information.

For our regression analysis we use abnormal returns as the dependent variable and unanticipated interest rate changes as our independent variable. To further analyze the effects of interest rates changes on the Icelandic market it would be beneficial to incorporate additional variables. We would have liked to research if interest rate changes affect company sectors in a different way. For example, companies in the financial and real estate sector might be more sensitive to interest rate changes then companies in the retail business. In addition to that company characteristics such as size, internationalization and if companies account their revenue in foreign currency.

As mentioned earlier, the years between 2009 and 2013 had few firms in the same sector making the data set rather uniform. It is not a realistic option to add additional variables such as company characteristics since observations are limited due to the small Icelandic market.

Overall, our findings confirm the existence of an announcement effect in the Icelandic market. Interest rate changes have significant effect on stock prices though only when the market does not anticipate them to the full extend. The results show that the Icelandic stock market is efficient within the interest rate context, suggesting a semi-strong form of efficiency.
7. References


Flannery, M. J., & James, C. M. (1984). The Effect of Interest Rate Changes on the
1153. https://doi.org/10.1111/%28ISSN%291540-6261/issues

Economics, 49*(1), 75–97. https://doi.org/10.1016/S0304-3932(01)00093-9

Goldbaum, D., & Panchenko, V. (2010). Learning and adaptation’s impact on market
https://doi.org/10.1016/j.jebo.2010.09.003

88. https://doi.org/10.1016/j.irfa.2015.05.009


Iceland cuts interest rates. (n.d.). Retrieved February 21, 2017, from
http://www.ft.com/fastft/2016/08/24/iceland-cuts-interest-rates/


https://doi.org/10.1016/j.jpolmod.2007.06.015


https://doi.org/10.1016/S0304-405X(97)00047-0


