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Monumental Monetary Measures: An Icarian Flight? The Effects of Expansionary Monetary Policy on the United States' Corporate Bond Market for Non-Financial Companies between 2007 and 2020

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Abstract

Financial analysts voiced concerns about the current state of the United States' corporate bond market and named the Federal Reserve's expansionary monetary policy measures as a cause for increased corporate debt levels. This research seeks to estimate the effects of the Federal Reserve's monetary policy measures on corporate bond issuance and investors' risk aversion in the United States' non-financial corporate bond market. This is done by estimating two multiple linear regression models that incorporate variables relating to conventional and unconventional monetary policy and additional control variables that capture other factors which can influence the supply and demand for capital. This research covers the period from the first quarter of 2007 until the fourth quarter of 2020. The results indicate that Federal Reserve's treasury bond purchases led to increased corporate bond issuance by non-financial companies, measured as a share of the United States' gross domestic product. This is in accordance with the portfolio-rebalancing channel. No statistically significant effect has been found for any other monetary policy measure. Furthermore, it is estimated that increases in Federal Reserve's mortgage-backed securities and government-sponsored enterprise debt stock led to a decrease in the credit spread for AAA and BBB rated non-financial corporate bonds, meaning that investors' risk aversion decreased. However, expansionary interest rate policy led to an increase in the credit spread for AAA and BBB rated non-financial corporate bonds. It is uncertain how these effects net out, as they are dependent on the policy mix. The robustness and validity of the results are debatable and future research on the effects might be desirable.

Keywords: Monetary policy, Quantitative easing, Interest rate policy, Corporate bonds, Non-financial companies

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"Now listen to me, Icarus. We are flying over the sea to Athens, where I am sure Theseus will welcome us. But take care as you go. Fly too low and the waves will soak your wings and drag you under. Fly too close to the sun and the heat of its rays will melt the candle wax that is holding the feathers together, you understand?"[*]

* Fry (2018) retelling the myth of Icarus and Daedalus.

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1. Introduction

Greek mythology has provided us with some of the most iconic sagas and legends. These stories have inspired people throughout the centuries, as they bear important messages and life teachings. Many of these stories tell tales about brave heroes who defeated dangerous foes by their cunning or strength. Other stories tell tales about geniuses who outsmarted their adversaries. One such story is about the inventor Daedalus (Fry, 2018). He was the cleverest inventor to have ever existed. However, Daedalus fell out of grace with King Minos after Daedalus betrayed him. King Minos imprisoned Daedalus and his son, Icarus, in the tallest tower of his palace. Daedalus immediately worked on their escape. He built two pairs of wings in order to fly away, such was Daedalus' creative mind.

Daedalus warned his son before taking off. Their wings would get wet and they would drown if they flew too close to the waves. However, their wings would melt and they would fall from the sky if they flew too high. Keeping to the middle, i.e. a symbolic path of moderation, was their only way out. This warning turned out to be in vain, as Icarus had forgotten this warning shortly after taking off. He flew higher and higher. The sun eventually melted his wings. Icarus was punished for flying too close to the sun as he fell from the sky.

The tale of Icarus' flight provided the reader with an understanding that they should keep to the path of moderation. However, this tale is not only applicable to an individual's life. Moderate inflation, i.e. price stability, is in some way the goal of many central banks in developed economies around the world (International Monetary Fund [IMF], 2020). Yet, there is an increasing concern about the effects of contemporary monetary policy on financial markets (CNBC, 2021). Did monetary policy deviate from its path of moderation? An example of such concerns can be found in the United States' (US) corporate bond market for non-financial companies. Levels of debt securities and loans of US non-financial companies crossed the ten trillion United States dollar (USD) threshold in the third quarter of 2019 (Board of Governors of the Federal Reserve System, n.d.-a). Financial analysts were quick to label this a bubble and named expansionary monetary policy as one of the primary causes for the growth of corporate debt (CNBC, 2021; Vazza, Kraemer, & Gunter, 2019; Kraemer, Gunter, & Palmer, 2020). The concerns and current monetary policy measures raise questions on the effects and implications of these policies. The central question of this research is therefore the following:

What are the effects of the Federal Reserve's expansionary monetary policy measures on the United States' corporate bond market for non-financial companies?

The term *effect* should be interpreted broadly and includes the effects of monetary policy on bond issuance, investors' risk aversion for corporate bonds, and the central bank's ability to conduct future monetary policy. The other terms and concepts will be defined and further discussed in section 2.

The question is highly relevant from a policy and academic perspective. The policy relevance lies within the fact that answering this question might lead to a better understanding of the effects of monetary policy on the corporate bond market. This is especially helpful if substantial monetary policy responses are once again required in order to avoid a financial crisis. Furthermore, the answers might provide insights into possible threats to the financial stability that have occurred within the corporate bond market due to monetary policy. The benefits of identifying such threats are twofold. First, it ensures that possible safeguards can be put into place that counter such threats. Second, it allows policy makers to account for these threats in their decision-making process. This would be the necessary if the central bank returns to more restrictive monetary policy.

The question is scientifically relevant, as it contributes and builds upon three strings of economic literature. First, this research adds to the literature on the effects of (unconventional) monetary policy on financial markets, section 3.1 will elaborate on this literature. An example of such research is that by Lo Duca, Nicoletti, and Vidal Martínez (2016). They looked into the effects of US monetary policy on global corporate bond issuance and found that corporate bond issuance increased in response to certain expansionary monetary policy measures implemented by the Federal Reserve. Second, this research relates to the literature on the channels through which monetary policy can affect the corporate bond market. These channels are discussed in section 3.2 and are relevant, as they provide an explanation on the mechanisms through which any estimated effect might work. Third, the policy implications presented in section 6 relate to the literature on leaning against the wind policies. An example of research on such policies is that by Kockerols and Kok (2019). They estimated the cost and benefits of attaining financial stability through monetary or macroprudential policy. It was concluded that monetary policy carried net marginal costs in attaining increased financial stability, whereas macroprudential policy presented net marginal benefits. This means macroprudential policies are more suitable for safeguarding financial stability and that macroprudential policies can function as complementary policy tools for central banks.

The central question posed in this research will be answered by estimating two multiple linear regression models, similar to the model presented by Lo Duca et al. (2016). The model includes control variables that account for domestic and global factors that could affect the supply and demand for capital. The multiple regression analyses will be performed in order to estimate the effects of monetary policy on bond issuance and investors' risk aversion. The data on bond issuance has been retrieved from the Federal Reserve Economic Data[base]. This source also provides data on macroeconomic and monetary policy variables. The final dataset combines all sources and covers the period from the first quarter of 2007 until the fourth quarter of 2020.

The results of the analyses show that the Federal Reserve's treasury bond purchasing programme led to a statistically significant increase in non-financial corporate bond issuance. The other monetary policy tools do not show any significant effect. Furthermore, it is found that increased equity market performance and equity market volatility are associated with decreased non-financial corporate bond issuance.

Analyses on the effects of monetary policy on the credit spread indicate that increases in the Federal Funds Rate and the Federal Reserve's mortgage-backed securities (MBS) and government-sponsored enterprise (GSE) debt stock led to decreased credit spreads for both AAA and BBB rated corporate bonds. Furthermore, the COVID-19 pandemic is associated with statistically significantly lower credit spreads. However, the net results on investor's risk aversion remains uncertain, as they are dependent on the policy mix introduced by the central bank.

The robustness of the results are debatable, as it is possible that the estimates are affected by omitted variable bias. The results of the analysis on corporate bond issuance are in line with those presented by Lo Duca et al. (2016). No precedent exists with regard to the analysis on the corporate bond credit spread, i.e. investor's risk aversion.

This research will be structured as follows. Section 2 will define and explain the core concepts of this research, as well as provide background information. Section 3 will discuss the literature related to this research. Section 4 presents the methodology and data used in this research. The results of the analyses will be presented in section 5. After which the policy implications of these results will be discussed in section 6. This research and its results will be discussed in section 7. Section 8 concludes.

2. Core concepts & Background

This section is devoted to defining and explaining the core concepts presented in this research. First, the core concepts that relate to the corporate bond market will be discussed. Subsequently the concepts relating to monetary policy will be discussed.

It should be noted that this research will only look into the effects of monetary policy on corporate bonds issued by non-financial companies in the US corporate bond market. This is sometimes explicitly stated, but is also meant if this research refers to corporate bonds or the corporate bond market without adding any reference to non-financial companies or the US market.

2.1. Corporate bonds

A corporate bond is defined as a debt obligation issued by a company and offered on a publicly accessible financial market. Bonds involve investors lending money to the issuing company, which in turn makes a legal commitment to pay interest, i.e. a coupon, and, generally, returns the principal when the bond matures (SEC Office of Investor Education and Advocacy, 2013). There are three general types of coupon rate structures, all of whom are taken into account in this research. First, a fixed coupon rate indicates that the coupon rate stays the same irrespective of changes in the market interest rate or time. Second, a zero-coupon bond means that the issuer does not pay any coupon on the bond. This type of bond is associated with a single payment to the lender when the bond matures, which is generally higher than the initial purchase price. Third, a floating coupon rate indicates that the coupon rate is periodically adjusted and therefore affected by changing market circumstances. Such a coupon rate is based on the market interest rate or an index. The coupon rate is determined by a number of determinants. These determinants include, but are not limited to, the market interest rate, the maturity of the bond, credit rating, and taxes (RBC Wealth Management, n.d.; Elton, Gruber, Agrawal, & Mann, 2001; Ranosz, 2017).

Rating agencies will often assess the quality of the bond and subsequently assign a credit rating to the bond. A dichotomy exists within the corporate bond market between the investment grade and non-investment grade bonds, the latter category is also referred to as high-yield or speculative bonds (SEC Office of Investor Education and Advocacy, 2013). An overview of the credit ratings and what constitutes an investment or a non-investment bond is presented in Appendix I.

The risk of a bond affects a bond's coupon, higher risks require a higher coupon (Cecchetti, & Di Cesare, 2012). Corporate bonds carry differing levels of risks, as stated. However, US treasury bonds carry relatively low-risk, and are sometimes even considered relatively risk-free (Habib, Stracca, Venditti, 2020; Kenny, 2019). Figure 1 highlights the fact that higher-risk bonds require higher coupon rates.

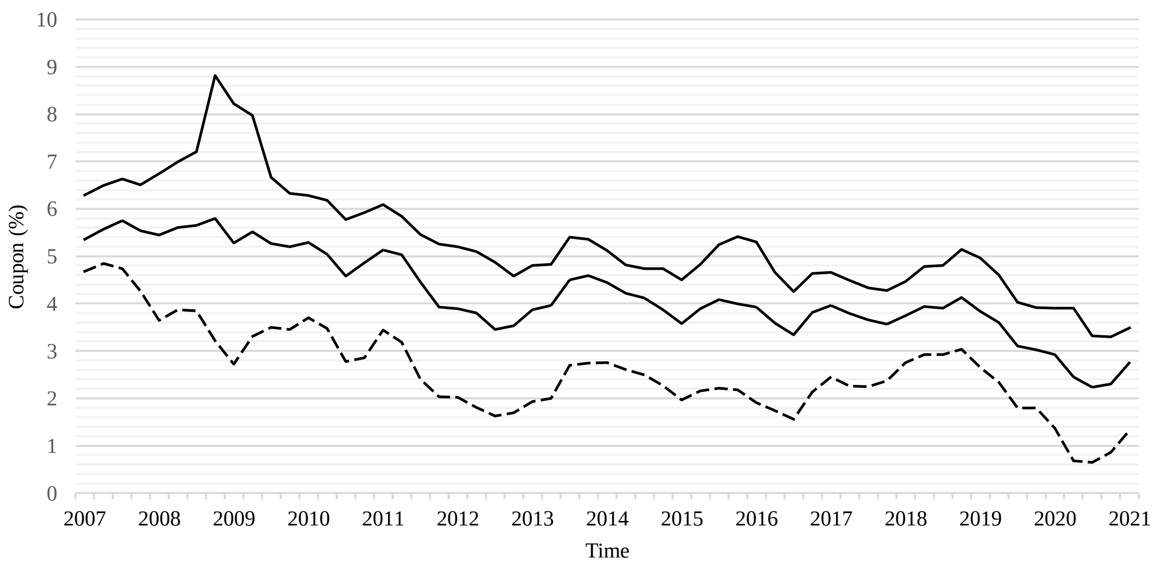

Figure 1 The average coupon rate in quarter t for BBB rated corporate bonds (black solid line), AAA rated corporate bonds (black dotted line), and 10-year US treasury bonds (black dashed line) 1 January 2007 and 31 March 2021. Source: Board of Governors of the Federal Reserve System (n.d.-b, n.d.-c), Investing.com (n.d.-a)

A credit spread is obtained by computing the difference between the yields of two financial instruments. Taking the credit spread of a corporate bond with a certain rating over a 10-year US treasury bond provides a proxy for investors' risk aversion. The credit spread of corporate bonds for a certain rating class over the 10-year US treasury bond is used as the dependent variable in equation (3), as will be discussed in section 4.1. The default probability for a certain corporate bond rating is thereby assumed to be constant over time and equal for all corporate bonds with a certain rating classification. Any changes in the credit spread are therefore due to changes in investors' risk aversion and not changes in the underlying riskiness of the underlying corporate bonds. It is thus possible to equate any changes in the credit spread with changes in investors' risk aversion. A higher credit spread indicates higher investors' risk aversion, as investors require higher compensation. A lower credit spread on the other hand infers that investors require lower compensation.

2.2. Monetary policy

A central bank has two sets of policy instruments to its disposal: conventional and unconventional policy measures. Conventional monetary policy encompasses interest rate policy, open market operations, and capital requirement levels for commercial banks, among others (Cecchetti, & Schoenholtz, 2014). Such policies allow the central bank to directly affect the short-term interest rate and stimulate the economy (Marsé, 2019). The Federal Funds Rate is the Federal Reserve's main policy rate and thereby its main conventional policy tool (Cúrdia, & Woodford, 2010). The effective Federal Funds Rate is presented in Figure 2.

Unconventional monetary policy consists of a multitude of policy tools and central banks differ in the policies that they have implemented over the years (Borio, & Zabai, 2016). Unconventional monetary policy measures include, but are not limited to, negative interest rates, forward guidance, and large-scale asset purchases, i.e. quantitative easing (Committee on the Global Financial System, 2019). The Federal Reserve only implemented the last two measures (Borio, & Zabai, 2016). The unconventional monetary policy measures are implemented when the conventional measures cannot generate sufficient results. This is because the effectiveness of conventional monetary policy diminishes when the short-term interest rate approaches the zero lower bound and the threat of a liquidity trap occurs (Marsé, 2019; Keynes, 1936). The Federal Funds Rate approached the zero-lower bound during 2009, see Figure 2.

Quantitative easing policies generally entail the purchasing of medium- and long-term treasury bonds and securities. This is done in order to complement the conventional policy measures, lower long-term interest rates, and create more accommodative financial conditions (IMF, 2013). The Federal Reserve started their quantitative easing programme during the fourth quarter of 2008 and purchased three types of assets: (i) agency debt, (ii) agency mortgage-backed securities, and (iii) treasury securities. The start of this programme coincided with the Federal Funds Rate approaching the zero-lower bound. The Federal Reserve enacted three rounds of large-scale asset purchases prior to the COVID-19 pandemic (Federal Reserve Bank of New York, n.d.). This resulted nearly four trillion USD in asset purchases, which meant that the Federal Reserve's balance sheet grew approximately 400% between 2008 and 2014. It should be noted that the balance sheet only grew by approximately 26% between 2002 and 2008. The interest rates were once again raised at the end of 2015, see Figure 2. This was combined with a balance sheet normalization programme (Federal Reserve Bank of New York, n.d.), which can be observed in Figure 3 as the balance sheet size declined.

Interest rates were once again brought close to the zero-lower bound during the COVID-19 pandemic. The Federal Reserve also expanded its balance sheet in reaction to the pandemic. This resulted in a 76% increase, corresponding to approximately $3.2 trillion added to the Federal Reserve's balance sheet in a couple of months' time, as can be seen in Figure 2 and 3.

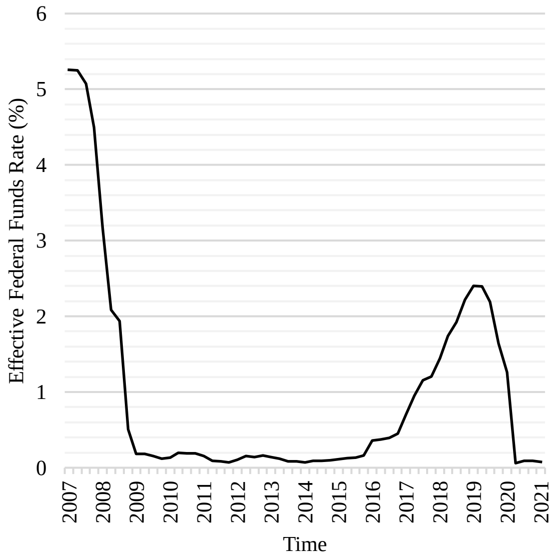

Figure 2 Effective Federal Funds Rate in percentages between 1 January 2007 and 31 March 2021. Interest rate cuts as a result of the global financial crisis of 2007 – 2008 and the COVID-19 recession are visible. Source: Board of Governors of the Federal Reserve System (n.d.-d)

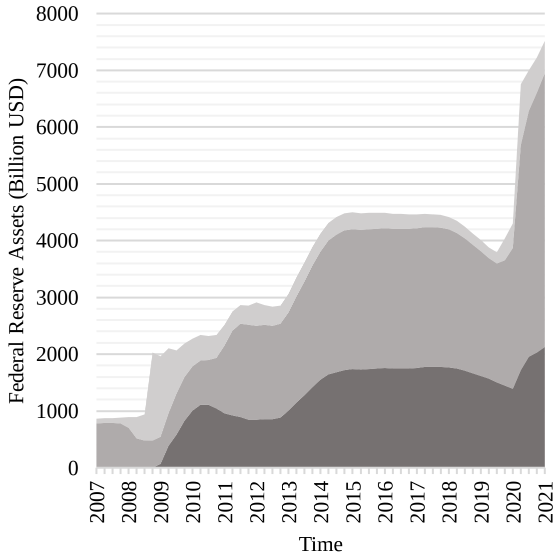

Figure 3 Size and composition of the Federal Reserve's balance sheet in billions USD between 1 January 2007 and 31 March 2021. The darkest grey indicates MBS and GSE security levels held by the Federal reserve. The lighter grey indicates US treasury security levels. The lightest shade of grey consists of all other assets held by the Federal Reserve. Source: Board of Governors of the Federal Reserve System (n.d.-e, n.d.-f, n.d.-g)

3. Related Literature

The relevant core concepts have been discussed and provide insights into the context of this subject. However, this does not explain how these two aspects relate to each other. This section will discuss the relationship and channels through which monetary policy influences the corporate bond market. Although it should be noted that this matter is subject of an ongoing debate (Di Maggio, Kermani, & Palmer, 2020). It is nevertheless beneficial to discuss the literature, as they provide the contemporary empirical and theoretical background in which this research is embedded. This in turn ensures a better understanding of the results presented in this research.

3.1. The effects of monetary policy

Effects on macroeconomic indicators

This research relates to three strings of economic literature. First, the literature on the general effects of unconventional monetary policy, and quantitative easing in particular. Extensive research has been done into the effects of such policies. Borio and Zabai (2016) analysed the effects of unconventional monetary policy measures on financial and macro-economic conditions by conducting a literary overview of the economic research on the topic. The authors concluded that the effects on output, inflation, and financial conditions are hard to quantify and are subject to debate. However, the effects on gross domestic product (GDP) and inflation seem to be positive in response to quantitative easing (Chung, Laforte, Reifschneider, & Williams, 2011).

Furthermore, it is stated that unconventional monetary policy measures are likely to be subject to diminishing marginal returns (Borio, & Gambacorta, 2017; Borio, & Zabai, 2016). The cost benefit balance also deteriorates over time (Borio, 2014; Borio, & Disyatat, 2014). This infers that unconventional monetary policy measures provide short-term gains, but also create long-term costs (Borio, 2016). The intuition for this result is that a central bank's ability to respond to the future recessions diminishes once it implements larger unconventional monetary policy measures (Bank for International Settlements [BIS], 2014). Although it should be noted that the increased reliance upon unconventional monetary policy measures, and thereby the possibility of increased future costs and risks, are the result of external forces that forced central banks to adapt these policy measures in order to avoid a worse counterfactual, rather than reckless policy decisions made by the central bank, according to the authors. These external forces include an unbalanced policy response after the financial crisis of 2007 – 2008 and not fully understood forces that kept inflation below target levels (BIS, 2014, 2016).

More recent studies provided similar results. Di Maggio et al. (2020) analysed the effects of quantitative easing on the real economy by estimating a number of multiple linear regression models using mortgage-market microdata. The research shows that the effect of quantitative easing on the real economy is dependent on the composition and nature of the assets purchased by the central bank, as well as the degree of segmentation in the markets. The research also provides evidence on the portfolio-rebalancing transmission channel of monetary policy. This channel will be discussed in section 3.2.

Boehl, Goy, and Strobel (2020) added to the aforementioned findings by looking at the macroeconomic effects of quantitative easing. The researchers used a nonlinear Bayesian likelihood approach and found that output increased as a result of the Federal Reserve's quantitative easing programme. This was accompanied by a drop in aggregate consumption. However, the quantitative easing programme also improved financing and investment conditions in the economy. Combined, this resulted in a disinflationary effect due to the quantitative easing programme, according to the authors.

Effects on financial markets

The effects of quantitative on financial markets are dependent on the nature of these markets and purchased assets (Di Maggio et al, 2020). Marsé (2019) showed that the differentiated effects also occur with regard to corporate investment rates via a multiple linear regression model. The author finds a differentiated effect between the Federal Reserve's purchases of medium- to long-term treasury securities and medium- to long-term MBS purchases. The former has a positive statistically significant relationship with the corporate investment rate, whereas the latter shows a negative statistically significant relationship.

Hamilton and Wu (2012) found that quantitative easing led to lower US government bond yields. Although it should be noted that this effect is at least partially driven by the policy announcements itself rather than the actual asset purchases (Neely, 2015).

The effects of quantitative easing on the corporate bond market have been studied by Lo Duca et al. (2016). The authors find a strong effect of the Federal Reserve's quantitative easing programme on global corporate bond issuance for non-financial companies in emerging and advanced economies. This effect is estimated by a multiple linear regression model that included control variables for domestic and global factors that could affect the supply and demand for capital. The authors conclude that their results support the gap-filling theory presented by Greenwood, Hanson, and Stein (2010). This theory proposes that the corporate bond market fills the "gap" created in the financial markets by the central bank due to the large-scale asset purchases. The intuition behind this theory is that the large-scale asset purchases and holdings crowded out investors from those markets where the Federal Reserve intervened. Thereby moving investors into the corporate bond market and accelerating the mechanisms of the portfolio-rebalancing channel.

A similar effect of quantitative easing on corporate bond issuance was found by De Santis and Zaghini (2019). The European Central Bank added the corporate sector purchase programme to its quantitative easing programme in June 2016. The authors find a significant increase in issuance of corporate bonds that are eligible to partake in the European Central Bank's Corporate sector purchase programme. The effect was estimated by constructing a multiple linear regression model and collecting detailed data on euro-denominated corporate bonds that were being issued between October 2013 and June 2018.

The effects of quantitative easing on the corporate bond market are not limited to bond issuance. Ireland (2015) found that monetary policy had a significant effect on bond risk premia. It was concluded that tighter monetary policy would lead to increased risk premia in the bond market, whereas expansionary monetary policy would have an opposite effect. Similar effects of expansionary monetary policy were found by Paligorova and Santos (2017), albeit with regard to a different financial market. Paligorova and Santos (2017) concluded that banks show a greater risk appetite during times of expansionary monetary policy and that this coincides with lower their risk premiums for riskier borrowers, relative to safer borrowers. Additionally, Gilchrist and Zakrajšek (2013) looked into the effect of the Federal Reserve's quantitative easing programme on corporate credit risk. They used data on credit default swaps as a proxy for credit risk and subsequently estimated a linear regression model. The authors find that quantitative easing programme announcements led to a significant drop in the cost of insuring against default risk. The aforementioned findings seem to suggest that expansionary monetary policy leads to increased risk-taking behaviour in corporate debt markets.

3.2. The relationship between monetary policy and the corporate bond market

This research also relates to the literature on the relationship between monetary policy and the corporate bond market. The findings in the previous section showed the effects of monetary policy, but it does not discuss the channels. This section will discuss three channels. It should be noted that other channels exist through which monetary policy is able to affect parts of the economy and the corporate bond market, however the three discussed below are considered to be the most relevant to the effects of monetary policy on the US corporate bond market for the purposes of this research.[1]

Portfolio-rebalancing channel

The portfolio-rebalancing channel is one of the most discussed channels in research related to quantitative easing (Joyce, Lasaosa, Stevens, & Tong, 2011). This channel stems from the portfolio balance theory presented by Tobin (1969). This theory states that central bank asset purchases lead to a lower supply of the purchased asset type, which in turn increases its price and lower its yield. This causes spillover effects of monetary policy, as investors will substitute between financial instruments in reaction to the increased price (Tobin, 1969; Boehl et al., 2020). Such a theoretical sequence of events is supported by recent research which concluded that a positive quantitative easing shock induces debt investors to rebalance their portfolios (Takaoka, & Takahashi, 2021).

When this is applied to the case presented in this research, it becomes clear that the Federal Reserve's quantitative easing programme, which relied on the purchasing of agency debt and treasury bonds, increased prices and lowered yields for these assets, which in turn might have incentivized investors to reallocate their resources to the next-best alternative: corporate bonds (Lo Duca et al., 2016). Corporate bonds are considered a relatively safe asset (Habib et al., 2020), in particular those bonds which carry an investment grade credit rating. Corporate bonds therefore form a relatively good substitute for the safe assets bought by the Federal Reserve. Such an explanation is in line with the gap-filling theory presented by Greenwood et al. (2010), discussed in section 3.1.

Although it should be noted that the increased investors' demand for corporate bonds might not fully explain increased bond issuance. This could possibly be explained through a corporate look on the

[1] These omitted channels include, but are not limited to, the (i) inflation channel, (ii) duration risk channel, (iii) safety premium channel, (iv) liquidity premium channel, and (v) default risk channel (Krishnamurthy, & Vissing-Jorgensen, 2011).

financial markets. Low interest rates, combined with the other effects of the quantitative easing programme, incentivized companies to issue corporate bonds, rather than other ways of obtaining credit, thereby increasing corporate bond supply. This way of securing credit is especially conducive in times when investors demand for debt securities is high (Lo Duca et al., 2016).

Di Maggio et al. (2020) add that the portfolio-rebalancing channel also affects the market risk. The intuition is that the central bank removes relatively safe assets from the market through their large-scale asset purchases and thereby incentivising otherwise relatively cautious investors to take more risk. Draghi (2015) and Santis and Zaghini (2019) even state that substitution towards riskier asset classes is actively encouraged. The claims presented by Di Maggio et al. (2020) are supported by Takaoka and Takahashi (2021), as they find that a positive quantitative easing shock stimulates risk-taking behaviour by investors.

Risk-taking channel

The second channel of monetary transmission is the risk-taking channel. The premise of the risk-taking channel was first introduced by economist after the financial crisis of 2007 – 2008 (Paligorova, & Sierra Jimenez, 2011). This mechanism is in some ways complementary to the portfolio-rebalancing channel. The risk-taking channels states that investors are incentivized to supply credit to riskier borrowers in times of prolonged low interest rates, resulting in riskier investment portfolios (Paligorova, & Sierra Jimenez, 2011; Borio, & Zhu, 2012).

There are at least two ways through which the risk-taking channel operates (Borio, & Gambacorta, 2017). First, low interest rates lead to lower returns on government securities, which are considered relatively risk-free. This creates incentives to replace these assets with riskier assets in order to increase the return on investment. Corporate bonds provide a good substitute for investors, as stated. However, these assets are generally riskier than those purchased by the central bank, thereby increasing portfolio risk. Second, prolonged periods of low interest rates might affect investors' perception of market risk, this is a result of the contemporary measurement systems that are in place to assess risks.

The effects of the risk-taking channel also relate to the leaning against the wind policies discussed in section 3.3, as such policies seek to counter the effects of this channel.

Signalling channel

The signalling channel has been identified as an important channel and is often discussed in the literature (Joyce et al., 2011). Eggertsson and Woodford (2003) argue that unconventional monetary policies can only have the desired effects if the central bank is able to credibly commit to its low interest rate policy. This can be achieved through sizeable large-scale asset purchases (Clouse, Henderson, Orphanides, Small, & Tinsley, 2000). The intuition is the following: if the central bank were to raise the interest rates shortly after they purchased large quantities of assets, they would incur losses on these long-term assets.

Krishnamurthy and Jorgensen (2011) therefore state that the large-scale asset purchase programme signals a credible commitment to keep the interest rates low for the foreseeable future.

This relates to the risk-taking channel, as this credible commitment also increases risk-taking behaviour (Paligorova, & Sierra Jimenez, 2011; Borio, & Zhu, 2012). Agur and Demertzis (2013) confirm the signalling effects of the large-scale asset purchases by central banks, as they find that the Federal Reserve's commitment to a low interest rate policy has led to increased risk-taking in financial markets.

3.3. Leaning against the wind

Furthermore, this research relates to the economic literature on leaning against the wind policies, as section 6 will provide policy implications based on the results of the main analyses with regard to bond issuance and investors' risk aversion. Central to the leaning against the wind literature is the premise that prolonged expansionary monetary policy has led to increased risk-taking incentives for financial institutions and investors (Agur, & Demertzis, 2013; Kockerols, & Kok, 2019). Increased risk-taking was one of the causes of the global financial crisis of 2007 – 2008 (Agur, & Demertzis, 2013; Geithner, 2014; *Causes of the recent financial and economic crisis*, 2010). This crisis resulted in increased interest into the notion that central banks should take risk-taking and financial stability into account when making policy decisions (Agur, & Demertzis, 2013; Kokores, 2015). Such policies are referred to as leaning against the wind policies.

Agur and Demertzis (2013) analysed the practical implications of implementing such policies. They concluded that central banks which have a financial stability objective need to keep interest rate cuts brief once they are confronted with a negative shock. However, it should be noted that the central bank does need to lower the interest rate further if the central bank simultaneously seeks to close the output gap. The authors therefore argue that central banks should implement deep interest rate cuts at the through of the recession whilst commercial banks are building down risk, in order to allow for rapid interest rate increases when the commercial banks start building up risk again. This would reduce risk taking by banks, as commercial banks are more likely to pursue a riskier investment strategy if they expect a prolonged period of low interest rates.

The approach taken by Agur and Demertzis (2013) does not provide any information on the cost or benefits of leaning against the wind policies. Kockerols and Kok (2019) seek to address this by analysing the costs and benefits of leaning against the wind with regard to monetary and macroprudential policy. It is found that implementing tighter monetary policy measures for such a purpose carry net marginal cost. Contrarily, implementing macroprudential policy provides net benefits. The authors therefore conclude that macroprudential policies provide a better solution in addressing potential risks to financial stability. It is additionally stated that implementing such policies can alleviate monetary policy's role in safeguarding financial stability. Similar conclusions are reached by Brandao-Marques, Gelos, Narita, and Nier (2020). These findings would indicate that the monetary policy recommendations made by Agur and Demertzis (2013) would inflict net losses on the economy.

4. *Methodology & Data*

This section presents the methodology, data, and possible issues and biases resulting from this approach. The section is structured according to the aforementioned order. The variables will be discussed in section 4.1, whereas the corresponding variables will be discussed in section 4.2, as this ensures a clear distinction between the selection of the variables and the central characteristics of the data.

4.1. Methodology

This research sets out to answer the central question by estimating two multiple regression models. These models will assess (i) the effects of monetary policy on corporate bond issuance, and (ii) the effects of monetary policy on investor's risk aversion.

Monetary policy and corporate bond issuance

The first effect will be estimated by using a regression equation of the following form:

$$B_t = \alpha + \left(\sum_{n=1}^{N} \beta_n U_{n,t}\right) + \gamma I_t + \left(\sum_{m=1}^{M} \delta_m D_{m,t}\right) + \mu C_t + \varepsilon_t \qquad (1)$$

Where $t \in T$ indexes all quarters from the first quarter of 2007 up till the fourth quarter of 2020. This means there are 56 time indicators. The dependent variable B_t is defined as gross non-financial corporate bond issuance in the US corporate bond market during quarter t, expressed as a percentage of US GDP. Scaling the dependent variable by GDP has a distinct advantage over using the bond issuance level measured in USD, as it is not necessary to include measurements on macroeconomic activity that capture firms' investment opportunities once the dependent variable is scaled by GDP (Lo Duca et al., 2016).

The regression equation can be broken down into six separate parts. The variables related to monetary policy, i.e. $U_{n,t}$ and I_t, are the main explanatory variables. Other control variables are added in order to account for omitted variable bias.

α represents the regression constant. In other words, it shows the value of the dependent variable when all independent variables are equal to zero. The second term captures the effect of a set of quantitative easing variables $U_{n,t}$ on the dependent variable at time t. n indicates a variable included in this set and is equal to an integer on the interval [1, 4], which corresponds to the number of variables contained in this set. Thus, the set consists of four variables, as is consistent with the work of Lo Duca et al. (2016): (i) the average stock of US treasury bonds held by the Federal Reserve in quarter t as a percentage of the total US government debt, (ii) the average stock of MBS and GSE debt held by the Federal Reserve in quarter t as a percentage of the total MBS and GSE debt outstanding, (iii) purchases of US treasury bonds by the Federal Reserve in quarter t as a percentage of the total US government debt, and (iv) purchases of MBS and GSE debt by the Federal Reserve in quarter t as a percentage of the total of MBS and GSE debt outstanding. The distinction between asset stock and purchases makes it possible to account for stock and purchase effects of quantitative easing (Lo Duca et al., 2016; D'Amico, & King, 2013). All aforementioned variables are be expressed in percentages of their total amount of securities outstanding, as the larger the fraction of securities held or purchased by the central bank, the lower the supply to the public, and the larger the impact of monetary policy is expected to be (Lo Duca et al., 2016). β represents the regression coefficient of variable n.

The third term represents the Federal Reserve's interest rate policy. This variable is included because it forms an integral part of US monetary policy and it is a factor than can affect both the supply and demand of capital in the corporate bond market (Lo Duca et al., 2016). I_t represents the effective policy rate of the Federal Reserve at time t. This variable is measured monthly, therefore a quarterly average is taken in order use it in the model. γ represents the regression coefficient of I_t.

The fourth term tries to capture other relevant factors D_t at time t that can affect the supply and demand of capital in the corporate bond market, which would otherwise lead to omitted variable bias. The interpretation of the variables is somewhat similar to the second term. m indicates a variable that is included in this set and is equal to an integer on the interval [1, 3], which corresponds to the number of variables contained in this set. First, the volatility of equity markets at time t will be taken into account, as measured by the average daily Chicago Board Options Exchange's (CBOE) Volatility Index. This variable is included as it serves a dual function. The CBOE Volatility Index measures the implied volatility on the S&P500 index at time t, it is therefore often used as a proxy for uncertainty levels in the market (Bekaert, Hoerova, & Lo Duca, 2013). Furthermore, the S&P500 index is one of the main equity indexes in the US (Carlozo, 2018), the volatility of the index, as measured by the CBOE Volatility Index, can therefore function as an indicator of time varying country risk (Lo Duca et al., 2016). This volatility index is measured daily, the value of the index in quarter t is determined by the average value of a given quarter. Second, equity market performance at time t will be accounted for. This will consist of the average daily S&P500's return in quarter t. Equity market returns are taken into account in order to control for a number of hard-to-measure characteristics or events. Examples of such are changes in societal sentiments due to macroeconomic of political events that might affect financial conditions (Lo Duca et al., 2016). Furthermore, some evidence exists to support the notion that equity market performance is related to changes in financial conditions (Stein, 2012; Elliott, Koëter-Kant, & Warr, 2008). It is stated that firms who expect positive returns on the equity market might wish to buy-back company shares. They will in turn finance these buy-backs with credit obtained via corporate bond issuances. Including equity returns partially captures this effect (Lo Duca et al., 2016). The third variable concerns the 10-year US treasury bond yield. This variable is included, as an inverse relationship exists between bond issuance and (long term) yields (Baker, & Wurgler, 2002). It is therefore important to account for this variable. δ represents the regression coefficient of variable m.

C_t represents a dummy variable that is equal to 1 throughout 2020 and zero otherwise, as it represents the COVID-19 pandemic. μ represents the regression coefficient of the COVID-19 variable. Omitting this would likely lead biased results. ε_t represents the error term at time t, which is assumed to have a zero mean.

Monetary policy and risk aversion in the corporate bond market

The second effect will be estimated similarly to that in the first equation. However, the dependent variable has been changed and some additions are made in order to include variables that would otherwise bias the estimates. Investors' risk aversion will be measured by taking the credit spread between the yields of corporate and US treasury bonds, as discussed in section 2.1. The credit spread of a bond is calculated according to the following equation:

$$S_{i,t} = Y_{i,t} - DG_t \qquad (2)$$

Where $t \in T$ indexes all quarters from the first quarter of 2007 up till the fourth quarter of 2020 and $i \in I$ indexes the credit rating of bond i. This research studies the effects on two credit ratings: the top-rated AAA corporate bonds and BBB rated corporate bonds, which constitute a higher risk relative to the AAA bond.[2] This means that i can take a value of 1 or 2. Doing so also provides insights into the possibility effects of corporate bonds with differing levels of credit risks.

$Y_{i,t}$ represents the yield of a corporate bond with credit rating i in percentages at time t. $Y_{i,t}$ is presented as the average value during quarter t, as $Y_{i,t}$ is measured daily. DG_t represents the yield of a 10-year US treasury bond measured in percentages at time t. The yield of a 10-year US treasury bond is subject to daily changes, therefore the quarterly average yield is taken as measurement for the yield in quarter t. The 10-year US treasury bond is chosen as it can be considered a relatively risk-free instrument (Habib et al., 2020). The credit spread at time t, measured in percentage-points, is obtained by subtracting the average yield from a 10-year US treasury bond at time t from the yield of a corporate bond with rating i at time t.

In addition to the variables presented by equation (1), a relevant macroeconomic indicator will be added in order to capture economic activity that might affect the credit spread: GDP quarter-to-quarter growth rate at time t (GDP_t). This variable is added, as it is indicative of the overall conditions in the economy and might affect the dependent variable (Callen, 2020). Furthermore, the size of the non-financial corporate bond market at time t, measured as a share of US GDP, will be added (L_t), as this indicates the overall supply of corporate bonds in a given quarter and might therefore have an effect on the credit spread of bonds with rating i at time t. This results in the following regression model:

$$S_{i,t} = \alpha + \left(\sum_{n=1}^{N} \beta_n U_{n,t}\right) + \gamma I_t + \left(\sum_{m=1}^{M} \delta_m D_{m,t}\right) + \zeta GDP_t + \eta L_t + \mu C_t + \varepsilon_{i,t} \qquad (3)$$

[2] The BBB credit rating includes the BBB+ and BBB- rated corporate bonds as well.

ζ represents the regression coefficient of the variable related to GDP growth rate at time t. η represents the regression coefficient of the size of the corporate bond market at time t. The interpretation of all other variables, coefficients, and constants remains the equal to those presented above.

4.2. Data

Data is required on all these variables in order to estimate the effects. Appendix II provides an overview of all the data used in this research, this includes the data characteristics and formulas used to compute the variables presented in Table 1. Table 1 provides the characteristics of all variables used in the regression models, ordered alphabetically. Some outliers and oddities will be discussed.

First, the dependent variable, i.e. non-financial corporate bond issuance, shows minimum value of -0.0691. This means that the minimum observed value of non-financial corporate bond issuance is equal to -0.0691% of GDP. This infers that corporate bond levels, as a percentage of GDP, decreased during that quarter.

The Federal Reserve's holdings of MBS and GSE debt show a minimum value of 0. This is due to the fact that the Federal Reserve started buying these assets at the end of 2008, as discussed in section 2 and shown in Figure 3, whereas data is collected from 2007 onwards.

The negative minimum value shown for the Federal Reserve's purchases of MBS and GSE debt meant that the balance sheet size of these assets decreased. This occurred during the balance sheet renormalization policies in 2017 (Federal Reserve Bank of New York, n.d.). This holds for the Federal Reserve's purchases of US treasury bonds as well.

The equity market performance shows a 1.9149% mean growth. However, it also shows a high volatility level, as follows from the standard deviation of 6.4924 percentage points (p.p.). This is also reflected from the minimum and maximum value, which strongly differ from the mean value.

The credit spreads for AAA and BBB rated corporate bonds highlight the differences between both rating categories. The mean credit spread for BBB rated corporate bonds is 1 p.p. higher compared to AAA rated corporate bonds. The standard deviation is two times larger for BBB rated bonds compared to AAA rated bonds.

Lastly, the minimum value of quarter-to-quarter GDP growth stands out among the variables. It shows a -9.4662% economic decline. This occurred during the second quarter of 2020 as a result of the COVID-19 pandemic and strict lockdown measures.

Table 1 Overview and descriptive statistics of the variables

No.	Variable	Unit	Present in equation	Note	Mean	Std. dev.	Min	Max
(1)	10-year US treasury bond yield	%	1	See Appendix II.W.	2.5988	0.9364	0.6459	4.8463
(2)	CBOE Volatility Index	Index points	1, 3	See Appendix II.T.	19.9705	8.6567	10.3079	58.5959
(3)	Credit spread AAA rated non-financial corporate bonds	%	2, 3	See Appendix II.Z.	1.6320	0.3858	0.6837	2.5787
(4)	Credit spread BBB rated non-financial corporate bonds	%	2, 3	See Appendix II.AA.	2.7400	0.7727	1.6170	5.5971
(5)	Effective Federal Funds Rate	%	1, 3	See Appendix II.S.	0.9725	1.3904	0.0600	5.2567
(6)	Equity market performance	% Quarter-to-quarter growth	1, 3	See Appendix II.V.	1.9149	6.4924	-27.1598	13.2397
(7)	Federal Reserve MBS & GSE debt stock	% Of total MBS & GSE debt outstanding	1, 3	See Appendix II.Q.	8.3083	4.2674	0	12.8065
(8)	Federal Reserve treasury bond stock	% Of total US federal debt	1, 3	See Appendix II.J.	10.3227	3.0263	4.2687	16.5095
(9)	Federal Reserve MBS & GSE debt purchases	% Of total MBS & GSE debt outstanding	1, 3	See Appendix II.R.	0.3043	0.7753	-0.5790	3.3340
(10)	Federal Reserve treasury bond purchases	% Of total US federal debt	1, 3	See Appendix II.K.	0.3220	0.9628	-1.9625	5.6078
(11)	GDP growth rate	% Quarter-to-quarter growth	3	See Appendix II.D.	0.7811	1.8581	-9.4662	8.4535
(12)	Non-financial corporate bond issuance	% Of US GDP	1	See Appendix II.F.	0.4194	0.3105	-0.0691	1.8635
(13)	Corporate bond market size	% Of US GDP	3	See Appendix II.E.	28.2292	3.1130	22.5216	36.7588

Note: Table 1 presents an overview of the variables used in the various regression equations as well as their descriptive statistics. All variables are observed for 56 quarters from 2007 to 2020. Column 1 presents a number for every variable and Column 2 presents the variable's name. Column 3 presents the unit of measurement. Column 4 and 5 indicate the equations in which a given variable is used and additional notes respectively. The mean value of a variable is shown in Column 6. Column 7 presents the standard deviation. Finally, Column 8 and 9 show the minimum and maximum value respectively. All values are rounded to four decimal places.

4.3. Possible issues and biases

Section 4.1 has provided the methodology on how to measure the impact of monetary policy on the corporate bond market. A number of control variables were included that might otherwise have biased the results. It should be noted that the inclusion of several control variables does not mean the omitted variable bias problem has been solved. It is possible that there are other variables that affect both monetary policy and bond issuance or the credit spread, i.e. investors' risk aversion, that are unaccounted for. Some possible variables will be discussed in section 7. The coefficients of monetary policy could not be interpreted causally if this were to be the case, as the conditional independence assumption would fail to hold. It is therefore important to remain cautious when interpreting the presented results.

Additionally, the inclusion of 10-year US treasury yields and CBOE Volatility Index might lead to an underestimation of the effects of monetary policy. Bekaert et al. (2013) found evidence to support the claim that these variables are affected by monetary policy. Fratzscher, Lo Duca, and Straub (2018) added that these effects are stronger for quantitative easing measures. This means that any monetary policy effects on bond issuance might also be transmitted through these variables. However, if the monetary policy coefficients were to be significant, they might provide a conservative estimate of the real impact of monetary policy. Lo Duca et al. (2016) concluded that accounting for this problem only provides weak evidence to support the claim that the impact of quantitative easing might be larger than the model can account for.

It should also be noted that reserve causality could be a problem, which could result in an overestimation of the results. This research seeks to estimate the effects of monetary policy on the corporate bond market. Yet, it is possible that the corporate bond market affects monetary policy, as follows from Ireland (2015). A similar inference could be made from statements by Jerome Powell, the chair of the Federal Reserve. Powell (2021) stated that the Federal Reserve monitors the situation in the corporate bond market. The results of a Granger causality test are presented in Appendix III, providing further evidence for the presence of reverse causality.

5. Results

5.1. Monetary policy and corporate bond issuance

First, the results of the analysis on the effects of monetary policy on bond issuance are presented in Table 2. The table is divided into three columns. Column 1 presents a regression model without the different control variables. Column 2 includes the control variables presented in section 4.1, excluding the COVID-19 dummy. Column 3 adds a dummy for the COVID-19 pandemic in order to present the full model.

It follows from Table 2 that the monetary policy variables are not statistically significant, barring the variable related to the Federal Reserve's treasury bond purchases. This variable has a positive coefficient and is significant for all three models, albeit of a lesser degree in the full model, presented in the third column. This result infers that a 1 p.p. increase in the Federal Reserve's treasury bond purchasing programme, when measured as a percentage of GDP, increases non-financial corporate bond issuance by 0.1159 p.p., also measured as a percentage of GDP. Such an effect is in line with the portfolio-rebalancing channel discussed in section 3.2, as an investment transition occurs from the treasury bond market to the corporate bond market. The magnitude of the effect is similar to that estimated by Lo Duca et al. (2016). The authors found that purchases of treasury bonds had a statistically significant effect of 0.136 p.p..

No reliable conclusions can be made with regard to the other monetary policy variables, as they are insignificant and alternate between positive and negative coefficients among the models. However, it should be noted that these results are similar to those presented by Lo Duca et al. (2016). The authors found that only the variables relating to a central bank's asset purchases were significant, whereas the effects of asset stocks and the central bank's policy rate were statistically insignificant for advanced economies.

Additionally, it follows from Columns 2 and 3 that increased market volatility, as measured by the CBOE Volatility Index, leads to a reduction in corporate bond issuance. An increase of 1 index point is associated with a 0.0240 p.p. decrease in bond issuance. This variable cannot be interpreted causally, even though the variable shows a statistically significant relationship, as this relationship could be affected by variables that are exogenous to this model. This holds similarly for equity market performance. Even though these are not causal, the estimates do shed light on the relationship between corporate bonds and the equity market. The negative relationship between equity market performance and corporate bond issuance is indicative of a substitution effect between both markets, as more investors will move to equity markets once equity markets provide higher returns.

The variable related to the 10-year US treasury bond yield is weakly significant as follows from Column 2. However, this variable loses its significance once the dummy variable for the COVID-19 pandemic is added. The variable has a negative coefficient in both Columns, this is similar to the results found by Lo Duca et al. (2016). The negative sign is in line with the what was to be expected from the portfolio-rebalancing channel and the notion that corporate bonds are a substitute to US treasury bonds. However, the coefficients are not consistently statistically significant, hence no reliable inferences can be made.

This research added separate stock and purchase variables relating to quantitative easing. This was done in order to assess potential stock or purchase effects of large-scale asset purchases. No statistically significant evidence was found for any stock effects of quantitative easing. This means that the asset stock held by the central bank has no significant effect on corporate bond issuance by non-financial companies. As discussed, evidence is found to support the presence of purchase effects, as the Federal Reserve's treasury bond purchasing programme shows a statistically significant effect on corporate bond issuance by non-financial companies. However, this research does not find such effects with regard to MBS and GSE debt purchases, contrary to Lo Duca et al. (2016).

Table 2 Regression estimates of monetary policy on non-financial corporate bond issuance

Non-financial corporate bond issuance (% of GDP)	1	2	3
Federal Reserve treasury bond stock	0. 0237	-0.0026	-0.0146
	(0.0212)	(0.0245)	(0.0256)
Federal Reserve MBS & GSE debt stock	-0.0153	-0.0226	-0.0223
	(0.0165)	(0.0183)	(0.0181)
Federal Reserve treasury bond purchases	0.1278**	0.1433***	0.1159**
	(0.0487)	(0.0498)	(0.0528)
Federal Reserve MBS & GSE debt purchases	-0.0093	0.0724	0.0698
	(0.0584)	(0.0675)	(0.0667)
Federal Funds Rate	-0.0154	0.0133	-0.0225
	(0.0379)	(0.0458)	(0.0517)
CBOE Volatility Index		-0.0155*	-0.0240**
		(0.0090)	(0.0107)
Equity market performance		-0.0179*	-0.0240**
		(0.0096)	(0.0104)
10-year US treasury bond yield		-0.1426*	-0.0906
		(0.0761)	(0.0836)
COVID-19			0.3924
			(0.2739)
Constant	0.2789*	1.2677**	1.4517***
	(0.1648)	(0.5085)	(0.5191)
R^2	0.2163	0.3000	0.3299
Observations	56	56	56
Monetary policy variables	Yes	Yes	Yes
Control variables	No	Yes	Yes
COVID-19 dummy	No	No	Yes

Note: Table 2 presents the regression results of the estimated model. The results are shown as percentage points changes in non-financial corporate bond issuance as % of GDP if the independent variable were to increase by 1 unit. Column 1 only includes the main explanatory variables, i.e. those variables which are directly related to monetary policy, and the constant. Column 2 includes three control variables, whilst Column 3 adds a dummy variable for the COVID-19 pandemic. All estimates are rounded to four decimal places. Standard errors are shown in parentheses. Significance levels of the coefficient estimates are indicated by the asterisks: * if p<0.10, ** if p<0.05, and *** if p<0.01.

Overall, these results imply that the Federal Reserve's treasury bond purchasing programme did have an effect on corporate bond issuance, which is in line with the portfolio-rebalancing channel. Similarly, increased market volatility and equity market performance are associated with a decrease in corporate bond issuance by non-financial companies. The increased equity market performance presents evidence for a substitution effect between the equity and corporate bond market. Even though the full model presents no statistically significant negative effects of US treasury bond yields on corporate bond issuance, this can still form an indication of the substitution between these two financial instruments. The results will be further discussed in section 7.

5.2. Monetary policy and investors' risk aversion

The results of the analyses on the effect of monetary policy on the credit spread are presented in Table 3. Column 1 to 3 show the regression estimates with regard to AAA rated corporate bonds, whereas Column 4 to 6 show the estimates with regard to BBB rated corporate bonds. Columns 1 and 4 presents a regression model without the different control variables, similarly to Table 3. Columns 2 and 5 include the control variables presented in section 4.1, excluding the COVID-19 dummy. Finally, Columns 3 and 6 add the dummy for the COVID-19 pandemic.

AAA rated corporate bonds

First, the effects with regard to the AAA rated corporate bonds. Only the coefficients of the Federal Reserve's MBS and GSE debt stock, Federal Funds Rate, and the COVID-19 pandemic appear to be consistently statistically significant. It follows from Column 1 to 3 that the Federal Reserve's MBS and GSE debt stock is associated with a statistically significant negative effect on AAA rated corporate bonds. The full model estimates this effect to be approximately -0.0711 p.p. if the Federal Reserve increases it MBS and GSE debt stock by 1 p.p., as measured in percentages of the total MBS and GSE debt. Contrary to corporate bond issuance, stock effects of quantitative easing appear to have an effect on investors' risk aversion for AAA rated corporate bonds. This result infers that increases in the balance sheet size of these financial instruments leads to decreased risk aversion for AAA rated corporate bonds, as the credit spread decreases. This is in line with what follows from the literature relating to the signalling channel. Sizeable asset stocks held by the Federal Reserve constitute a credible commitment to keep interest rates low for a prolonged period of time. Thereby signalling this to investors, who are then willing to take more risks. Although it should be noted that the purchasing of these instruments had no statistically significant effect, according to the estimated models.

Increases in the Federal Funds Rate are also associated with a statistically significant negative effect on the credit spread of AAA rated corporate bonds. The full model estimates a negative effect on the credit spread of -0.2839 p.p. if the Federal Funds Rate increases by 1 p.p.. This result suggests that expansionary interest rate policies increase the credit spread, i.e. increase investors' risk aversion. This result is counterintuitive, as the risk-taking channel of monetary policy would predict the opposite effect.

The coefficient on the Federal Reserve's treasury bond stock is statistically significant in the full model. However, it is insignificant for all other versions of the model. Treasury bond purchases only show a weakly significant effect in Column 2. Additionally, the COVID-19 coefficient is statistically significant at the 5% level, implying that the pandemic coincided with decreased credit spreads and therefore lower investors' risk aversion. All other variables are either consistently statistically insignificant or lose their significance once more variables are added to the model.

Table 3 Regression estimates of monetary policy on credit spreads for AAA and BBB rated non-financial corporate bonds

	Credit spread AAA rated non-financial corporate bonds			Credit spread BBB rated non-financial corporate bonds		
	1	2	3	4	5	6
Federal Reserve treasury bond stock	0.0130	0.0194	0.0297**	-0.0142	0.0033	0.0377
	(0.0130)	(0.0137)	(0.0141)	(0.0338)	(0.0267)	(0.0245)
Federal Reserve MBS & GSE debt stock	-0.0680***	-0.0555***	-0.0711***	-0.1390***	-0.1060***	-0.1581***
	(0.0101)	(0.0154)	(0.0166)	(0.0263)	(0.0301)	(0.0289)
Federal Reserve treasury bond purchases	-0.0373	-0.0662*	-0.0430	-0.0672	-0.2513***	-0.1737
	(0.0299)	(0.0365)	(0.0368)	(0.0774)	(0.0711)	(0.0642)
Federal Reserve MBS & GSE debt purchases	-0.0140	0.0238	0.0231	0.0428	0.1022	0.0997
	(0.0358)	(0.0377)	(0.0363)	(0.0928)	(0.0734)	(0.0633)
Federal Funds Rate	-0.3094***	-0.2903***	-0.2839***	-0.4816***	-0.3823***	-0.3609***
	(0.0233)	(0.0254)	(0.0247)	(0.0603)	(0.0495)	(0.0430)
CBOE Volatility Index		0.0026	0.0083		0.0360***	0.0550***
		(0.0057)	(0.0061)		(0.0111)	(0.0106)
Equity market performance		-0.0095	-0.0051		-0.0069	0.0072
		(0.0066)	(0.0067)		(0.0129)	(0.0116)
GDP growth rate		-0.0203	-0.0115		-0.0655*	-0.0362
		(0.0182)	(0.0180)		(0.0355)	(0.0314)
Corporate bond market size		-0.0036	0.0230		0.0426	0.1315***
		(0.0177)	(0.0211)		(0.0345)	(0.0368)
COVID-19			-0.364**			-1.2153***
			(0.1699)			(0.2964)
Constant	2.3799***	2.2729***	1.4300***	4.5188***	2.152***	-0.6656
	(0.1011)	(0.3351)	(0.5092)	(0.2619)	(0.6528)	(0.8883)
R^2	0.8090	0.8551	0.8685	0.6804	0.8629	0.9002
Observations	56	56	56	56	56	56
Monetary policy variables	Yes	Yes	Yes	Yes	Yes	Yes
Control variables	No	Yes	Yes	No	Yes	Yes
COVID-19 dummy	No	No	Yes	No	No	Yes

Note: Table 3 presents the regression results of the estimated model. The results are shown as percentage point changes in the credit spread if the independent variable were to increase by 1 unit. Column 1 to 3 present the results with regard to AAA rated non-financial corporate bonds. Column 4 to 6 present the results with regard to BBB rated non-financial corporate bonds. Column 1 and 4 only include the main explanatory variables, i.e. those variables which are directly related to monetary policy, and the constant. Column 2 and 5 include four control variables, whilst Column 3 and 6 add a dummy variable for the COVID-19 pandemic. All estimates are rounded to four decimal places. Standard errors are shown in parentheses. Significance levels of the coefficient estimates are indicated by the asterisks: * if $p<0.10$, ** if $p<0.05$, and *** if $p<0.01$.

BBB rated corporate bonds

The regression estimates for BBB rated corporate bonds yield similar results, albeit with a higher order of magnitude. These results are presented in Column 4 to 6 of Table 3. The Federal Reserve's MBS and GSE debt stock, Federal Funds Rate, and the COVID-19 pandemic appear to be consistently statistically significant once again. The CBOE Volatility Index is statistically significant as well, whereas it is insignificant with regard to the AAA rated corporate bonds.

The Federal Reserve's MBS and GSE debt stock is associated with a statistically significant negative effect on BBB rated corporate bonds, as follows from Columns 4 to 6. The full model estimates this effect to be approximately -0.1581 p.p. if the Federal Reserve increases it MBS and GSE debt stock by 1 p.p., as measured in percentages of the total MBS and GSE debt. These results are in line with what was to be expected according to the signalling-channel. This result infers that increased balance sheet sizes of these financial instruments leads to decreased risk aversion with regard to BBB rated corporate bonds. It should be noted that the estimated effect is approximately double compared to the estimated results for AAA rated corporate bonds.

The Federal Funds Rate also has a statistically significant negative effect on the credit spread for BBB rated corporate bonds. This effect is estimated to be -0.3609 p.p. by the full model, as follows from Column 6. This has similar inferences as it does to the AAA rated corporate bonds and implies that expansionary interest rate policies lead to increased risk aversion for BBB rated corporate bonds.

The CBOE Volatility Index shows a significant effect with respect to BBB rated corporate bond credit spreads. Column 5 and 6 present statistically significant positive effects at the 1% level. This could be explained by the fact that investors require increased compensation if the financial markets become more volatile, i.e. if uncertainty about future movements increases, especially in the case of a financial instrument with a higher risk profile. This intuitive result implies that increased volatility increases investors' risk aversion. However, this coefficient cannot be interpreted causally, as this relationship could be affected by variables that are exogenous to this model. Yet, it does provide insights into the possible relationship between market volatility and the credit spread of BBB rated corporate bonds.

Additionally, the COVID-19 coefficient is statistically significant at the 1% level, implying that the pandemic coincided with decreased credit spreads and therefore lower risk aversion. The effect of the pandemic was over three times larger for BBB rated corporate bonds compared to their AAA rated counterparts, according to the model.

The Federal Reserve's treasury bond purchases and the corporate bond market size show significant estimates for only one of the three models. The former is statistically significant at the 1% level and implies that the treasury bond purchases led to decreased credit spread, i.e. decreased risk aversion. The latter implies that a larger corporate bond market, scaled to GDP, coincides with higher credit spreads for BBB rated corporate bonds. All other variables are statistically insignificant, according to the model.

The results presented above highlight the differing characteristics of both types of corporate bonds, as AAA and BBB rated corporate bonds differ in the magnitude of the estimated effect and between significant variables. The estimated models provide evidence to support the claim that the Federal Funds Rate and the Federal Reserve's MBS and GSE debt holdings had an effect on the credit spread of AAA and BBB rated non-financial corporate bonds. However, it is uncertain what the net effects of monetary policy on a corporate bond's credit spread are, as this differs between the policy instruments used in a policy mix. This holds for AAA and BBB rated non-financial corporate bonds. The results will be further discussed in section 7.

6. Policy implications

The results presented in section 5 do not answer the question what these result imply for future monetary policy. This section seeks to provide an answer based on the findings of this research and the theoretical background discussed in section 3.

It is first important to understand the current policy mandate of the Federal Reserve in order observe the framework in which the central bank can and should operate. The Federal Reserve currently acts under the dual mandate (Steelman, 2011). This means that the Federal Reserve pursues multiple objectives at once. The mandate is enshrined in section 2A of the Federal Reserve Act (1913) and is as follows:

> *"The Board of Governors of the Federal Reserve System and the Federal Open Market Committee shall maintain long run growth of the monetary and credit aggregates commensurate with the economy's long run potential to increase production, so as to promote effectively the goals of maximum employment, stable prices, and moderate long-term interest rates."*

Three separate policy objectives follow from this mandate; namely, (i) maximum employment, (ii) stable prices, and (iii) moderate long-term interest rates. Although overall economic stability is not explicitly stated objective, it is a mechanism through which these policy objectives are attained. Such stability is therefore complementary to the goals presented in the policy mandate.

The expansionary monetary policies, which were enacted in the wake of the 2007 – 2008 financial crisis and were kept relatively low for a prolonged period of time, were put into place in order to attain a stable inflationary level. The findings of this research provide support to the claim that the Federal Reserve's treasury bond purchasing programme increased corporate bond issuance. These events coincided with effects on investors' risk aversion.

Even though any effect is hard to quantify, threats to the financial stability arise when the policy mix is such that it leads to significant increases in the overall market risk. This can happen when monetary policy leads to increased corporate bond issuance, whilst at the same time leading to a larger share of non-investment grade bonds, and decreased investors' risk aversion. Evidence has been provided to show increased corporate bond issuance. However, the effect of monetary policy on corporate bond ratings remains unstudied by this research. Yet, evidence for increased issuance of non-investment grade corporate bonds has been presented by Kraemer et al. (2020). The authors found that investment grade corporate bond issuance dropped by 2%, whereas non-investment grade corporate bond issuance increased by 6%. Such threats as a result of a policy mix are hence not implausible, as follows from the evidence provided by this research and the channels discussed in section 3.2.

The Federal Reserve is therefore creating potential sources of future threats. These threats can be amplified given that sizeable unconventional policy measures hinder future policy options and the likelihood that quantitative easing programmes are subject to diminishing returns to scale (Borio, & Gambacorta, 2017).

The aforementioned threats need to be countered in order to safeguard the central bank's policy objectives. The Federal Reserve has two major policy options to its disposal in order to do so. First, it can enact macroprudential policies to regulate the corporate bond market for non-financial companies in order to safeguard the financial stability and prevent such threats from arising. This would be in line with the literature relating to leaning against the wind policies. Second, it is possible for the Federal Reserve to take the effects of monetary policy on the corporate bond market into account when deciding on monetary policy measures. This might be desirable when the corporate bond market experiences increasing levels of non-investment grade bonds coupled with a large share of bonds with a floating coupon rate structure, as floating coupon rate structures are affected by changes in the interest rate. Sudden changes to tighter monetary policy could destabilize financial markets if a lot of corporate bonds were to be affected by tighter monetary policy. However, it should be kept in mind that the literature states that monetary policy measures are less desirable in relation to safeguarding financial stability, as follows from section 3.3.

7. Discussion & Shortcomings

This research sought to assess the effects of the Federal Reserve's monetary policy measures on corporate bond issuance by non-financial companies. It did so by estimating two different multiple linear regression models in order to capture the effects of monetary policy on bond issuance, and investor's risk aversion for corporate bonds, measured via the corporate bond's credit spread. The estimated effects on corporate bond issuance were somewhat similar to those presented by Lo Duca et al. (2016). The similarity between results does not prove that the estimates are unbiased. It can merely be stated that the similarity in the general results is indicative for the validity, albeit weakly. The estimated effects on the credit spread were in some ways counterintuitive and showed less clear-cut results, especially as they are in some ways contrary to what the literature would predict.

7.1. Discussion

The presented results leave some questions unanswered. Why do some monetary policy measures have a significant effect, whilst others do not? Why does the stock of debt assets show a statistically insignificant effect, whereas the treasury bond purchasing programme is statistically significant? Why do the estimated effects differ between AAA and BBB rated corporate bonds? This section will briefly contemplate and hypothesise on the possible answers to these questions.

This research finds a statistically significant effect for the Federal Reserve's treasury bond purchases on corporate bond issuance, but not for its purchases of MBS and GSE debt. The heterogeneous effect of unconventional monetary policy measures could possibly be explained by the findings of Di Maggio et al. (2020) and the portfolio-rebalancing channel. The effects of quantitative are dependent on the nature and composition of the purchased assets (Di Maggio et al., 2020), this premise allows for differing effects of differing assets. Additionally, the portfolio-rebalancing channel states that investors will be crowded out of the market in which the central bank purchases assets and substitute to other instruments. Section 3.2 implicitly assumes that MBS, GSE, and treasury debt purchases all lead to equal substitution towards corporate bonds. However, the presented results indicate the contrary. This might be due to treasury bonds being more complementary to corporate bonds, compared to MBS and GSE debt. This would explain why the latter does not show a statistically significant effect on corporate bond issuance. Although it should be noted that Lo Duca et al. (2016) do find statistically significant effects of MBS and GSE debt purchases by the Federal Reserve. More research into the nature of the effects of MBS and GSE debt purchases might therefore be desirable.

An explicit distinction is made between asset stock and purchases in order to differentiate between stock and purchase effects of quantitative easing. The results presented in section 5 show the absence of stock effects, i.e. the size of the Federal Reserve's balance sheet does not have a statistically significant effect on corporate bond issuance, whereas the treasury bond purchases does show a statistically significant effect. This could be due to that any alterations to the market occur at the moment of asset purchase. Any change in the balance sheet size is then seen as an evidential consequence of the asset purchase by investors and therefore does not entail any further effects on corporate bond issuance. However, this research does not provide any empirical evidence to support this claim. Hence, this merely constitutes a hypothesis on the rationale behind the results.

Table 3 shows that AAA and BBB rated bonds react differently to the variables used in the model. Most notably is the significance of the CBOE Volatility Index for BBB rated corporate bonds, as this variable is insignificant for AAA rated corporate bonds. This might indicate that investors are sensitive to different variables for differing levels of risk. BBB rated corporate bonds might be more affected by market volatility, as these bonds are the lowest type of investment grade bonds and are therefore possibly prone to be downgraded to a non-investment grade rating if the market becomes more volatile. Such a downgrade would force some investors to sell these bonds (CNBC, 2021). Hence, this might explain the increased risk aversion for BBB rated bonds as a result of increased market volatility.

Additionally, the estimated statistically significant effects for BBB rated corporate bonds are larger than those for AAA rated corporate bonds, with the estimated effect of the Federal Reserve's MBS and GSE debt stock being twice as large, as follows from Table 3. It could be argued that a larger absolute effect is to be expected, as the BBB rated corporate bonds pose a larger credit spread compared to AAA rated corporate bonds, as follows from Table 1. However, the relative effect, measured as the coefficients size as a share of the constant, appears to be larger as well. Although it should be noted that the constants presented in Columns 4 to 6 in Table 3 do not show a consistent estimate. However, if it were to be assumed that these estimates are true, this phenomenon could possibly be explained by increased investors' sensitivity to risk if they act on a higher level of risk. This would mean that investors react more strongly when they act on a higher baselevel of risk, as the potential losses are losses. Although it should be noted that this is merely a hypothesis and that this is untested in this research.

Finally, the estimates for the Federal Funds Rate presented in Table 3 turned out to be counterintuitive, as it suggests that expansionary monetary policy increases investors' risk aversion. It is uncertain what causes this result. Failures of the methodology? Does the investor prove to be a rational being that takes the increased risk-taking behaviour of other market participants into account? Or something else? The rationality explanation raises more questions than it answers, e.g. why does this only occur with regard to the Federal Reserve's interest rate policies and not the quantitative easing measures? This research therefore leaves the possible intuition of this result unanswered.

7.2. Shortcomings

It is possible that the results presented in section 5 are affected by variables that are exogenous to the presented model. Bank lending to non-financial corporations might be one such variable. Lo Duca et al. (2016) introduce this variable in their robustness analysis in order to account for possible substitution effects between bank lending and market finance. The authors state that accounting for such an effect might be especially desirable in advanced economies where the banking system experienced a severe shock and credit supply remained weak. A crisis in the banking sector is expected to cause increased corporate bond issuance (De Fiore, & Uhlig, 2015; Adrian, Colla, & Shin, 2012), such was the case after the financial crisis of 2007 and 2008. This infers that the estimates presented in this research are possibly an underestimation of the true effect. This variable was left out for this research, as no suitable data on this variable has been found. Adding this variable might therefore present more reliable results.

Another omitted variable might be related to a change in the Federal Reserve's monetary policy objectives. Jerome Powell announced that the Federal Reserve would revise their long-run monetary policy framework by changing its' focus from inflation targeting to average inflation targeting (Famiglietti, & Garriga, 2020; Martínez-García, Coulter, & Grossman, 2021). This might have affected investors' expectations about future monetary policy and possibly their actions with respect to the corporate bond market. Yet, the model presented in this research does not account for this change. This might therefore be a source of omitted variable bias.

Similarly, the interaction between the COVID-19 pandemic and monetary policy is not present in the model. This leads to the fact that this research is unable to make any conclusions on the interaction between monetary policy and the COVID-19 pandemic, which might have fuelled the growth in corporate bond issuance. Furthermore, monetary policy has changed during the COVID-19 pandemic, as the Federal Reserve expanded the scope of its quantitative easing programme to include corporate debt (Smialek, 2020). This is omitted from the model and might therefore form a source of omitted variable bias.

Future research might wish to add the GDP growth rate to the presented model. This research omits such a variable in equation (1), as the dependent variable is already scaled by GDP, in accordance with the research by Lo Duca et al. (2016). Yet, it is possible to argue that GDP rate is a source of exogeneity, as monetary policy is reactive to changing macroeconomic circumstances which are captured by the GDP growth rate and not by scaling the dependent variable by GDP.

The addition of the CBOE Volatility Index and 10-year US treasury bond yield could possibly lead to an underestimation of the results, as discussed in section 4.3. Even though Lo Duca et al. (2016) concluded that accounting for this problem does not significantly alter the impact of quantitative easing on corporate bond issuance. It is possible that the implications of the addition of these variables might be different for this research compared to Lo Duca et al. (2016). It might therefore be desirable to assess the effects of the inclusion of such variables in future research.

Another point of consideration is more general and concerns the fact that any effect is hard to quantify and should be handled with great care. This point is presented by Borio and Zabai (2016) in their literary overview on the effects of monetary policy and is echoed by this research. The estimated results are dependent on the data and might be biased as a result of this.

There might also be more fundamental methodological concerns. This research estimates a linear multiple regression model, inspired by the model presented by Lo Duca et al. (2016). However, evidence suggests that unconventional monetary policy measures are likely to be subject to diminishing returns to scale, as follows from Borio and Gambacorta (2017). It is therefore possible to argue that such marginal effects also apply to the effects on the non-financial corporate bond market. Such a result would infer that the model presented in this research is flawed, as it is unable account for this. A polynomial regression model, that allows for such effects, might thus be more suitable model.

It should be noted that the model presented in this research only considers contemporaneous effects of monetary policy on the corporate bond market. However, it is likely that past monetary policy conditions affect current outcomes in the corporate bond market. The model used in this research does not take this into account. This might therefore be a source of heterogeneity. A model that allows for lagged variables might hence be desirable.

It is also possible to argue that the distinction between AAA and BBB rated corporate bonds, which is being applied with respect to the credit spread analysis, is not well suited for its' intended purpose. Appendix I shows the full range of credit ratings that the three major credit rating agencies apply. Selecting just two of these rating classes might ignore widely differing characteristics and responses of other rating classes. It might therefore be beneficial to consider a wider selection of credit groups in future research. This was not done by this research, as no suitable data has been found in order to do so.

Related to this is the fact that this research only controls for the size of the entire corporate bond market in equation (3), even though the dependent variable is based on corporate bonds with a certain credit rating. This leaves the different sizes of the corporate bond markets for each credit rating unaccounted for. Future research might take this into account by splitting up the corporate bond market according to a bond's credit rating.

It might additionally be argued that the proposed dependent variable for investors' risk aversion, i.e. a corporate bonds credit spread relative to a 10-year US treasury bond, is not suitable for its intended purpose. It is assumed that the subtraction of the 10-year US treasury bond yield eliminates the systematic risk, but this might be questionable. Future research might therefore wish to assess the validity of this approach or develop a more suitable dependent variable.

Furthermore, evidence presented by Ireland (2015), statements by Powell (2021), and the Granger causality test make it seem plausible that the estimates presented in this research are overestimated as a result of reverse causality. In other words, the effects of monetary policy on non-financial corporate bond issuance are, at least partially, caused by the effect non-financial corporate bond issuance on monetary policy. Isolating such effects is difficult, but might be overcome by analysing possible shock effects of monetary policy announcements or implementations. Such research has been performed by McAndrews, Sarkar, and Wang (2017), Ueda (2012), Hausman, and Wieland (2014), Filardo and Hofmann (2014), and Weale and Wieladek (2016), among others.

Finally, it is possible to debate the external validity of these results. This holds for the external validity with regard to place and time. The applicability of the results to other financial systems than the US is uncertain, even if the estimated results were assumed to reflect the true effects. This is because the underlying financial market and monetary mechanisms might differ too much in order to allow for external applicability. It is possible that the general effect, i.e. positive or negative, would remain the same, but that the magnitude differs significantly. Similar inferences can be made with regard to the possibility to extrapolate these results outside the studied timespan. The general results are likely to be the same, but the magnitude of the effects might differ. Especially if the quantitative easing programmes continue for a prolonged period of time and start to show larger diminishing effects. Although it should be noted that this research makes no claims on the applicability of the results to other economies than the US. The policy implications presented in section 6 therefore only apply to the Federal Reserve.

8. Conclusion

Much research has been performed on the effects of monetary policy. This literature has been discussed in section 3. It follows from this presentation that monetary policy had an effect on macroeconomic indicators and financial markets. However, a literary overview also shows that the magnitude of the estimated effect is dependent on the data and methodology used in the research. Hence, results differ a lot between research.

This research seeks to estimate the effects of monetary policy on non-financial corporate bond issuance and investors' risk aversion with regard to non-financial corporate bonds. This is done by estimating two multiple linear regression models. The model is inspired by Lo Duca et al. (2016), but includes additional variables that have been identified to possibly bias the results if they were left out. The data has been collected from multiple sources, but mainly the Federal Reserve Economic Data[base].

The analysis seems to provide evidence that the Federal Reserve's treasury bond purchasing programme led to increased non-financial corporate bond issuance, measured as a percentage of GDP. Such results would be in line with the portfolio-rebalancing channel. Yet, the other variables related to conventional and unconventional monetary policy do not provide for any statistically significant results. Equity market returns and volatility do show a statistically significant result and are associated with decreased non-financial corporate bond issuance. However, it should be noted that these variables cannot be interpreted causally.

The results presented with regard to credit spread and investors' risk aversion are partially counterintuitive to what the risk-taking and signalling channel would predict. The results show a negative statistically significant estimate for increases in the Federal Funds Rate on the credit spread for AAA and BBB rated non-financial corporate bonds. Indicating that expansionary interest rate policy increases the credit spread, i.e. increasing investors' risk aversion. However, the estimates for the Federal Reserve's MBS and GSE debt stock indicate an opposite effect. All other variables related to monetary policy are not consistently statistically significant for both rating types of non-financial corporate bonds. Whether these results are robust, driven by exogeneity, or any other bias is uncertain. Future research might wish to take additional variables into account, test the results for other credit ratings, or apply a different methodology.

It might be interesting to take the points presented in section 7 into account for future research. A different research approach, e.g. a methodology that can account for diminishing marginal effects of monetary policy, additional variables, e.g. bank lending to non-financial companies or lagged variables, and tests whether the addition of adding the CBOE Volatility Index and 10-year US treasury bond yield affect the estimates might be desirable.

This research looked to the corporate bond market as a singular entity, only with a differentiated dependent variable with regard to the non-financial corporate bond credit spread. However, corporate bonds have a lot of differentiating characteristics, as stated in section 2. It might be interesting to assess the effects of monetary policy on non-financial corporate bond issuance with a specific coupon rate structure. However, this is left to future research.

It turned out that Icarus flew to close to the sun. He was punished for his actions by the Gods as a result. However, only time can tell if the financial analysts were right by labelling the corporate bond market a bubble. It remains to be seen whether or not the Federal Reserve's policy measures had a destabilizing effect on the financial markets and whether they strayed too far from their mandate. This research provided evidence to support the claim that some monetary policy facets led to increased non-financial corporate bond issuance, but whether this is a prelude or cause to the next financial crash remains a question that can only be answered by the passing of time.

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10. Appendices

Appendix I – Comparative credit ratings

Table I.A. Overview of credit ratings issued by Fitch, Moody's, and Standard & Poor's

	Description	Fitch	Moody's	S&P
Investment grade	Highest quality	AAA	Aaa	AAA
		AA+	Aa1	AA+
	High quality	AA	Aa2	AA
		AA-	Aa3	AA-
		A+	A1	A+
	Strong payment capacity	A	A2	A
		A-	A3	A-
		BBB+	Baa1	BBB+
	Adequate payment capacity	BBB	Baa2	BBB
		BBB-	Baa3	BBB-
Non-investment grade		BB+	Ba1	BB+
	Likely to fulfil obligations, ongoing uncertainty	BB	Ba2	BB
		BB-	Ba3	BB-
		B+	B1	B+
	High credit risk	B	B2	B
		B-	B3	B-
		CCC+	Caa1	CCC+
	Very high credit risk	CCC	Caa2	CCC
		CCC-	Caa3	CCC-
	Near default with possibility of recovery	CC	Ca	CC
		C		C
	Default	RD	C	D
		D		

Note: Table I.A. presents the credit ratings issued by the three major credit rating agencies, Fitch, Moody's, and Standard & Poor's (S&P). Column 1 indicates whether a given constitutes an investment grade of non-investment grade corporate bond. Column 2 provides a short description of what a given credit rating entails, based on Afonso, Gomes, and Rother (2006). Column 3 to 5 show the rating categories of Fitch, Moody's, and S&P respectively. The addition of a plus (+) or minus (-) sign indicates the relative standing withing the major rating categories. Source: Fitch Ratings (n.d.), Moody's Investors Service (n.d.), S&P Global Ratings (n.d.).

Appendix II – Data

This appendix provides the characteristics of the underlying variables used to compute the main variables for the analyses. Furthermore, it presents the formulas used in order to compute the variables. The variables are ordered such that it provides a logical and coherent build-up of the data. Any cross-references are made by referring to the corresponding number presented in the title of the variable section, e.g. II.A.. Additionally, each subsection presents the unit of measurement, number of observations, mean, standard deviation, and minimum and maximum value of a given variable in a table.

II.A. Corporate bonds outstanding issued by non-financial companies

Table II.A.1. Descriptive statistics

Unit	N	Mean	Std. dev.	Min	Max
Million USD	57	4,957,389	1,217,752	3,145,734	7,256,816

Note: Table II.A.1. presents the descriptive characteristics on the variable relating to corporate bonds outstanding issued by non-financial companies. Column 1 presents the unit of measurement. Column 2 shows the number of observations. The mean value of a variable is shown in Column 3. Column 4 presents the standard deviation. Finally, Column 5 and 6 show the minimum and maximum value respectively. All values are rounded to the nearest integer.

This variable has been retrieved from the Federal Reserve Economic Data[base] and shows the corporate securitized debt level of non-financial companies in millions of USD (Board of Governors of the Federal Reserve System, n.d.-h). The data is observed quarterly from the fourth quarter of 2006 up till the fourth quarter of 2020. This variable forms the basis of the dependent variable used in section 5.1.

II.B. Corporate bond issuance by non-financial companies

Table II.B.1. Descriptive statistics

Unit	N	Mean	Std. dev.	Min	Max
Million USD	56	73,412	60,112	-15,024	363,786

Note: Table II.B.1. presents the descriptive characteristics on the variable relating to corporate bonds issued by non-financial companies. Column 1 presents the unit of measurement. Column 2 shows the number of observations. The mean value of a variable is shown in Column 3. Column 4 presents the standard deviation. Finally, Column 5 and 6 show the minimum and maximum value respectively. All values are rounded to the nearest integer.

This variable is calculated based on the variable presented under II.A. and shows the level of corporate bonds issued by non-financial companies. This variable is computed according to the following formula:

$$BI_t = BL_t - BL_{t-1} \quad \text{(i)}$$

Where BI_t indicates the gross amount of non-financial corporate bonds issued in millions of USD during quarter t. BL_t indicates the level of the corporate bond market for non-financial in millions of USD at time t. The amount issued is therefore equal to the difference between the size of the non-financial corporate securitized debt level at time t and $t-1$.

II.C. US GDP

Table II.C.1. Descriptive statistics

Unit	N	Mean	Std. dev.	Min	Max
Billion USD	57	17,381	2,478	14,037	21,747

Note: Table II.C.1. presents the descriptive characteristics on the variable relating to the US GDP. Column 1 presents the unit of measurement. Column 2 shows the number of observations. The mean value of a variable is shown in Column 3. Column 4 presents the standard deviation. Finally, Column 5 and 6 show the minimum and maximum value respectively. All values are rounded to the nearest integer.

This variable has been retrieved from the Federal Reserve Economic Data[base] and shows US GDP in billions of USD (Board of Governors of the Federal Reserve System, n.d.-i). The data is observed quarterly from the fourth quarter of 2006 up till the fourth quarter of 2020. This variable is used in order to scale II.A. and II.B..

II.D. US GDP growth rate

Table II.D.1. Descriptive statistics

Unit	N	Mean	Std. dev.	Min	Max
%	56	0.7811	1.8581	-9.4662	8.4535

Note: Table II.D.1. presents the descriptive characteristics on the variable relating to the US GDP growth rate. Column 1 presents the unit of measurement. Column 2 shows the number of observations. The mean value of a variable is shown in Column 3. Column 4 presents the standard deviation. Finally, Column 5 and 6 show the minimum and maximum value respectively. All values are rounded to four decimal places.

This variable is calculated based on the variable presented under II.C. and shows the US GDP growth rate. This variable is computed according to the following formula:

$$GDP_t = \frac{(GDPl_t - GDPl_{t-1})}{GDPl_{t-1}} * 100 \qquad \text{(ii)}$$

Where GDP_t indicates the US' GDP growth rate at time t. $GDPl_t$ indicates the US GDP in billions of USD at time t.

II.E. Corporate bond market size as a share of US gross domestic product

Table II.E.1. Descriptive statistics

Unit	N	Mean	Std. dev.	Min	Max
%	56	28.2292	3.1130	22.5216	36.7588

Note: Table II.E.1. presents the descriptive characteristics on the variable relating to the size of the US corporate bond market as a share of US GDP. Column 1 presents the unit of measurement. Column 2 shows the number of observations. The mean value of a variable is shown in Column 3. Column 4 presents the standard deviation. Finally, Column 5 and 6 show the minimum and maximum value respectively. All values are rounded to four decimal places.

This variable is calculated based on the variables presented under II.A. and II.C. and shows the level of corporate bonds outstanding by non-financial companies as a share of US GDP. This variable is computed according to the following formula:

$$L_t = \frac{BL_t * 1{,}000{,}000}{GDPl_t * 1{,}000{,}000{,}000} * 100 \quad \text{(iii)}$$

Where L_t indicates the nominal level of corporate bonds issuance at time t, measured as a share of US GDP. BI_t indicates the amount of non-financial corporate bonds issued in millions of USD at time t. $GDPl_t$ indicates the US GDP in millions of USD at time t.

II.F. Corporate bond issuance by non-financial companies as a share of US gross domestic product

Table II.F.1. Descriptive statistics

Unit	N	Mean	Std. dev.	Min	Max
%	56	0.4194	0.3105	-0.0691	1.8635

Note: Table II.F.1. presents the descriptive characteristics on the variable relating to the size of US corporate bond issuance by non-financial companies as a share of US GDP. Column 1 presents the unit of measurement. Column 2 shows the number of observations. The mean value of a variable is shown in Column 3. Column 4 presents the standard deviation. Finally, Column 5 and 6 show the minimum and maximum value respectively. All values are rounded to four decimal places.

This variable is calculated based on the variables presented under II.B. and II.C. and shows the level of corporate bonds issuance by non-financial companies as a share of US GDP. This variable is computed according to the following formula:

$$B_t = \frac{BI_t * 1{,}000{,}000}{GDPl_t * 1{,}000{,}000{,}000} * 100 \quad \text{(iv)}$$

Where B_t represents non-financial corporate bond issuance in the US corporate bond market at t, expressed as a percentage of US GDP. BI_t indicates the gross amount of non-financial corporate bonds issued in millions of USD at time t. $GDPl_t$ indicates the US GDP in billions of USD at time t.

II.G. Federal Reserve treasury bond holdings

Table II.G.1. Descriptive statistics

Unit	N	Mean	Std. dev.	Min	Max
Million USD	744	1,839,502	935,911	474,619	4,688,916

Note: Table II.G.1. presents the descriptive characteristics on the variable relating to the Federal Reserve's treasury bond holdings. Column 1 presents the unit of measurement. Column 2 shows the number of observations. The mean value of a variable is shown in Column 3. Column 4 presents the standard deviation. Finally, Column 5 and 6 show the minimum and maximum value respectively. All values are rounded to the nearest integer.

This variable has been retrieved from the Federal Reserve Economic Data[base] and shows the Federal Reserve's treasury bond assets in millions of USD (Board of Governors of the Federal Reserve System, n.d.-f). The data is observed weekly from the fourth quarter of 2006 up till the fourth quarter of 2020. The average of the Federal Reserve's treasury bond holdings is taken for every quarter in order to scale the observations to the required time interval, i.e. quarterly observations. This is done according to equation (v). This results in 57 observations.

$$Uth_t = \frac{\sum_1^N Th_{n,t}}{N_t} \quad \text{(v)}$$

Where Uth_t represents the average level of treasury bonds held by the Federal Reserve measured in millions of USD at time t. $Th_{n,t}$ represents the all observations, n, on the Federal Reserve's treasury bond assets during quarter t. N_t represents the number of observations during quarter t. Table II.G.2. shows the resulting descriptive characteristics.

Table II.G.2. Descriptive statistics

Unit	N	Mean	Std. dev.	Min	Max
Million USD	56	1,855,820	935,840	474,972	4,581,015

Note: Table II.G.2. presents the descriptive characteristics on the variable relating to the quarterly averaged Federal Reserve's treasury bond holdings. Column 1 presents the unit of measurement. Column 2 shows the number of observations. The mean value of a variable is shown in Column 3. Column 4 presents the standard deviation. Finally, Column 5 and 6 show the minimum and maximum value respectively. All values are rounded to the nearest integer.

II.H. Federal Reserve treasury bond purchases

Table II.H.1. Descriptive statistics

Unit	N	Mean	Std. dev.	Min	Max
Million USD	56	67,894	218,815	-186,281	1,484,785

Note: Table II.H.1. presents the descriptive characteristics on the variable relating to the Federal Reserve's treasury bond purchases. Column 1 presents the unit of measurement. Column 2 shows the number of observations. The mean value of a variable is shown in Column 3. Column 4 presents the standard deviation. Finally, Column 5 and 6 show the minimum and maximum value respectively. All values are rounded to the nearest integer.

This variable is calculated based on the variable presented under II.G. and shows the amount of treasury bonds purchased by the Federal Reserve. This variable is computed according to the following formula:

$$Utp_t = Uth_t - Uth_{t-1} \quad \text{(vi)}$$

Where Utp_t indicates the amount of treasury bonds purchased by the Federal Reserve in millions of USD during quarter t. Uth_t indicates the level of the treasury bond assets held by the Federal Reserve at time t. The purchased amount is therefore equal to the difference between the assets held at time t and $t-1$.

II.I. Total US federal debt

Table II.I.1. Descriptive statistics

Unit	N	Mean	Std. dev.	Min	Max
Million USD	56	16,953,520	4,806,578	8,849665	27,747,798

Note: Table II.I.1. presents the descriptive characteristics on the variable relating to the US' federal debt. Column 1 presents the unit of measurement. Column 2 shows the number of observations. The mean value of a variable is shown in Column 3. Column 4 presents the standard deviation. Finally, Column 5 and 6 show the minimum and maximum value respectively. All values are rounded to the nearest integer.

This variable has been retrieved from the Federal Reserve Economic Data[base] and shows the total US federal debt in millions of USD (Board of Governors of the Federal Reserve System, n.d.-j). The data is observed quarterly from the first quarter of 2007 up till the fourth quarter of 2020. This variable is used in order to scale II.G. and II.H..

II.J. Federal Reserve treasury bond holdings as a share of the total US federal debt

Table II.J.1. Descriptive statistics

Unit	N	Mean	Std. dev.	Min	Max
%	56	10.3227	3.0263	4.2684	16.5095

Note: Table II.J.1. presents the descriptive characteristics on the variable relating to the total Federal Reserve's treasury bond holdings as a share of the total US' federal debt. Column 1 presents the unit of measurement. Column 2 shows the number of observations. The mean value of a variable is shown in Column 3. Column 4 presents the standard deviation. Finally, Column 5 and 6 show the minimum and maximum value respectively. All values are rounded to four decimal places.

This variable is calculated based on the variables presented under II.G. and II.I. and shows the level of the Federal Reserve's treasury bond stock as a percentage of the total US federal debt. This variable is computed according to the following formula:

$$Uthp_t = \frac{Uth_t}{FD_t} * 100 \tag{vi}$$

Where $Uthp_t$ indicates the amount of treasury bond assets held by the Federal Reserve as a share of the total US federal debt during quarter t. Uth_t indicates the level of the treasury bond assets held by the Federal Reserve in millions of USD at time t. FD_t is the total US federal debt in millions of USD during at time t.

II.K. Federal Reserve treasury bond purchases as a share of the total US federal debt

Table II.K.1. Descriptive statistics

Unit	N	Mean	Std. dev.	Min	Max
%	56	0.3220	0.9628	-1.9625	5.6078

Note: Table II.K.1. presents the descriptive characteristics on the variable relating to the total Federal Reserve's treasury bond purchases as a share of the total US' federal debt. Column 2 shows the number of observations. The mean value of a variable is shown in Column 3. Column 4 presents the standard deviation. Finally, Column 5 and 6 show the minimum and maximum value respectively. All values are rounded to four decimal places.

This variable is based on the variables presented under II.H. and II.I. and shows the level of the Federal Reserve's treasury bond purchases as a percentage of the total US federal debt during quarter t. This variable is computed according to the following formula:

$$Utpp_t = \frac{Utp_t}{FD_t} * 100 \tag{vii}$$

Where $Utpp_t$ indicates the amount of treasury bond assets purchased by the Federal Reserve as a share of the total US federal debt during quarter t. Utp_t indicates the amount of treasury bonds purchased by the Federal Reserve in millions of USD during quarter t. FD_t is the total US federal debt in millions of USD during at time t.

II.L. Federal Reserve MBS & GSE debt holdings

Table II.L.1. Descriptive statistics

Unit	N	Mean	Std. dev.	Min	Max
Million USD	744	1,154,289	649,163	0	2,086,574

Note: Table II.L.1. presents the descriptive characteristics on the variable relating to the Federal Reserve's MBS and GSE debt holdings. Column 1 presents the unit of measurement. Column 2 shows the number of observations. The mean value of a variable is shown in Column 3. Column 4 presents the standard deviation. Finally, Column 5 and 6 show the minimum and maximum value respectively. All values are rounded to the nearest integer.

This variable has been retrieved from the Federal Reserve Economic Data[base] and shows the Federal Reserve's MBS and GSE debt holdings in millions of USD (Board of Governors of the Federal Reserve System, n.d.-e). The data is observed weekly from the fourth quarter of 2006 up till the fourth quarter of 2020. The average of the Federal Reserve's treasury MBS and GSE debt holdings are taken for every quarter in order to scale the observations to the required time interval, i.e. quarterly observations. This is done according to equation (viii). This results in 57 observations.

$$Umgh_t = \frac{\sum_1^N MGh_{n,t}}{N_t} \qquad \text{(viii)}$$

Where $Umgh_t$ represents the average level of MBS and GSE debt held by the Federal Reserve measured in millions of USD at time t. $MGh_{n,t}$ represents the all observations, n, on the Federal Reserve's MBS and GSE assets during quarter t. N_t represents the number of observations during quarter t. Table II.L.2. shows the resulting descriptive characteristics.

Table II.L.2. Descriptive statistics

Unit	N	Mean	Std. dev.	Min	Max
Million USD	56	1,173,893	640,344	0	2,026,542

Note: Table II.L.2. presents the descriptive characteristics on the variable relating to the quarterly averaged Federal Reserve's MBS and GSE debt holdings. Column 1 presents the unit of measurement. Column 2 shows the number of observations. The mean value of a variable is shown in Column 3. Column 4 presents the standard deviation. Finally, Column 5 and 6 show the minimum and maximum value respectively. All values are rounded to the nearest integer.

II.M. Federal Reserve MBS & GSE debt purchases

Table II.M.1. Descriptive statistics

Unit	N	Mean	Std. dev.	Min	Max
Million USD	56	36,188	93,660	-77,494	330,330

Note: Table II.M.1. presents the descriptive characteristics on the variable relating to the Federal Reserve's MBS and GSE debt purchases. Column 1 presents the unit of measurement. Column 2 shows the number of observations. The mean value of a variable is shown in Column 3. Column 4 presents the standard deviation. Finally, Column 5 and 6 show the minimum and maximum value respectively. All values are rounded to the nearest integer.

This variable is calculated based on the variable presented under II.L. and shows the amount of treasury bonds purchased by the Federal Reserve. This variable is computed according to the following formula:

$$Umgp_t = Umgh_t - Umgh_{t-1} \tag{ix}$$

Where $Umgp_t$ indicates the amount of MBS and GSE debt purchased by the Federal Reserve in millions of USD during quarter t. $Umgh_t$ indicates the level of MBS and GSE debt assets held by the Federal Reserve at time t. The purchased amount is therefore equal to the difference between the assets held at time t and $t-1$.

II.N. Total agency MBS debt outstanding

Table II.N.1. Descriptive statistics

Unit	N	Mean	Std. dev.	Min	Max
Million USD	14	7,411,586	1,030,637	5,801,006	9,833,900

Note: Table II.N.1. presents the descriptive characteristics on the variable relating to the total agency MBS debt outstanding. Column 1 presents the unit of measurement. Column 2 shows the number of observations. The mean value of a variable is shown in Column 3. Column 4 presents the standard deviation. Finally, Column 5 and 6 show the minimum and maximum value respectively. All values are rounded to the nearest integer.

This variable has collected by Securities Industry and Financial Markets Association (n.d.-a) and shows the total of MBS agency debt outstanding in millions of dollars at time t. The data is observed yearly from 2007 up till 2020. The variable is presumed to remain constant throughout a given year. This variable forms the basis for II.P..

II.O. Total GSE debt outstanding

Table II.O.1. Descriptive statistics

Unit	N	Mean	Std. dev.	Min	Max
Million USD	14	5,755,894	1,536,554	2,644,481	7,665,782

Note: Table II.O.1. presents the descriptive characteristics on the variable relating to the total GSE debt outstanding. Column 1 presents the unit of measurement. Column 2 shows the number of observations. The mean value of a variable is shown in Column 3. Column 4 presents the standard deviation. Finally, Column 5 and 6 show the minimum and maximum value respectively. All values are rounded to the nearest integer.

This variable has collected by Securities Industry and Financial Markets Association (n.d.-b) and shows the total of GSE debt outstanding in millions of dollars at time t. The data is observed yearly from 2007 up till 2020. The variable is presumed to remain constant throughout a given year. This variable forms the basis for II.P..

II.P. Total MBS & GSE debt outstanding

Table II.P.1. Descriptive statistics

Unit	N	Mean	Std. dev.	Min	Max
Million USD	14	13,167,480	2,404,834	8,445,487	17,499,682

Note: Table II.P.1. presents the descriptive characteristics on the variable relating to the total agency MBS and GSE debt outstanding. Column 1 presents the unit of measurement. Column 2 shows the number of observations. The mean value of a variable is shown in Column 3. Column 4 presents the standard deviation. Finally, Column 5 and 6 show the minimum and maximum value respectively. All values are rounded to the nearest integer.

This variable is calculated based on the variables presented under II.N. and II.O. and shows the total amount of agency MBS and GSE debt outstanding at time t. This variable is computed according to the following formula:

$$Tmg_t = Tm_t + Tg_t \tag{x}$$

Where Tmg_t indicates the total agency MBS and GSE debt outstanding in millions of USD at time t. Tm_t indicates the total agency MBS debt outstanding in millions of USD at time t. Tg_t indicates the total GSE debt outstanding in millions of USD at time t. The variable is presumed to remain constant throughout a given year. This variable is used in order to scale II.L. and II.M..

II.Q. Federal Reserve MBS & GSE debt holdings as a share of the total MBS & GSE debt outstanding

Table II.Q.1. Descriptive statistics

Unit	N	Mean	Std. dev.	Min	Max
%	56	8.3083	4.2674	0.0000	12.8065

Note: Table II.Q.1. presents the descriptive characteristics on the variable relating to the Federal Reserve's MBS and GSE debt holdings as a share of the total agency MBS and GSE debt outstanding. Column 1 presents the unit of measurement. Column 2 shows the number of observations. The mean value of a variable is shown in Column 3. Column 4 presents the standard deviation. Finally, Column 5 and 6 show the minimum and maximum value respectively. All values are rounded to four decimal places.

This variable is calculated based on the variables presented under II.L. and II.P. and shows the level of the Federal Reserve's MBS and GSE debt holdings as a percentage of the agency MBS and GSE debt. This variable is computed according to the following formula:

$$Umghp_t = \frac{Umgh_t}{Tmg_t} * 100 \tag{xi}$$

Where $Umghp_t$ indicates the amount of MBS and GSE debt held by the Federal Reserve as a share of the total agency MBS and GSE debt at time t. $Umgh_t$ indicates the level of MBs and GSE debt held by the Federal Reserve in millions of USD at time t. Tmg_t is the total amount of agency MBS and GSE debt outstanding in millions of USD during at time t.

II.R. Federal Reserve MBS & GSE debt purchases as a share of the total MBS & GSE debt outstanding

Table II.R.1. Descriptive statistics

Unit	N	Mean	Std. dev.	Min	Max
%	56	0.3043	0.7753	-0.5790	3.3340

Note: Table II.R.1. presents the descriptive characteristics on the variable relating to the Federal Reserve's MBS and GSE debt purchases as a share of the total agency MBS and GSE debt outstanding. Column 1 presents the unit of measurement. Column 2 shows the number of observations. The mean value of a variable is shown in Column 3. Column 4 presents the standard deviation. Finally, Column 5 and 6 show the minimum and maximum value respectively. All values are rounded to four decimal places.

This variable is calculated based on the variables presented under II.M. and II.P. and shows the level of the Federal Reserve's MBS and GSE debt purchases as a percentage of the agency MBS and GSE debt. This variable is computed according to the following formula:

$$Umgpp_t = \frac{Umgp_t}{Tmg_t} * 100 \qquad \text{(xi)}$$

Where $Umgpp_t$ indicates the amount of MBS and GSE debt purchased by the Federal Reserve as a share of the total agency MBS and GSE debt at time t. $Umgp_t$ indicates the level of MBs and GSE debt purchases by the Federal Reserve in millions of USD at time t. Tmg_t is the total amount of agency MBS and GSE debt outstanding in millions of USD during at time t.

II.S. Effective Federal Funds Rate

Table II.S.1. Descriptive statistics

Unit	N	Mean	Std. dev.	Min	Max
%	168	0.9725	1.3871	0.0500	5.2600

Note: Table II.S.1. presents the descriptive characteristics on the variable relating to the effective Federal Funds Rate. Column 1 presents the unit of measurement. Column 2 shows the number of observations. The mean value of a variable is shown in Column 3. Column 4 presents the standard deviation. Finally, Column 5 and 6 show the minimum and maximum value respectively. All values are rounded to four decimal places.

This variable has been retrieved from the Federal Reserve Economic Data[base] and shows the effective Federal Funds Rate in percentages (Board of Governors of the Federal Reserve System, n.d.-d). The data is observed weekly from the first quarter of 2007 up till the fourth quarter of 2020. The average of the effective Federal Funds Rate is taken for every quarter in order to scale the observations to the required time interval, i.e. quarterly observations. This is done according to equation (xii). This results in 56 observations.

$$I_t = \frac{\sum_1^N FFR_{n,t}}{N_t} \qquad \text{(xii)}$$

Where I_t represents the average effective Federal Funds Rate measured in percentages at time t. $FFR_{n,t}$ represents the all observations, n, on effective Federal Funds Rate during quarter t. N_t represents the number of observations during quarter t. Table II.S.2. shows the resulting descriptive characteristics.

Table II.S.2. Descriptive statistics

Unit	N	Mean	Std. dev.	Min	Max
%	56	0.9725	1.3904	0.0600	5.2567

Note: Table II.S.2. presents the descriptive characteristics on the variable relating to the quarterly averaged effective Federal Funds Rate. Column 1 presents the unit of measurement. Column 2 shows the number of observations. The mean value of a variable is shown in Column 3. Column 4 presents the standard deviation. Finally, Column 5 and 6 show the minimum and maximum value respectively. All values are rounded to four decimal places.

II.T. CBOE Volatility Index

Table II.T.1. Descriptive statistics

Unit	N	Mean	Std. dev.	Min	Max
Index points	3525	19.9782	9.7579	9.1400	82.9600

Note: Table II.T.1. presents the descriptive characteristics on the variable relating to the CBOE Volatility Index. Column 1 presents the unit of measurement. Column 2 shows the number of observations. The mean value of a variable is shown in Column 3. Column 4 presents the standard deviation. Finally, Column 5 and 6 show the minimum and maximum value respectively. All values are rounded to four decimal places.

This variable has been retrieved from the Federal Reserve Economic Data[base] and shows CBOE Volatility Index measured in index points (Board of Governors of the Federal Reserve System, n.d.-k). The data is observed daily from the first quarter of 2007 up till the fourth quarter of 2020. The average of the CBOE Volatility Index is taken for every quarter in order to scale the observations to the required time interval, i.e. quarterly observations. This is done according to equation (xiii). This results in 56 observations.

$$Dvi_t = \frac{\sum_1^N VI_{n,t}}{N_t} \tag{xii}$$

Where Dvi_t represents the average CBOE Volatility Index measured in index points at time t. $VI_{n,t}$ represents the all observations, n, on the CBOE Volatility Index during quarter t. N_t represents the number of observations during quarter t. Table II.T.2. shows the resulting descriptive characteristics.

Table II.T.2. Descriptive statistics

Unit	N	Mean	Std. dev.	Min	Max
Index points	56	19.9705	8.6567	10.3079	58.5959

Note: Table II.T.2. presents the descriptive characteristics on the variable relating to the quarterly averaged CBOE Volatility Index. Column 1 presents the unit of measurement. Column 2 shows the number of observations. The mean value of a variable is shown in Column 3. Column 4 presents the standard deviation. Finally, Column 5 and 6 show the minimum and maximum value respectively. All values are rounded to four decimal places.

II.U. S&P500

Table II.U.1. Descriptive statistics

Unit	N	Mean	Std. dev.	Min	Max
Index points	3525	1,892	705	677	3,756

Note: Table II.U.1. presents the descriptive characteristics on the variable relating to the closing value of the S&P500. Column 1 presents the unit of measurement. Column 2 shows the number of observations. The mean value of a variable is shown in Column 3. Column 4 presents the standard deviation. Finally, Column 5 and 6 show the minimum and maximum value respectively. All values are rounded to the nearest integer.

This variable has been retrieved from investing.com and shows the effective closing value of the S&P500 in index points (Investing.com, n.d.-b). The data is observed daily from the first quarter of 2007 up till the fourth quarter of 2020. This variable forms the basis for II.V..

II.V. Equity market performance

Table II.V.1. Descriptive statistics

Unit	N	Mean	Std. dev.	Min	Max
%	3524	0.0362	1.3102	-11.9841	11.5800

Note: Table II.V.1. presents the descriptive characteristics on the variable relating to equity market performance as measured by the return on the S&P500. Column 1 presents the unit of measurement. Column 2 shows the number of observations. The mean value of a variable is shown in Column 3. Column 4 presents the standard deviation. Finally, Column 5 and 6 show the minimum and maximum value respectively. All values are rounded to four decimal places.

This variable is calculated based on the variable presented under II.U. and shows the daily growth rate of the S&P500. This variable is computed according to the following formula:

$$EMr_t = \frac{SPc_t - SPc_{t-1}}{SPc_{t-1}} * 100 \quad \text{(xiii)}$$

Where EMr_t indicates the daily return of the S&P500 at time t. SPc_t indicates the closing value of the S&P500 in index points at time t. The average of the daily return of the S&P500 for every quarter is taken in order to scale the observations to the required time interval, i.e. quarterly observations. This is done according to equation (xiv). This results in 56 observations.

$$Demr_t = \frac{\sum_1^N EMr_{n,t}}{N_t} \quad \text{(xiv)}$$

Where $Demr_t$ represents the average quarterly return of the S&P500 at time t. $EMr_{n,t}$ represents the all observations, n, on the daily S&P500 return during quarter t. N_t represents the number of observations during quarter t. Table II.V.2. shows the resulting descriptive characteristics.

Table II.V.2. Descriptive statistics

Unit	N	Mean	Std. dev.	Min	Max
%	56	1.9149	6.4924	-27.1598	13.2397

Note: Table II.V.2. presents the descriptive characteristics on the variable relating to the quarterly averaged equity market performance. Column 1 presents the unit of measurement. Column 2 shows the number of observations. The mean value of a variable is shown in Column 3. Column 4 presents the standard deviation. Finally, Column 5 and 6 show the minimum and maximum value respectively. All values are rounded to four decimal places.

II.W. 10-year US treasury bond yield

Table II.W.1. Descriptive statistics

Unit	N	Mean	Std. dev.	Min	Max
%	4093	2.5268	0.9371	0.5020	5.2890

Note: Table II.W.1. presents the descriptive characteristics on the variable relating to 10-year treasury bond yield. Column 1 presents the unit of measurement. Column 2 shows the number of observations. The mean value of a variable is shown in Column 3. Column 4 presents the standard deviation. Finally, Column 5 and 6 show the minimum and maximum value respectively. All values are rounded to four decimal places.

This variable has been retrieved from investing.com and shows the yield on a 10-year US treasury bond in percentages at time t (Investing.com, n.d.-a). The data is observed daily from the first quarter of 2007 up till the fourth quarter of 2020. The average yield of a 10-year US treasury bond is taken for every quarter in order to scale the observations to the required time interval, i.e. quarterly observations. This is done according to equation (xv). This results in 56 observations.

$$DG_t = \frac{\sum_1^N GY_{n,t}}{N_t} \quad \text{(xv)}$$

Where DG_t represents the average quarterly 10-year US treasury bond yield at time t. $GY_{n,t}$ represents the all observations, n, on the 10-year US treasury bond yield during quarter t. N_t represents the number of observations during quarter t. Table II.W.2. shows the resulting descriptive characteristics.

Table II.W.2. Descriptive statistics

Unit	N	Mean	Std. dev.	Min	Max
%	56	2.5988	0.9364	0.6459	4.8463

Note: Table II.W.2. presents the descriptive characteristics on the variable relating to the quarterly averaged 10-year treasury bond yield. Column 1 presents the unit of measurement. Column 2 shows the number of observations. The mean value of a variable is shown in Column 3. Column 4 presents the standard deviation. Finally, Column 5 and 6 show the minimum and maximum value respectively. All values are rounded to four decimal places.

II.X. AAA rated corporate bond yields

Table II.X.1. Descriptive statistics

Unit	N	Mean	Std. dev.	Min	Max
%	3506	4,2312	0,9125	2,0100	6,5500

Note: Table II.X.1. presents the descriptive characteristics on the variable relating to AAA rated corporate bond yields. Column 1 presents the unit of measurement. Column 2 shows the number of observations. The mean value of a variable is shown in Column 3. Column 4 presents the standard deviation. Finally, Column 5 and 6 show the minimum and maximum value respectively. All values are rounded to four decimal places.

This variable has been retrieved from the Federal Reserve Economic Data[base] and shows the yield of a AAA rated corporate bond in percentages at time t (Board of Governors of the Federal Reserve System, n.d.-c). The data is observed daily from the first quarter of 2007 up till the fourth quarter of 2020. The average yield of AAA rated corporate bond is taken for every quarter in order to scale the observations to the required time interval, i.e. quarterly observations. This is done according to equation (xvi). This results in 56 observations.

$$Y_{AAA,t} = \frac{\sum_1^N Yaaa_{n,t}}{N_t} \tag{xvi}$$

Where $Y_{AAA,t}$ represents the average quarterly AAA rated corporate bond yield at time t. $Yaaa_{n,t}$ represents the all observations, n, on the AAA rated corporate bond yield during quarter t. N_t represents the number of observations during quarter t. Table II.X.2. shows the resulting descriptive characteristics.

Table II.X.2. Descriptive statistics

Unit	N	Mean	Std. dev.	Min	Max
%	56	4.2308	0.9049	2.2333	5.7973

Note: Table II.X.2. presents the descriptive characteristics on the variable relating to the quarterly averaged AAA rated corporate bond yield. Column 1 presents the unit of measurement. Column 2 shows the number of observations. The mean value of a variable is shown in Column 3. Column 4 presents the standard deviation. Finally, Column 5 and 6 show the minimum and maximum value respectively. All values are rounded to four decimal places.

II.Y. BBB rated corporate bond yields

Table II.Y.1. Descriptive statistics

Unit	N	Mean	Std. dev.	Min	Max
%	3506	5.3385	1.1597	3.1100	9.5400

Note: Table II.Y.1. presents the descriptive characteristics on the variable relating to BBB rated corporate bond yields. Column 1 presents the unit of measurement. Column 2 shows the number of observations. The mean value of a variable is shown in Column 3. Column 4 presents the standard deviation. Finally, Column 5 and 6 show the minimum and maximum value respectively. All values are rounded to four decimal places.

This variable has been retrieved from the Federal Reserve Economic Data[base] and shows the yield of a BBB rated corporate bond in percentages at time t (Board of Governors of the Federal Reserve System, n.d.-c). The data is observed daily from the first quarter of 2007 up till the fourth quarter of 2020. The average yield of BBB rated corporate bond is taken for every quarter in order to scale the observations to the required time interval, i.e. quarterly observations. This is done according to equation (xvii). This results in 56 observations.

$$Y_{BBB,t} = \frac{\sum_{1}^{N} Ybbb_{n,t}}{N_t} \tag{xvii}$$

Where $Y_{BBB,t}$ represents the average quarterly BBB rated corporate bond yield at time t. $Ybbb_{n,t}$ represents the all observations, n, on the BBB rated corporate bond yield during quarter t. N_t represents the number of observations during quarter t. Table II.X.2. shows the resulting descriptive characteristics.

Table II.Y.2. Descriptive statistics

Unit	N	Mean	Std. dev.	Min	Max
%	56	5.3388	1.1571	3.2977	8.8156

Note: Table II.Y.2. presents the descriptive characteristics on the variable relating to the quarterly averaged BBB rated corporate bond yield. Column 1 presents the unit of measurement. Column 2 shows the number of observations. The mean value of a variable is shown in Column 3. Column 4 presents the standard deviation. Finally, Column 5 and 6 show the minimum and maximum value respectively. All values are rounded to four decimal places.

II.Z. Credit spread AAA rated non-financial corporate bond

Table II.Z.1. Descriptive statistics

Unit	N	Mean	Std. dev.	Min	Max
%	56	1.6320	0.3858	0.6837	2.5787

Note: Table II.Z.1. presents the descriptive characteristics on the variable relating to the credit spread of AAA rated corporate bond relative to a 10-year US treasury bond. Column 1 presents the unit of measurement. Column 2 shows the number of observations. The mean value of a variable is shown in Column 3. Column 4 presents the standard deviation. Finally, Column 5 and 6 show the minimum and maximum value respectively. All values are rounded to four decimal places.

This variable is calculated based on the variable presented under II.W. and II.X. and shows the credit spread between a AAA rated corporate bond and a 10-year US treasury bond. This variable is computed according to the following formula:

$$S_{AAA,t} = Y_{AAA,t} - DG_t \tag{xviii}$$

Where $S_{AAA,t}$ indicates the credit spread between a AAA rated corporate bond and a 10-year US treasury bond at time t. $Y_{AAA,t}$ represents the average quarterly AAA rated corporate bond yield at time t. DG_t represents the average quarterly 10-year US treasury bond yield at time t.

II.AA. Credit spread BBB rated non-financial corporate bond

Table II.AA.1. Descriptive statistics

Unit	N	Mean	Std. dev.	Min	Max
%	56	1.6320	0.3858	0.6837	2.5787

Note: Table II.AA.1. presents the descriptive characteristics on the variable relating to the credit spread of BBB rated corporate bond relative to a 10-year US treasury bond. Column 1 presents the unit of measurement. Column 2 shows the number of observations. The mean value of a variable is shown in Column 3. Column 4 presents the standard deviation. Finally, Column 5 and 6 show the minimum and maximum value respectively. All values are rounded to four decimal places.

This variable is calculated based on the variable presented under II.Y. and II.X. and shows the credit spread between a BBB rated corporate bond and a 10-year US treasury bond. This variable is computed according to the following formula:

$$S_{BBB,t} = Y_{BBB,t} - DG_t \quad \text{(xviii)}$$

Where $S_{BBB,t}$ indicates the credit spread between a BBB rated corporate bond and a 10-year US treasury bond at time t. $Y_{BBB,t}$ represents the average quarterly BBB rated corporate bond yield at time t. DG_t represents the average quarterly 10-year US treasury bond yield at time t.

Appendix III – Granger causality

The results presented in section 5 might be subject to reverse causality, as discussed in section 4.3. Evidence to support this has been provided by Ireland (2015) and Powell (2021). The results of a Granger causality tests are presented in Table III.A.. The three Columns indicate differing levels of lag. Column 1 presents the test with a single quarter lag. Column 2 and 3 show the results from the Granger causality test with a two and four quarter lag respectively. It should be noted that these values do not represent any true causal relationship and that this test does not solve any omitted variable bias.

Table III.A. Results of the Granger causality test

Equation	Excluded	Probability > Chi^2		
		1	2	3
Federal Reserve treasury bond stock	Bond issuance by non-financial companies	0.252	0.697	0.093*
Federal Reserve MBS & GSE debt stock	Bond issuance by non-financial companies	0.047**	0.546	0.004***
Federal Reserve treasury bond purchases	Bond issuance by non-financial companies	0.180	0.511	0.004***
Federal Reserve MBS & GSE debt purchases	Bond issuance by non-financial companies	0.134	0.119	0.149
Effective Federal Funds Rate	Bond issuance by non-financial companies	0.649	0.794	0.003***
Bond issuance by non-financial companies	Federal Reserve treasury bond stock	0.634	0.090*	0.213
Bond issuance by non-financial companies	Federal Reserve MBS & GSE debt stock	0.570	0.556	0.246
Bond issuance by non-financial companies	Federal Reserve treasury bond purchases	0.947	0.229	0.036**
Bond issuance by non-financial companies	Federal Reserve MBS & GSE debt purchases	0.162	0.836	0.284
Bond issuance by non-financial companies	Effective Federal Funds Rate	0.322	0.007***	0.032**

Note: Table III.A. presents the results of a Granger causality test on the variables related to monetary policy and corporate bond issuance by non-financial companies. The test seeks to answer whether the *Excluded* variable is Granger causal to the *Equation* variable. Column 1 shows the results for the Granger causality test with a single quarter lag. Column 2 presents the results of the test with a two-quarter lag. Column 3 shows the results for of the test with a four-quarter lag. All estimates are rounded to three decimal places. Asterisks are added in order to allow for an effortless interpretation of the estimates, where: * if p<0.10, ** if p<0.05, and *** if p<0.01.

It follows from Table III.A. that the Granger causality goes both ways between the monetary policy and corporate bond issuance variables, albeit for differing lags and variables. Bond issuance by non-financial companies appear to be Granger causal to all monetary policy variables with a four-quarter lag, except for the Federal Reserve's MBS and GSE debt purchases. The Federal Reserve's treasury bond stock is Granger causal to bond issuance, albeit whilst being weakly significant and only for a two-quarter lag.

Treasury bond purchases on the other hand are Granger causal to bond issuance for a four-quarter lag. Finally, the Federal Funds Rate is Granger causal for the two and four quarter lags. The variables related to MBS and GSE related monetary policy appear not to be Granger causal.

These results do support the notion that any causal effect might go both ways between monetary policy and corporate bond issuance. Any implications for the results presented in section 5 are discussed in section 7.