The Determinants of Corporate Bond Underpricing in Times of Quantitative Easing
– an Analysis of the European Investment Grade Bond Market

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Abstract

This study examines the determinants of bond underpricing in the EUR corporate investment grade space. Moreover, it assesses whether the European Central Bank (ECB), through its quantitative easing, has caused a structural change in bond underpricing. Insights on the nature of underpricing and the ECB's influence are complemented by a novel conceptualisation of underpricing. Contrarily to previous research, this study measures underpricing on the day of issuance and thereby from an ex-ante, rather than an ex-post perspective. Based on a sample of 947 bonds issued by 320 non-financial corporations, this thesis finds that bonds in the corporate investment grade space are subject to an average New Issue Premium of 7bps on the day of pricing. Deal-specific and market-related variables help to explain bond underpricing, supporting information-based theories of the phenomenon. Surprisingly, the ECB's quantitative easing appears to have only a marginal impact on the magnitude of underpricing and its determinants.

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1 Introduction and Motivation

During the Great Financial Crisis in 2008 and 2009, bank lending conditions tightened immensely. In response, non-financial corporations in the Eurozone shifted towards the issuance of debt securities as an alternative source of financing (De Fiore & Uhlig, 2015). The ability of firms to dynamically adjust their composition of debt financing is an important feature of resilience, as diversified alternatives to access capital can help to mitigate adverse developments in financial markets. Since then, and particularly in recent years, the issuance volume of corporate bonds denominated in EUR has grown steadily (Maitra et al, 2018). While the EUR corporate bond market still has not reached its US counterpart in terms of total and relative size, it now constitutes an important and well-established source of capital (Celik, Demirtas, & Isaksson, 2020).

Several studies provide evidence that corporate bond offerings, similar to equity offerings, experience systematic underpricing which contributes directly to the financing costs of borrowers. Although smaller in magnitude, the cumulative amount of underpricing in monetary terms is enormous. Over the past five years, non-financial companies with an investment grade rating have issued a total of EUR 1.85tr in corporate bonds (International Capital Markets Association, 2020). Thus, considering the size of the market, even modest underpricing results in a massive wealth transfer from issuers to investors.

Simultaneously, as part of its unconventional monetary policy toolkit, the European Central Bank (ECB) has become an important player in the bond market. The underlying objective is to lift inflation towards its target rate and improve the financing conditions of the Eurozone's real economy. Since 2016, the ECB has purchased corporate bonds in excess of EUR 200bn and hence, has become a driving force in the market (European Central Bank, 2020). Various researches show that the ECB has been successful in effectively lowering bond yields in the corporate space and its interaction has led to an increase in issuance activity.

Since underpricing contributes directly to the financing conditions of borrowers, the question arises whether the ECB's quantitative easing has also caused a structural change in underpricing. In this context, this study contributes to the existing literature threefold. As the first study to focus exclusively on the corporate investment grade space, it attempts to identify the determining factors of bond underpricing in the EUR market. Based on an extensive sample of 946 EUR-denominated bonds issued by 320

corporations with an investment grade rating, the explanatory power of several deal-specific and market-related economic predictors is tested. Secondly, this thesis links the existing literature on bond underpricing with investigations of the ECB's quantitative easing and therefore contributes to understanding how its monetary policy impacts bond underpricing. Thirdly, insights on the nature of underpricing and the ECB's influence are complemented by a novel conceptualisation of underpricing. Contrarily to previous research, this study measures underpricing on the day of issuance and thereby from an ex-ante, rather than an ex-post perspective.

The structure of this thesis is as follows. Section 2 lays out the institutional framework. Here, the issuance process of corporate bonds is described, and an overview of the ECB's unconventional monetary policy tools is provided. Afterwards, Section 3 reviews existing literature on bond underpricing and the ECB's impact on bond prices and yields. It thereby forms the basis for the development of the theoretical foundation of the thesis in Section 4. Subsequently, the study's methodology is outlined in Section 5 and in Section 6, the empirical findings are presented. Afterwards, in Section 7 the findings are discussed, practical implications are drawn, and potential areas of further research are explored. Finally, concluding remarks are presented in Section 8.

2 Institutional Framework

In the following, the institutional framework of this thesis is laid out. Bond underpricing occurs on the primary market for corporate bonds where bonds are initially sold to investors. To provide an understanding for the dynamics on the primary market, the issuance process and the stakeholders involved are discussed. Afterwards, the ECB's quantitative easing is presented. As one element of its large-scale asset purchase programme, the ECB launched the so-called Corporate Sector Purchase Programme (CSPP), a dedicated programme targeting the corporate bond market. Since the CSPP is only one component of the ECB's unconventional monetary policy tools, it is important to comprehend the context in which it was initiated.

2.1 The Primary Market for Corporate Bonds

On the primary market, bonds are originated and initially sold to investors. The new issuance process of corporate bonds normally follows the bookbuilding method which

has established itself as market practice. In this method, the issuer begins with appointing one or a group of investment banks (syndicate) to manage the issuance process. In many cases, these banks also underwrite the transaction (International Capital Markets Association, 2014). Among the syndicate group several roles must be filled. Appendix 2 provides a more detailed overview of these roles. Throughout the preparation period prior to the envisaged day of pricing, the syndicate group updates the issuer on latest market developments and advises on structuring the transaction accordingly. Aspects to consider include the currency of issuance, the number of tranches, the respective amount per tranche, as well as the coupon type (European Commission, 2017). Depending on the documentation, the preparation of a bond issuance frequently lasts up to three months. However, it can also be completed within one or two days. In the latter case, the issuer has a so-called EMTN (European Medium-Term Note)- programme in place which serves as a framework for ad-hoc issuances (Thomson Reuters Practical Law, 2020).

On the day of pricing, the exact features of the bond are communicated to the market with initial thoughts on pricing, and the orderbook is opened. Pricing for EUR-denominated investment grade bonds is quoted as a spread to EUR Mid-Swaps[1]. Simultaneously, the syndicate banks' sales force starts to market the transaction to investors and to collect orders. Once the orderbook is closed, the transaction is priced and the syndicate decides on allocation, which must follow a pre-defined set of rules communicated to the financial regulators in accordance with Article 40 of the MiFID II Delegated Regulation. This is to ensure that investors are not discriminated based on existing or future business relationships (European Commission, 2016). Nevertheless, some discretion in terms of allocation remains with the syndicate banks. Roadshow attendance as well as the investors' feedback on pricing and other aspects of the transaction are some of the factors determining allocations. Ultimately, the bond is free to trade on the secondary market, where the syndicate banks often continue to act as market makers (International Capital Market Association, 2016).

2.2 The European Central Bank's Asset Purchase Programmes

In response to the Great Financial Crisis, the European Central Bank introduced small asset purchase programmes in order to ease the refinancing conditions for financial

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[1] The EUR-Mid Swap is the maturity-matched, fixed leg of the EUR interest rate swap, where six-months EURIBOR is the floating leg. Mid-prices are used as reference.

institutions in the Eurozone. On July 2nd, 2009 the ECB launched its first asset purchase programme targeting covered bonds (CBPP1) as a mean to help banks to restructure their balance sheets. The programme had a notional volume of EUR 60bn and was active until the end of June 2010 (European Central Bank, 2009). A second covered bond purchase programme (CBPP2) with a total volume of EUR 16.3bn was active between November 3rd, 2011 and October 31st, 2012 (European Central Bank, 2011).

Two years later, in mid-2014, the ECB announced a large-scale asset purchase programme (APP) to support the monetary policy transmission mechanism. Complementing a series of interest rate cuts and other non-standard monetary policy measures, the APP was designed to ensure price stability within the Eurozone. One component of it was a third covered bond programme (CBPP3) through which the ECB acquired covered bonds from October 20th, 2014 onwards (European Central Bank, 2014). The CBPP3 was complemented by an asset-backed securities programme (ABSPP) which was launched shortly afterwards. In addition to the CBPP3 and the ABSPP, a public bond purchase programme (PSPP) was introduced in March 2015, targeting bonds issued by governments, government-related agencies, and European institutions, among others (European Central Bank, 2015).

On March 10th, 2016 the ECB announced its corporate sector purchase programme (CSPP) through which the Central Bank has a mandate to buy investment grade bonds issued by non-financial corporations in the Eurozone (European Central Bank, 2016). As one component of its APP, the objective of the CSPP is to further enhance the transmission of the Eurosystem's asset purchases to the financing conditions of the real economy (European Central Bank, 2016). A couple of weeks after the announcement, the ECB published a list of technical parameters which bonds must fulfil in order to be eligible for purchase under the CSPP. Appendix 3 summarises these eligibility criteria. Bond purchases under the CSPP commenced on June 8th, 2016 and are conducted by six national central banks from different Eurozone countries (Belgium, Finland, France, Germany, Italy, and Spain) in coordination with the ECB. Transparency on the activity is promoted through weekly publications of all bonds purchased as well as monthly disclosures of total holdings. Moreover, securities bought under the CSPP are made available for securities lending in order to sustain market liquidity (European Central Bank, 2016).

Net purchases under the different components of the APP were terminated on December 19th, 2018 and from that date onwards proceeds (regular coupon payments and principal repayments) were fully reinvested across the different APP portfolios. Not even a year later, on September 12th, 2019 the ECB communicated that asset purchases would be reactivated with a monthly target volume of EUR 20bn from November 2019 onwards. By the end of March 2020, the ECB held EUR 2,666bn in assets across the different portfolios with the PSPP accounting for approximately 81% of total holdings. Thus, the PSPP is, and has been, comprising by far the largest holdings of all programmes under the APP-umbrella.

Figure 1: Timeline of the ECB's Asset Purchase Programmes
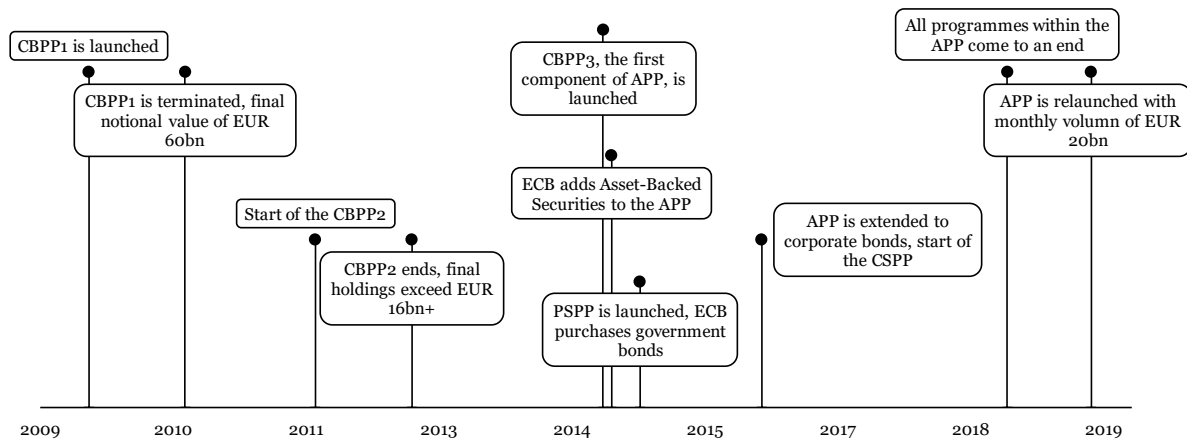
3   Literature Review

In order to investigate the impact of the CSPP on New Issue Concessions expediently it is essential to understand (i) the determinants of bond underpricing and (ii) the CSPP's impact on bond markets. To firstly comprehend the determinants of bond underpricing, existing literature on the topic is presented starting with early studies on the US market. These analyses aim to provide evidence for the existence of underpricing. Afterwards, more recent papers also focusing on the US market are discussed as they shed more light on the explanatory variables of underpricing. Concluding the first part of the literature review, evidence from different European markets is reviewed. As second step, existing research on the CSPP's impact on bond

markets is examined. While there is, to date, only one paper touching upon the effect of the ECB's asset purchase programmes on bond underpricing, more extensive research investigates the influence of the CSPP on bond prices and yields.

3.1 Evidence of Bond Underpricing

3.1.1 Early Evidence of Bond Underpricing in the US Market

The pricing of new securities is naturally important to a range of stakeholders including issuers, underwriters, investors, and regulators. Hence, new issue pricing (or mispricing) of financial securities has been a common theme in the financial literature with the bulk of empirical studies focusing on equity offerings, including IPOs and follow-ons. In comparison to equity offerings, less research has been conducted on bond issuances and most studies follow either information- or liquidity- based approaches. Moreover, most of the literature concentrates on the US market.

Early studies including Ederington (1974) and Lindvall (1977) as well as Sorenson (1982) analyse the yield convergence between newly issued and comparable bonds outstanding and argue that quickly converging yields are evidence of bond underpricing. Rather than assessing yields, Weinstein (1978) looks at secondary market returns over different holding periods and finds that newly issued corporate bonds show excess benchmark-adjusted returns. He then reasons that these returns can be explained by initial underpricing.

While these papers provide early evidence for underpricing, they do not differentiate whether the bond issuance was an initial (IBO) or seasoned offering (SBO). In this context, the term *seasoned* refers to the fact that an issuer has traded bonds outstanding at the time of the respective new issuance. Datta, Iskandar-Datta & Patel (1997) focus exclusively on IBOs and find significant positive returns for high yield, but negative returns for investment grade IBOs. They conclude that bond underpricing relates to information asymmetries as high yield bonds contain more issuer-specific risks. Helwege & Kleiman (1998) as well as Hale & Santos (2006) provide further support that the degree of underpricing is larger for riskier firms.

A more comprehensive analysis is provided by Cai, Helwege & Warga (2007) who are the first to distinguish between IBOs and SBOs. Firstly, they find significant underpricing in high yield IBOs, but no evidence for underpricing in investment grade IBOs. Secondly, they show that underpricing also exists in high yield SBOs, which has

not been documented before. The authors reason that underpricing is a compensation for investors who provide feedback on the price determination during the bookbuilding process. Their findings therefore further support the argument that underpricing is greater for riskier bonds due to the greater amount of valuation uncertainties.

3.1.2 Recent Studies on Underpricing in the US Market

After evidence for the existence of underpricing in bonds has been provided, more recent studies attempt to identify the determinants of the phenomenon. Another advancement relates to the quality of data as the above-mentioned studies were mostly based on limited data sets from discrete sources such as rating agencies or insurance companies.

Goldberg & Ronn (2013) are the first to examine the determinants of bond underpricing in the investment grade space based on the TRACE database[2]. The set of economic predictors they use to explain New Issue Premia contains deal-related variables as well as predictors capturing the market sentiment. Firstly, Goldberg & Ronn show that the influence of market credit spreads works twofold. While high absolute level of market credit spreads reduce the magnitude of underpricing, positive changes in spreads leads to higher New Issue Concessions. The authors argue that in the first case, investors are willing to dispense some of the premium in order to have access to larger blocks of bonds with attractive yields which they cannot purchase on the secondary market. Contrarily, increasing market credit spreads are most likely the results of deteriorating credit conditions and hence impact New Issue Premia negatively. Secondly, Goldberg & Ronn provide evidence that underpricing is a mean to mitigate valuation uncertainties as their results also indicate that bond underpricing is positively correlated to market volatility. These findings complement the work of Lowry, Officer & Schwert (2010) who examine the effect of market-wide uncertainty on equity offerings. Thirdly, Goldberg & Ronn postulate the pseudo-underwriter hypothesis. The authors reason that underpricing is a mean of banks to compensate investors for bearing valuation uncertainties in order to pre-empt the price discovery process. In this context, large institutional investors receive an allocation which exceeds their actual investment needs and thereby implicitly underwrite the bond

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[2] Under the Trade Reporting and Compliance Engine (TRACE), which was instituted in 2002 and fully operational by 2006, dealers in fixed income securities are obliged to report all trades to a central clearing house within 15 minutes of execution (SEC, 2011). Since all bond transactions are collected centrally, more extensive analyses can be conducted.

issuance. Hence, underpricing arises due to the symbiotic relationship between investment banks and institutional investors.

Further contributing to the understanding of the determinants of bond underpricing, Goh & Yang (2015) study whether underpricing is caused by temporary and permanent price pressure. The authors find that underpricing is positively related to the size of the bond offering which is consistent with evidence from equity offerings that larger amounts cause greater downward price pressure (Corwin, 2003). The effect of price pressure on bond underpricing is later also confirmed by Helwege & Wang (2016). Moreover, Goh & Yang's results yield larger underpricing for lower rated bonds with longer maturities as well as for bond offerings completed during times of elevated market volatility.

3.1.3 Evidence from European Capital Markets

Outside of the US, the literature on bond underpricing is scarce due to limited data availability and is therefore based on rather small sample sizes. The findings of Wasserfallen & Wydler (1988) for Switzerland, Zaremba (2014) for Poland, Aronsson & Tano (2016) for Sweden and Mietzner, Proelss & Schweizer (2017) for the German mini-bond market[3] generally support the existence of bond underpricing in Europe. However, these studies concentrate on niche markets and are based on limited sample sizes.

Looking at EUR-denominated bonds, Rischen & Theissen (2018) are the first to extensively investigate the nature of bond underpricing and take into account a wide range of different collateral and issuer types. Firstly, Rischen & Theissen find that EUR-denominated bonds are significantly underpriced and observe the largest degree of underpricing for bonds issued by non-financial corporations. Secondly, their results show that the magnitude of underpricing relates to factors proxying the borrower's riskiness, valuation uncertainties regarding the specific issue, and particularly the market-wide level of volatility. Hence, their findings support information-based explanations of underpricing. Thirdly, the authors investigate how the ECB's monetary policy tools influence the magnitude of underpricing. This part of their research will be

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[3] Mini-bonds are issued by German small- and medium-sized enterprises. These financial securities have similar characteristic to traditional bonds but smaller face values (EUR 2m to EUR 200m) and are used as an alternative to bank loans. Mini-bonds trade on specialised market segments of German exchanges (Mietzner, Proelss, & Schweizer, 2017).

further discussed in Section 3.2 which explores the effects of quantitative easing on bond markets.

A second study on the EUR market is conducted by Maitra, Salt & Satchell (2018) who generally confirm the observations from the US and the findings of Rischen & Theissen (2018). However, their results deviate from previous findings in one particular case: While Goldberg & Ronn (2013) and Rischen & Theissen (2018) find a negative relationship between underpricing and market level of credit spreads, Maitra et al. show that high levels of market credit spreads lead to higher New Issue Concessions. The authors further add to the understanding of bond underpricing in that they provide evidence for a monotonic relationship between the New Issue Spread (measured as spread over EUR Mid-Swaps) and New Issue Premia.

To summarise, researchers argue that bond underpricing can be attributed to information- or liquidity-based explanations. In fact, information asymmetries and valuation uncertainties appear to be the key driver of underpricing. Following Goldberg & Ronn (2013), bond underpricing is positively correlated to market-wide volatility. Moreover, the relationship between investment banks and institutional investors appears to shape underpricing. Furthermore, Goh & Yang (2015) find that the tenor of the bond as well as its rating influence underpricing. The authors also show that underpricing is positively related to the size of the bond offering, an observation which supports liquidity-based approaches. Rischen & Theissen (2018) as well as Maitra et al. (2018) confirm these observations for the European market.

3.2 Effects of Quantitative Easing on Bond Markets

In response to the financial crisis, central banks have extended the range of monetary instruments which they use in order to implement their policies. From 2009 onwards, the ECB has introduced a series of asset purchase programmes through which bonds meeting several eligibility criteria are bought. In an early study, Joyce et al. (2012) show that unconventional monetary tools such as asset purchase programmes are effective in providing economic stimulus through lower interest rates. Therefore, these programmes have become an important component of central banks' tool kits.

As mentioned, Rischen & Theissen (2018) are the first to investigate the effects of quantitative easing on bond underpricing in the EUR market. Their results yield that underpricing for bonds which are purchased under one of the ECB's asset purchase programmes is significantly lower. Further, they show that eligibility for one of the

programmes is the key factor affecting underpricing and it does not matter whether the ECB ultimately purchases the respective bond. However, their data sample only includes bonds issued until May 2nd, 2017 and thus only captures a limited time period of the ECB's bond purchase programmes which are still active. Moreover, their work does not address why the ECB's quantitative easing leads to a decrease in bond underpricing.

More extensive research exists on the influence of the ECB's different asset purchase programmes, and especially the CSPP, on bond prices and yields. Examining the corporate bond market, Abidi & Miquel-Flores (2018) implement a regression discontinuity approach to investigate the causal effects of the CSPP. Their analysis focuses on the lower bound of the rating space within the ECB's eligibility framework (Baa3 by Moody's, BBB- by Standard & Poor's and Fitch). They attempt to exploit differences between the ECB's and market participants' rating treatment in the cross-over territory (bonds which have an investment grade rating from one agency, but a high yield rating from another one). While the ECB considers the best credit rating available, Abidi & Miquel-Flores argue that investment grade investors (mostly insurance companies and pension funds) impose stricter standards. This results in a sharp discontinuity in the likelihood of these investors including such bonds in their portfolios. Thus, there exists a subsample of bonds which qualify for purchase under the CSPP but are considered high yield by market participants. In this context, Abidi & Miquel-Flores find that the announcement of the CSPP has led to a meaningful decrease in credit spreads. Interestingly, the spread reduction is particularly noticeable for eligible bonds falling below the BBB- threshold as applied by market participants. This supports the authors' reasoning that the knowledge of the ECB's framework and the strict investor guidelines incentivises to rebalance portfolios towards CSPP-eligible bonds which fall below the market participants' cut-off. Thereby, the research supports the portfolio rebalancing mechanism introduced by Vayanos & Vila (2009) and further studied by Gagnon et al. (2011).

The portfolio rebalancing channel is also studied by Zaghini (2019) who assesses the influence of the CSPP during its first year of existence. The analysis focuses on the development of credit spreads of three different types of bonds: (i) eligible bonds which have been purchased, (ii) eligible bonds which have not been purchased, and (iii) non-eligible bonds. During the first six months of the CSPP, spreads of eligible bonds

decreased significantly regardless if the ECB bought them or not. Simultaneously, a slight spread widening could be observed for non-eligible bonds which reverted in the following six months period. Zaghini reasons that the ECB initially caused a demand shift in the eligible bond universe which led to a price increase (spreads decline), and later generated scarcity in the eligible segment which crowded out other investors and pushed them towards non-eligible bonds. This observation provides further evidence in favour of the portfolio rebalancing channel.

Later, Todorov (2019) investigates how the announcement of the CSPP impacts bond prices, liquidity and debt issuance volumes. His study is based on an observation period of 23 weeks (January to June 2016) including the significant dates March 10th when the CSPP was announced, and April 21st when the eligibility criteria were published. His findings disclose an inverse relationship between the bond's credit rating and the compression in yields. Moreover, bonds with longer tenors experience the largest decline in yields. Simultaneously, liquidity in eligible bonds was increased although the initial spike in trading activity decreased over time. The observation that eligible bonds with lower ratings and longer maturities experience the largest magnitude of yield reduction shows that the CSPP has a higher positive impact on riskier debt instruments. Furthermore, Todorov's findings indicate an overall increase in issuance volumes by eligible borrowers after the CSPP announcement and additionally show a shift towards EUR-denominated issuances from companies which frequently issue bonds in several currencies. However, his results are based on a short time horizon in the context of a bond issuance. Given that his observation period includes merely twelve weeks after the CSPP announcement, only companies which access the bond market regularly were able to react on the news and consequently increase their issuance volume.

De Santis & Zaghini (2019) further assess to what extend the CSPP has impacted corporate issuance activity in the Eurozone. As several quantitative measures were in place during their observation period, the authors focus on EUR-denomination as a key identification characteristic in order to single-out the effects of the CSPP. De Santis & Zaghini find that the probability of issuing bonds in EUR increases significantly for eligible corporates compared to non-eligible ones. Furthermore, the authors provide evidence that the shift towards eligible EUR-denominated bonds takes time to unfold:

The CSPP starts to have a significant effect from 2017 onwards (six months after the launch of the programme).

Further contributing to the literature on the CSPP, Montagna & Pegoraro (2019) investigate through which transmission channel the programme affects bond prices and issuance volumes the most. Like other studies, Montagna & Pegoraro use CSPP-eligibility as a variable to capture the effects of a scarcity channel, but they also introduce financial distress (negative price performance in months preceding the announcement) as a mean to observe the workings of a postulated risk channel. The authors provide evidence that the issuance of eligible relative to non-eligible bonds increases which supports the findings of Todorov (2019) and De Santis & Zaghani (2019). Interestingly, the risk channel appears to be a key component of the transmission mechanism of quantitative easing to bond prices: Distressed bonds experience the strongest price increase on the day of the CSPP announcement.

The effects of the CSPP on bond prices and yields has been studied extensively. Abidi & Miquel-Flores (2018) show that the CSPP causes portfolio rebalancing towards riskier bonds with lower credit spreads. The portfolio rebalancing channel is further studied by Zaghini (2019) who shows that also non-eligible bonds benefit from the CSPP albeit with some time lag. Todorov (2019) shows that the CSPP has a higher positive impact on riskier bonds as eligible bonds with lower ratings and longer maturities experience the largest magnitude of yield reduction. Furthermore, Todorov documents a pick-up in issuance volumes by eligible borrowers with an additional shift towards EUR-denominated issuances. These observations on new issuance activities are supported by De Santis & Zaghini (2019). Most recently, Montagna & Pegoraro (2019) show that the CSPP does not only work through a portfolio rebalancing mechanism but also through a dedicated risk channel as prices of formerly distressed bonds increase the most.

4   Theoretical Foundation

Reviewing the institutional framework and existing literature on underpricing as well as the CSPP's influence on New Issue Concessions amalgamates previous contributions and provides a foundation for further empirical investigation. The following outlines how the different areas of research fit together and highlights the gaps that are still to

be explored. Also, a common ground for the conceptualisation of bond underpricing is developed. Based on this, the research question is established, and several hypotheses are derived which will be tested in the further course of the study.

4.1 Research Gap

Bond underpricing has been thoroughly analysed with studies focusing almost exclusively on the US market. Drawing upon observations made in equity offerings, researchers attribute bond underpricing to (i) information asymmetries and valuation uncertainty or (ii) post-issuance bond liquidity. Overall, most research provides support for information-based explanations, also within the investment grade space. Furthermore, several studies investigate determinants of New Issue Concessions and conclude that both issue-related factors and the broader market environment inherent explanatory value. However, while the US market has been covered extensively and indeed yields valuable insights, there remains a lack of empirical evidence on bond underpricing in Europe.

Rischen & Theissen (2018) are the first to extensively investigate the phenomenon in the EUR market. Their study unquestionably forms a first foundation of empirical evidence on the EUR market, but it also evinces some eminent gaps. Firstly, considering a range of different issuers and collateral types, their findings are solely informative regarding the general nature of the characteristics of bond underpricing, and thereby miss to provide valuable insights on the corporate investment grade space. Secondly, while the authors do touch upon the effect of the ECB's influence on bond underpricing, they do not address the underlying mechanics. Thirdly, their data sample merely includes bonds issued until May 2nd, 2017 and therefore captures only a limited time period of the ECB's bond purchase programmes, which are still active today.

Simultaneously, research shows that the CSPP leads to a decrease in bond spreads. Especially riskier bonds with lower ratings and longer maturities experience the largest magnitude of yield reduction. The same holds true for bonds which traded in distress prior to the CSPP announcement. Moreover, eligibility for the programme does not appear to be a decisive factor as non-eligible bonds also experienced lower spreads. While these observations are based on bond prices and yields, the question remains to which extend the ECB has also influenced bond underpricing.

To conclude, existing research lacks insights on (i) the determinants of New Issue Premia in the EUR corporate investment grade space, which represents the largest

segment of corporate bond issuance, and (ii) the CSPP's mechanism in relation to bond underpricing.

4.2 Conceptualising Bond Underpricing

Prior to conducting any empirical research on corporate bond underpricing, it must be determined how underpricing is defined. While early studies assess the yield convergence of newly issued and outstanding bonds in order to estimate underpricing, more recent research calculates underpricing based on holding period returns. Due to their statistical properties, holding period returns can be analysed more easily and allow for comparison with other asset classes (e.g. equities where YTMs do not exist). Based on holding periods, there are two main approaches to measuring bond underpricing: (i) excess price returns based on bond prices and (ii) abnormal yield changes based on YTMs. In both cases the newly issued bonds are benchmarked against a market index or a set of outstanding bonds. Appendix 4 provides an overview of the papers discussed in the literature review and outlines the respective calculation methods used.

Since bond prices and underlying yields are inversely related, both approaches assume that bond underpricing is a function of YTMs as observed on the secondary market. However, yield changes not only relate to the firm-specific component captured by the credit spread but are also driven by moves in the broader interest rate environment. Hence, the results of studies which follow one of the two approaches to measure bond underpricing might be distorted due to duration mismatches. Non-parallel shifts of the underlying yield curve might affect the bond price/ YTM of the newly issued bond and the respective benchmark differently. One modification to the YTM-approach is to define underpricing as an excess credit spread compression. If a newly issued bond is underpriced, it is issued at a credit spread above fair value. Thus, following the issuance, the credit spread of the newly issued bond should tighten more than the spread of seasoned bonds or a credit index. Considering excess spread compression, opposed to excess returns, offers two advantages. Firstly, this approach mitigates the effects of changes in the interest rate curve which can cause return differences between the newly issued bond and the matched benchmark. Secondly, it allows to remove duration features and thus defines underpricing as a spread rather than a price effect.

Moreover, studies which are built on the secondary market performance of newly issued bonds take an ex-post perspective. Measuring bond underpricing as excess price returns/ abnormal YTM changes, these studies try to quantify the excess return investors receive as compensation for participating in the new bond issuance. Contrarily, secondary market developments are less relevant to issuers. Given that the coupon which is paid throughout the lifetime of the bond is determined during the pricing process, issuers are mostly concerned about the amount of underpricing occurring on the day of issuance. Here, an ex-ante approach to bond underpricing might provide additional insights which are of interest to borrowers. Looking at quoted prices of bonds outstanding prior to the transaction announcement, the implied fair value credit spreads for a given tenor can be interpolated. This fair value spread can then be compared to the reoffer spread at which the newly issued bond was priced. The main drawback of the ex-ante approach is that it limits the universe to issuers with secondary bonds outstanding.

4.3 Contribution to the Existing Literature

The review of existing research has highlighted that so far, the variables influencing corporate bond underpricing in the EUR investment grade space have not been investigated extensively and there is little understanding of the CSPP's mechanism on bond underpricing. This thesis aims to provide more insights into these areas by answering the following research question:

What influence does the ECB's quantitative easing have on the determinants of bond underpricing in the corporate investment grade space?

Following this central research principle, the study attempts to contribute to the existing literature threefold:

(i) As the first study to focus exclusively on investment grade offerings from non-financial issuers, it sheds further light on New Issue Concessions in the EUR market. Testing several variables which appear to be of influence in the US market, the determinants of corporate bond underpricing in the EUR investment grade space should become more visible.

(ii)   This thesis links the existing literature on bond underpricing with investigations of the CSPP's mechanism and contributes to understanding how the ECB's monetary policy impacts New Issue Concessions. It is the first study which is based on a dataset that includes the early phase of the CSPP (June 2016 – December 2018) as well as the time period after the relaunch (November 2019 onwards). Hence, the longer-term impact of the CSPP is captured for the first time.

(iii) Starting from the different concepts of underpricing discussed above, this thesis is the first to investigate underpricing from an ex-ante perspective. Yet, to ensure robustness of the results, several analyses are complemented by ex-post reviews.

4.4   Hypotheses Development

The existence of underpricing is a well-documented phenomenon and its magnitude can serve as a proxy for the efficiency of the observed bond market. Thus, answering the question to which extend underpricing exists in investment grade corporate bonds helps to assess the efficiency of one important section of the EUR bond market. With Rischen & Theissen (2018) providing first evidence of bond underpricing in the EUR market, underpricing is expected to persist in this study's sample, which leads to the first hypothesis:

Hypothesis 1: *EUR-denominated investment grade corporate bond offerings are significantly underpriced.*

Existing literature suggests that bond underpricing can mostly be attributed to information asymmetries and valuation uncertainties. This leads to a set of issue-specific and market-related variables which bear explanatory value. While New Issue Concessions are a tool to overcome these information asymmetries and valuation uncertainties, they represent a premium the issuer must pay in order to access the bond market. Knowledge about the deal-specific determinants of underpricing can help issuers and the syndicate banks alike to structure a bond issuance effectively in order to minimise the New Issue Premium. Moreover, a profound understanding of the influence of the broader market environment on bond underpricing is useful in timing the issuance. In this context, the following hypotheses are postulated:

Hypothesis 2a: *The magnitude of underpricing relates positively to economic predictors which capture the riskiness of a bond (credit rating, offering size, tenor).*

Hypothesis 2b: *The magnitude of underpricing relates positively to economic predictors which capture the existence of market-wide information asymmetries/ valuation uncertainties (market level of credit spreads, credit spread momentum, stock market volatility).*

Table 1 provides a comprehensive overview of the determinants and the suggested impact.

Table 1: Intuition for Economic Determinants of New Issue Premia

No.	Determinant	Postulated Influence	Impact
1	Credit Rating	Underpricing arises due to information uncertainties and is positively related to the riskiness of the offering. The credit rating of a bond is a good proxy to capture the inherent risk (e.g. Rischen & Theissen (2018)), a better rating suggesting lower risk.	↓
2	Issue Size	Larger offering amounts cause greater downward price pressure (e.g. Goh & Yang (2015), Rischen & Theissen (2018)).	↑
3	Tenor	Valuation uncertainties increase with longer time to maturity (e.g. Goh & Yang (2015)).	↑
4	Credit Spread Level	Market credit spread levels are a good predictor of the general levels of risk-aversion in the market (Maitra et al., 2018).	↑
5	Credit Spread Momentum	Due to deteriorating credit conditions market participants demand a higher risk premium for bearing valuation uncertainties (Goldberg & Ronn, 2013).	↑
6	Stock Market Volatility	Market-wide volatility increases valuation uncertainties (e.g. Goldberg & Ronn (2013), Rischen & Theissen (2018))	↑

Through its asset purchase programmes, the ECB attempts to improve the financing conditions for corporations in the Eurozone and is successful in doing so as its corporate bond purchase programme has a meaningful and well-documented impact on bond prices and yields. Simultaneously, bond underpricing directly impacts the interest rate at which borrowers can issue new bonds and it is therefore interesting to see whether the CSPP also leads to an improvement here. Under the programme, primary market purchases by the ECB are allowed and an initial study provides evidence that the CSPP has led to a decrease in New Issue Concessions. Simultaneously, CSPP-eligibility does not appear to be a decisive factor regarding yield compression on secondary markets if the observation period is long enough (Zaghini, 2019). Based on these observations the following hypotheses are formulated:

Hypothesis 3a: *New Issue Concessions during the periods when the CSPP is/was active should be lower compared to the time of inactivity.*

Hypothesis 3b: *There should not be a meaningful difference between CSPP-eligible and non-eligible bonds.*

The effects of the CSPP on bond prices and yields have been strongest for riskier bonds within the eligibility framework (De Santis & Zaghini, 2019). Lower rated bonds with longer maturities (Todorov, 2019) and those trading in distress prior to the programme's announcement have experienced the most significant reduction in yields (Montagna & Pegoraro, 2019). Transferring these observations to bond underpricing, the following hypothesis emerges:

Hypothesis 4: *The magnitude of reduction in New Issue Premia is larger for riskier bonds which are characterised by lower credit ratings and longer maturities.*

The ECB – with its objective to purchase corporate bonds according to a fixed quota – presents additional, price-inelastic demand regardless of the market environment. Hence, in volatile markets when investors require higher risk premia, the presence of the ECB should facilitate the placement of new bond offerings allowing for lower levels of underpricing. Based on this reasoning, the following hypothesis is postulated:

Hypothesis 5: *The CSPP has decreased the influence of predictors relating to the market environment on New Issue Concessions.*

By investigating these two hypotheses further light is shed on the transmission channels through which the ECB potentially impacts underpricing. Evidence in favour of Hypothesis 4 would imply that the portfolio rebalancing channel also works on the primary market and influences bond underpricing. Simultaneously, findings supporting Hypothesis 5 would indicate that the ECB's presence in the bond market somewhat decouples the cost of accessing the bond market from the broader market sentiment.

5 Methodology and Data

In this section the quantitative foundation of the empirical studies is laid out. Firstly, the methodology behind the ex-ante and ex-post calculations of bond underpricing are explained in greater detail. Secondly, the process of sourcing and cleaning the relevant data is described.

5.1 Methodology

As stated above, the empirical analyses conducted in this thesis strive to provide further insight on bond underpricing from an ex-ante perspective. While basic deal terms as well as pricing points communicated to the market throughout the bookbuilding process are publicly available, the ex-ante estimation of New Issue Concessions is based on an implied fair value credit spread prior to the transaction announcement. The credit spread at which the new bond is issued can then be compared to the implied fair value spread and the difference provides an estimate of the magnitude of bond underpricing occurring on the day of issuance.

As part of its financial markets offering "IGM Credit", the British intelligence and research company Informa PLC, provides a range of data points on primary bond markets for the European investment grade space, including estimations of New Issue Concessions. The IGM coverage team interviews the investment banks which are part of the syndicate group and asks them for estimates of fair value credit spreads prior to the transaction announcement. These interviews are complemented by independent analyses done by IGM analysts who compare the landing level of the newly issued bond to the implied fair value spread (Corbell, 2020).

This interview-based approach suffers from the drawback that it is a subjective estimation of underpricing and since interviewees might be biased, the IGM data on New Issue Concessions could already internalise some of the effects this thesis attempts to identify. Therefore, the ex-ante assessment of underpricing based on IGM data is supplemented with robustness checks based on the more established ex-post approaches. Here, underpricing is measured as the excess credit spread compression of the newly issued bond compared to (i) a market value-weighted credit index which serves as benchmark and (ii) the average credit spread of the issuer's secondary bonds.

The computation of the credit spread compression of the newly issued bond is displayed in Equation 1:

$$\Delta CS_i = CS_{i,t+n} - CS_{i,t} \qquad (1)$$

ΔCS_i represents the credit spread change of the newly issued bond with $i=1,2,\dots,946$ corresponding to each individual bond. $CS_{i,t+n}$ is the credit spread of the respective

bond for each point in time after the pricing date t and n counts the number of days post pricing.

Following the example of Rischen & Theissen (2018) who measure the excess price return of newly issued bonds against a value-weighted credit index, the IHS Markit iBoxx indices are used as a benchmark. The relevant indices iBoxx EUR Non-Financial AA, iBoxx EUR Non-Financial A, and iBoxx EUR Non-Financial BBB consist of 134, 616 and 1,008 bonds and have modified durations of 5.8, 6.1 and 5.1 years respectively (IHS Markit, 2020). Based on its rating, each bond within the sample is matched with the corresponding index[4]. In contrast to previous studies, the asset swap spread (ASW) of these indices is used in order to measure underpricing as the excess credit spread compression. The ASW change of the respective benchmark index is computed as:

$$\Delta BS_{j(i)} = BS_{j(i),t+n} - BS_{j(i),t} \qquad (2)$$

In this formula ΔBS_j stands for the ASW change of the respective benchmark index where $j=1,2,3$ corresponds to the matched index. The number of days after the individual bond was priced (t) is accounted for by n. $BS_{j(i),t+n}$ represents the benchmark's ASW throughout the observation period. The degree of underpricing $UP1_i$ is then calculated as the difference between the credit spread change of the newly issued bond and the ASW change of the benchmark index:

$$UP1_i = -(\Delta CS_i - \Delta BS_{j(i)}) \qquad (3)$$

The minus sign is used in order to obtain a positive value when the bond issue is underpriced.

Bessembinder et al. (2009) show that a market-value weighted index serves as a well-suited proxy to measure abnormal bond returns and several studies rely on credit indices as benchmarks to determine underpricing. Nevertheless, the index-based approach towards underpricing has the disadvantage that firm-specific developments

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[4] Bonds with an average rating of AA- or above are matched with the iBoxx EUR Non-Financial AA Index, bonds with an average rating of A+ to A- are matched with the iBoxx EUR Non-Financial A Index, and bonds with an average rating of BBB+ or below are matched with the iBoxx EUR Non-Financial BBB Index. In case the average rating lies within two rating buckets, the respective higher-ranked index was selected.

might be less visible. Hence, a second robustness check focusing on the respective issuer's outstanding bonds is conducted where the credit spread change of the newly issued bond is compared to the average credit spread change of the issuer's seasoned bonds. Analogously to the methodology presented above, the average credit spread change of the respective issuer's outstanding bonds excluding the newly issued bond is calculated as:

$$\Delta ACS_{k(i)} = ACS_{k(i),t+n} - ACS_{k(i),t-1} \qquad (4)$$

Here, ΔACS_k displays the average change in credit spreads of all bonds outstanding excluding the newly issued bond with $k=1,2,\dots,283$ corresponding to each individual issuer. In order to minimise diluting announcement effects of the respective bond issuance, average credit spread changes are based on close prices (and corresponding spreads) one day prior to pricing. $ACS_{k(i),t+n}$ represents the credit spread for each day n after pricing date t. Notably, the average credit spreads of secondary bonds are calculated on a parent company level. While corporations can issue bonds through dedicated entities (e.g. Daimler International Finance BV), the study focuses on all bonds associated with the parent company (e.g. Daimler AG) for better data availability. Further, bonds are required to meet the following criteria: (i) be denominated in EUR, (ii) have a fixed coupon, and (iii) be senior unsecured as payment rank. Underpricing $UP2_i$, defined as the excess credit spread compression of the newly issued bond compared to the bonds already outstanding, is then derived by:

$$UP2_i = -(\Delta CS_i - \Delta ACS_{k(i)}) \qquad (5)$$

Again, the minus sign yields a positive value when the bond issue is underpriced. Furthermore, the levels of underpricing of both ex-post approaches $UP1_i$ and $UP2_i$ are calculated across different holding periods.

5.2 Data

In order to compile the dataset forming the foundation for the following quantitative analyses, a two-step process is exerted: (i) retrieving relevant IGM data points and other sources (Appendix 5) and (ii) cleaning the data for deficient observations.

Firstly, all bond offerings meeting the following criteria are gathered from the IGM database:

- *Date of pricing between January 2016 and February 2020 (including):* IGM figures on New Issue Concessions are available from 2016 onwards which marks the beginning of the observation period.

- *EUR as currency of denomination:* As the contribution of this thesis is to conduct a thorough analysis of the EUR market, other currencies are excluded.

- *Investment grade as rating category:* As the contribution of this thesis is to conduct an exhaustive analysis of the investment grade space, lower rating categories are excluded.

- *Corporates as industry:* In line with the scope of this work, this criterion excludes financial institutions from the dataset. However, in line with common market practice, real estate companies are not excluded.

- *Fixed coupon type:* Bonds with deviating coupon types (e.g. Floating Rate Notes, Zerobonds, bonds with variable coupon structures) follow a different pricing procedure and therefore cannot be compared to fixed coupon bonds.

- *Exclude subordinated/hybrid/preferred:* In the event of default, subordinated bonds such as hybrids or preferred stocks have lower claims to the recovery value of the defaulted issuer. Due to this equity-like feature these instruments contain higher risks and consequently are excluded from the observation universe.

In total, 1,633 bonds meet the requirements stated above.

Secondly, the data is cleaned for deficient observations based on the following principles:

- *Missing New Issue Premia:* 551 bonds are excluded from the raw dataset because no ex-ante data for bond underpricing are available.

- *No secondary bonds outstanding:* 53 bonds are removed as the issuer did not have bonds outstanding at the time of issuance and thus the bond does not qualify as a seasoned offering.

- *Tap-issues:* 15 bonds are eliminated since they are tap-issues of existing bonds.

- *Missing credit rating:* Eight bonds are unrated and thus do not meet the requirement of an investment grade credit rating.

- *Size:* A minimum issue size of EUR 300m is required. Three bonds fall below this threshold and are therefore excluded.

- *Lack of secondary data:* 57 bonds are removed due to missing secondary market data needed for the ex-post calculations of underpricing.

Following the above procedure results in a final sample of 946 bonds. Table 2 provides an overview of the key characteristics of the sample.

Table 2: Description of Bond Sample

	Number	Percentage
Total Number of Bonds	946	100%
Total Number of Issuers	320	100%
Average Rating of A- or above	399	42.2%
Average Rating of BBB- to BBB+	547	57.8%
Amount Issued - Mean	735.8 EURm	N/A
Amount Issued - Median	650.0 EURm	N/A
Years to Maturity - Mean	8.8 years	N/A
Years to Maturity - Median	8.0 years	N/A
Issued while CSPP was active	561	59.3%
Issued while CSPP was inactive	385	40.7%
CSPP- Eligible	705	74.5%
Not CSPP- Eligible	241	25.5%

In order to obtain the average credit ratings, each rating was matched with a score (AAA corresponds to a score of 1, AA+ a score of 2, and so forth). The average is calculated, and the bonds are then grouped into the respective rating buckets. With 947 bonds issued by 320 different borrowers, the dataset entails enough variety to draw meaningful conclusions from the analyses.

The economic predictors designed to capture the influence of the broader market environment include the market-wide level of credit spreads, the credit spread momentum as well as stock market volatility. The matched iBoxx indices used to calculate ex-post measures of underpricing are also used as proxies for the market level of credit spreads. Correspondingly, the market credit spread momentum is computed based on index values and captures a time horizon of two weeks prior to pricing. In addition, the Euro Stoxx 50 Volatility Index (VSTOXX Index) is used to display stock market volatility. Appendix 6 provides an overview of the summary statistics for the various variables.

6 Empirical Analyses and Results

The presentation of the empirical results is structured according to the developed hypotheses. Each section describes the empirical procedures applied and presents the retrieved empirical results based on the ex-ante measures of underpricing. These are then compared against the findings from an ex-post perspective which function as robustness checks. Ultimately, based on the aggregated findings, the postulated hypotheses are assessed.

6.1 Evidence of Bond Underpricing

Firstly, this study investigates whether EUR-denominated corporate bonds in the investment grade space are significantly underpriced (Hypothesis 1). In order to do so the ex-ante as well as several ex-post measures of underpricing are calculated. The ex-post magnitude of underpricing is computed for several observation periods to provide further robustness. Concurrently, the respective outcomes are tested on significance with one-sample t-tests. The results are displayed in the table below.

Table 3: Measures of Bond Underpricing

This table displays the length of the observation period, the number of observations (N), the sample mean, the standard error (SE), the 99% confidence interval, the t-statistic, and the percentage of bonds with positive magnitude of underpricing for the different measures of underpricing across the entire sample. The statistical significance is indicated by ***/**/* for the 1%/5%/10% level respectively.

Measure of Underpricing	Observation Period	N	Mean	SE	99% Conf. Interval	t-stat	Positive NIC
IGM Data	Ex-ante	946	7.04***	0.28	[6.32; 7.76]	25.13	78.6%
iBoxx Indices	1w	946	4.72***	0.21	[4.19; 5.25]	22.92	82.5%
iBoxx Indices	2w	946	5.46***	0.26	[4.78; 6.14]	20.80	77.9%
iBoxx Indices	3w	946	5.96***	0.30	[5.19; 6.72]	20.09	77.4%
iBoxx Indices	4w	946	6.02***	0.37	[5.06; 6.99]	16.10	77.6%
Secondaries	1w	946	8.24***	0.49	[6.99; 9.49]	16.98	84.8%
Secondaries	2w	946	9.68***	0.72	[7.81; 11.54]	13.38	83.9%
Secondaries	3w	946	9.62***	1.14	[6.68; 12.56]	8.43	83.1%
Secondaries	4w	946	11.28***	1.97	[6.21; 16.34]	5.73	81.7%

The figures indicate a significant degree of underpricing for both calculation methods and across different observation periods. From an ex-ante perspective, 78.6% of all bonds are underpriced and an average New Issue Premium of 7bps occurs on the day of issuance. These findings are further supported by the ex-post measures. Depending on the computation method, underpricing varies between 5-6bps (based on iBoxx indices) and 8-11bps (based on secondary bonds). All findings are highly significant.

Simultaneously, the significance of underpricing seems to vanish over time. Not only does the percentage of bonds with positive underpricing decrease, but the corresponding t-stat values also point towards declining statistical significance. Furthermore, Appendix 7 provides an overview of the correlation between the various measures of underpricing. The ex-ante approach does not serve as an accurate predictor of underpricing later observed on secondary markets. In summary, the observations made above provide support for Hypothesis 1: EUR-denominated investment grade corporate bond offerings are significantly underpriced.

6.2 Determinants of Underpricing

After the existence of underpricing has been confirmed, the different determinants of underpricing (Hypotheses 2a and 2b) are explored in greater detail. To do so, the bonds are categorised into different subsamples according to their deal-specific features. Starting from the median value for each variable, the bonds are segmented into high and low subsamples. All subsamples (the smallest includes 399 bonds) are subjected to one-sample and two-sample t-tests. The results for each subsample as well as the difference between these are displayed in Table 4.

Table 4: Underpricing Across Different Subsamples

This table displays the number of observations (N), the sample mean, the standard error (SE), the 99% confidence interval, the t-statistic, and the percentage of bonds with positive magnitude of underpricing for various subsamples based on economic predictors. Underpricing is measured form an ex-ante perspective. The statistical significance is indicated by ***/**/* for the 1%/5%/10% level respectively.

	N	% of Total	Mean	SE	99% Conf. Interval	t-stat	Positive NIC (%)
Complete Sample	946	N/A	7.04***	0.28	[6.32; 7.76]	25.13	78.6%
Panel A: Credit Rating							
A- or above	399	42.2%	6.22***	0.38	[5.24; 7.21]	16.29	78.2%
BBB+ or below	547	57.8%	7.64***	0.39	[6.62; 8.66]	19.35	79.0%
Difference	-	-	1.42**	-	-	-2.58	-
Panel B: Issue Size							
≤ EUR 650m	482	51.0%	6.63***	0.36	[5.70; 7.57]	18.25	75.9%
EUR 650m+	464	49.0%	7.46***	0.43	[6.36; 8.57]	17.44	81.5%
Difference	-	-	0.83	-	-	-1.48	-
Panel C: Tenor							
≤ 8yrs	474	50.1%	7.02***	0.38	[6.05; 7.99]	18.67	78.7%
8yrs+	472	49.9%	7.06***	0.42	[5.99; 8.13]	16.98	78.6%
Difference	-	-	0.04	-	-	-0.06	-
Panel D: Credit Spread Level							
Low	477	50.4%	6.33***	0.34	[5.46; 7.21]	18.60	78.6%
High	469	49.6%	7.76***	0.44	[6.62; 8.91]	17.47	78.7%
Difference	-	-	1.43**	-	-	-2.55	-
Panel E: Credit Spread Momentum							
Low	478	50.5%	5.64***	0.40	[4.62; 6.67]	14.19	73.4%
High	468	49.5%	8.47***	0.38	[7.48; 9.46]	22.06	84.0%
Difference	-	-	2.83***	-	-	-5.11	-
Panel F: Stock Market Volatility							
Low	473	50.0%	5.76***	0.31	[4.97; 6.56]	18.69	74.2%
High	473	50.0%	8.32***	0.46	[7.13; 9.51]	18.06	83.1%
Difference	-	-	2.56***	-	-	-4.62	-

The figures illustrate statistically significant underpricing in each of the subsamples. As anticipated and in line with Hypothesis 2a, a pronounced relationship between the credit rating and the magnitude of underpricing can be observed at the 95% confidence level. Appendix 8 provides a more granular breakdown of New Issue Concessions for different credit ratings. Contrarily, the effects of the offer size as well as the tenor appear to be without statistically measurable influence. The visible difference associated with the offering size turns out to be non-significant and there is virtually no difference between the means of shorter and longer dated bonds.

The subsamples of the variables selected to capture the market sentiment and their influence on bond underpricing are displayed in Panels D to F. Across all six subsamples a significant portion of underpricing can be detected. As stated in Hypothesis 2b, the market level of credit spreads influences bond underpricing positively. However, the influence of credit spread momentum is even more profound. In times of secondary credit spread compression (as indicated by the first subsample in Panel D) underpricing amounts to 5.6bps compared to 8.5bps in an environment of widening spreads. The same is true for stock market volatility where an environment of low uncertainty is reflected in lower New Issue Concessions. The difference between the respective high and low subsamples is statistically significant across the three panels.

Furthermore, eight multivariate OLS regressions are conducted to shed further light onto the determinants of bond underpricing. In the first six regressions the variables are tested independently in order to visualise their individual effects. While Regression 7 takes all variables into account, the dummy variable used to incorporate the credit rating is excluded in Regression 8. If the credit rating is one of the key drivers of underpricing, excluding it allows to investigate the effects of the remaining variables more thoroughly. The regression coefficients and the heteroskedasticity robust standard errors of the respective regressions are displayed in the table below:

Table 5: Determinants of Underpricing: Cross-Sectional Regressions

This tables displays the regression coefficients for eight cross-sectional regressions. Standard errors (shown in parentheses) are heteroskedasticity robust. Underpricing is measured from an ex-ante perspective. The statistical significance is indicated by ***/**/* for the 1%/5%/10% level respectively.

Regression	1	2	3	4	5	6	7	8
No. of Obs.	946	946	946	946	946	946	946	946
Variable								
Credit Rating	1.42*** (0.55)	-	-	-	-	-	1.72** (0.84)	-
Issue Size	-	0.01*** (0.002)	-	-	-	-	0.01*** (0.002)	0.01*** (0.002)
Tenor	-	-	0.15* (0.08)	-	-	-	0.23*** (0.07)	0.22*** (0.07)
Credit Spread Level	-	-	-	0.04*** (0.01)	-	-	0.01 (0.01)	0.03*** (0.01)
Credit Spread Momentum	-	-	-	-	0.24*** (0.08)	-	0.29*** (0.07)	0.30*** (0.07)
Stock Market Volatility	-	-	-	-	-	0.38*** (0.08)	0.34*** (0.08)	0.28*** (0.07)
Intercept	6.22*** (0.38)	3.29*** (1.17)	5.74*** (0.71)	4.31*** (0.66)	7.05*** (0.28)	0.75 (1.31)	-6.9*** (2.13)	-6.31*** (2.13)
Adjusted R Squared	0.006	0.036	0.004	0.017	0.027	0.033	0.124	0.121

The results of the cross-sectional regressions confirm the observations made before. In terms of the deal- specific predictors, both the binary dummy variable representing the credit rating and the size of the offering still proof to be highly statistically significant. In contrast, the tenor of the bond is only influential at the 90% confidence level. Analogously to the previous findings, market-related variables are still highly significant. Interestingly, Regression 7 indicates that the explanatory value of the market credit spread level disappears when all variables are considered simultaneously. However, this observation does not hold anymore when the credit rating is excluded from the cross-sectional analysis as indicated by Regression 8. The difference between Regression 7 and 8 for the other predictors is marginal. The OLS regressions provide support that bond underpricing is a function of deal-related factors and variables associated with the broader market sentiment.

As robustness check, the empirical findings based on the ex-ante approach are cross checked with the discussed ex-post measures of underpricing. As indicated in section 6.1, the magnitude of underpricing increases over time from an ex-post perspective. Simultaneously, fewer bonds experience underpricing and the statistical

significance declines. In order to navigate this trade-off, an observation period of two weeks is chosen for the robustness checks throughout this thesis. The magnitude of underpricing using ex-post measures of underpricing across the various subsamples is displayed in Appendix 9. The difference between the subsamples is narrower compared to the ex-ante perspective. This observation is confirmed by a series of two-sample t-tests which yield no significant difference between most subsamples based on iBoxx measures. Concurrently, results based on secondary bonds only point towards a meaningful alteration relating to the variables tenor and credit spread level. Since the two-sample t-tests do not provide much visibility with regards to the determinants of underpricing from an ex-post perspective, several regression analyses are conducted following the procedure used before. Appendices 10 and 11 summarise the results of these regressions. In comparison to the ex-ante findings, the regression coefficients based on ex-post figures of underpricing inhibit less statistical significance. For both calculation methods the offerings size, the credit spread level as well as stock market volatility appear to entail explanatory value. While these robustness checks do not disprove the findings about the determinants of underpricing made from an ex-ante perspective, they fail to provide further support.

Summarising the above described findings, Hypothesis 2a can only be confirmed partially. The magnitude of underpricing relates positively to economic predictors which capture the riskiness of a bond (credit rating, offering size, tenor). However, issue size and tenor inhibit explanatory value only visible in the regression analysis. Simultaneously, the results support Hypothesis 2b. The magnitude of underpricing relates positively to economic predictors which capture the existence of market-wide information asymmetries/ valuation uncertainties.

6.3 The Influence of the CSPP on Bond Underpricing

After the existence of underpricing has been confirmed and the determinants have been investigated extensively, possible structural changes in bond underpricing associated with the CSPP are studied (Hypotheses 3a and 3b). Here, the significance of underpricing is tested across several subsamples. Since the time of issuance is one differentiating factor, bonds are divided into subsamples depending on whether they were issued while the CSPP was active or not. Additionally, bonds are distinguished according to the CSPP eligibility criteria. Firstly, a t-test is conducted on each subsample exclusively. Secondly, the respective subsamples are compared to each

other in a two-sample t-test. The results of the individual t-tests as well as the t-statistic of the comparison are summarised in Table 6:

Table 6: Structural Change in Underpricing Caused by the CSPP

This table displays the number of observations (N), the sample mean, the standard error (SE), the 99% confidence interval, the t-statistic, and the percentage of bonds with positive magnitude of underpricing for various subsamples, based on the status of the CSPP and eligibility criteria. Underpricing is measured from an ex-ante perspective. The statistical significance is indicated by ***/**/* for the 1%/5%/10% level respectively.

	N	% of Total	Mean	SE	99% Conf. Interval	t-stat	Positive NIC (%)
Complete Sample	946	100%	7.04	0.28	[6.32; 7.76]	25.13	78.6%
Panel A: Activeness							
Active	561	59.3%	7.11***	0.34	[6.24; 7.99]	20.95	80.4%
Inactive	385	40.7%	6.94***	0.48	[5.70; 8.17]	14.47	76.1%
Active vs Inactive	-	-	-0.15	-	-	0.30	-
Panel B: Eligibility							
Eligible	705	74.5%	6.97***	0.30	[6.19; 7.74]	23.15	80.6%
Non-Eligible	241	25.5%	7.25***	0.66	[5.55; 8.95]	11.00	73.0%
Eligible vs Non-Eligible	-	-	0.28	-	-	-0.39	-

Hypothesis 3a states that the CSPP should lead to a decrease in bond underpricing. Contrarily to the hypothesis, the data in Panel A suggest that the opposite is true as the average amount of underpricing occurring for bonds issued during an active CSPP is higher than underpricing observed for bonds issued while the programme was on halt. However, the detected difference is marginal. This observation is further supported by the two-sample t-test which yields no significant difference in means. At the same time Hypothesis 3b, which claims that there is no meaningful difference between eligible and non-eligible bonds, holds true. While on first sight it seems like non-eligible bonds are slightly more underpriced, the two-sample t-test reveals that the difference between the means of the two subsamples is not significant.

Inspired by Rischen & Theissen (2018) and Todorov (2019), the ECB's impact on bond underpricing is further studied using a difference-in-difference approach. In this context three dummy variables are created to identify:

(i) Bonds which meet the eligibility criteria for the CSPP (treatment dummy);

(ii) Bonds which have been issued while the programme is/was active (post dummy);

(iii) An interaction between these two dummies.

The coefficient on the interaction variable specifies if eligible bonds issued while the programme was active exhibit a degree of underpricing different from the control variables. For some variations of the difference-in-difference regressions other issue-specific and market-related independent variables are added. The results are displayed below:

Table 7: Difference-in-Difference Regressions

This tables displays the regression coefficients for four specifications of the difference-in-difference regressions. Standard errors (shown in parentheses) are heteroskedasticity robust. Underpricing is measured from an ex-ante perspective. The statistical significance is indicated by ***/**/* for the 1%/5%/10% level respectively.

Regression	1	2	3	4
No. of Obs.	946	946	946	946
Variable				
CSPP Active	-1.43 (1.32)	-1.26 (1.35)	0.39 (1.33)	0.51 (0.45)
CSPP Eligible	-1.49 (1.03)	-1.27 (0.99)	-1.52 (0.97)	-1.34 (-1.53)
Active x Eligible	2.25 (1.48)	2.19 (1.47)	1.72 (1.37)	1.60 (1.32)
Credit Rating	-	2.17*** (0.54)	-	0.80 (0.91)
Issue Size	-	0.01*** (0.002)	-	0.01*** (7.17)
Tenor	-	0.19*** (0.07)	-	0.24*** (3.64)
Credit Spread Level	-	-	0.03*** (0.01)	0.03** (2.14)
Credit Spread Momentum	-	-	0.22*** (0.08)	0.27*** (5.85)
Stock Market Volatility	-	-	0.36*** (0.08)	0.35*** (4.83)
Intercept	7.942*** (0.86)	0.649 (1.90)	-1.313 (1.70)	-8.23*** (-4.61)
Adjusted R Squared	0.000	0.054	0.072	0.123

The first specification focuses on the three dummy variables which indicate whether the bond was issued with the CSPP being active, if it meets the eligibility requirements, and the interaction of the two. The coefficients on *CSPP Active* and *CSPP Eligible* are deemed to be not statistically significant. The lack of significance is also valid for the coefficient on *Active x Eligible* which would otherwise suggest that bonds issued during an active programme and meeting the eligibility criteria experienced more underpricing. Controlling for several deal-related and market predictors in the other specifications, the lack of statistical significance persists.

Based on the analyses taking an ex-ante view, the CSPP does not appear to have a visible influence on bond underpricing. Contrarily, taking into consideration ex-post figures, the CSPP, on first sight, seems to cause a slight decrease in underpricing. The results are displayed in Appendix 12. Though, accounting for statistical significance the decline only persists for ex-post figures of underpricing based on secondary bonds at a 90% confidence level. Simultaneously, the results imply that the eligible bonds experience less underpricing than non-eligible ones, but also these differentiations lack statistical significance. In addition, Appendices 13 and 14 display the results of the difference-in-difference regressions, taking an ex-post perspective. Based on the calculation using secondary bonds, an active CSPP appears to lower the magnitude of bond underpricing. Yet, the effect vanishes when market-related predictors are added to the regressions. Concurrently, the interaction coefficient is statistically significant at the 90% confidence level which indicates that eligible bonds issued during an active programme exhibit a level of underpricing different from that of the control variables. Considering the results of the robustness checks, the conclusions made about structural changes in underpricing associated with the CSPP remain intact. It cannot be confirmed that the programme leads to a significant decrease in underpricing during its activeness. At the same time, there is no meaningful difference between eligible and non-eligible bonds.

Summarising the above findings, Hypothesis 3a is rejected. In most of the analyses the degree of underpricing for bonds issued while the CSPP was active is not significantly lower compared to times of inactivity. The only significant difference is visible for the ex-post measure based on secondary bonds. Moreover, there is no evidence that eligible and non-eligible bonds experienced differing levels of underpricing. This is true from both an ex-ante and ex-post perspective and therefore Hypothesis 3b is supported.

6.4 Influence of the CSPP on the Determinants of Bond Underpricing

While no meaningful influence of the CSPP on the general nature of bond underpricing can be detected, in a next step the programme's effect on single determinants and their respective explanatory power is assessed. Here, Hypotheses 4 and 5 are studied jointly. Analogously to the process applied to test Hypotheses 2a and 2b, the bonds are divided into different subsamples based on the economic predictors. In addition, these subsamples are further split into groups depending on whether the bonds were issued during an active CSPP or not. The resulting subsamples are then compared to each

other conducting two-sample t-tests. For instance, the sample containing bonds with an offering size ≤ EUR 650m (482 bonds) is further divided into a subsample of 290 bonds issued in times of activeness, and 192 issued in times of inactiveness. The objective of this procedure is to identify whether the CSPP's influence varies depending on the specific bond features. The results of the one- and two-sample t-tests are summarised in Table 8:

Table 8: Effects of the CSPP on Economic Predictors

This table displays the number of observations (N), the sample mean, and the t-statistic for various subsamples based on economic predictors and the status of the CSPP. Underpricing is measured from an ex-ante perspective. The statistical significance is indicated by ***/**/* for the 1%/5%/10% level respectively.

	CSPP Active			CSPP Inactive			Comparison	
	N	Mean	t-stat	N	Mean	t-stat	Diff.	t-stat
Panel A: Credit Rating								
A- or above	239	5.96***	16.72	160	6.61***	8.36	0.65	-0.75
BBB+ or below	322	7.97***	15.20	225	7.17***	11.98	-0.80	1.01
Panel B: Issue Size								
≤ EUR 650m	290	7.31***	16.50	192	5.61***	9.13	-1.70**	2.24
EUR 650m+	271	6.90***	13.29	193	8.25***	11.40	1.35	-1.52
Panel C: Tenor								
≤ 8yrs	277	7.06***	14.60	197	6.96***	11.63	-0.10	0.13
8yrs +	284	7.16***	15.01	188	6.91***	9.13	-0.15	0.28
Panel D: Credit Spread Level								
Low	448	6.57***	18.76	29	2.60**	2.05	-3.97***	3.02
High	113	9.25***	9.94	356	7.29***	20.15	-1.96*	1.85
Panel E: Credit Spread Momentum								
Low	248	5.16***	10.46	230	6.16***	9.75	1.00	-1.25
High	313	8.66***	19.33	155	8.09***	10.51	-0.57	0.67
Panel F: Stock Market Volatility								
Low	320	6.41***	17.32	153	4.40***	8.13	-2.01***	3.08
High	241	8.04***	13.08	232	8.61***	12.48	0.57	-0.62

For Hypotheses 4 and 5 to be true, the *Active* subsamples should display lower underpricing and the difference between the *Active* and *Inactive* subsamples should be statistically significant. However, the opposite is true. Comparing the different panels, most subsamples point towards higher underpricing in times of the ECB actively buying corporate bonds – a puzzling observation. At the same time, most of the observed differences between *Active* and *Inactive* are not statistically significant. A meaningful influence can only be noted for the smaller/lower subsamples of issue size and stock market volatility. Here, bonds appear to experience less underpricing while the CSPP was on hold. The smaller subsample of credit spread level, although statistically significant, is disregarded due to its size of only 29 bonds.

In a next step, the influence of the CSPP on the predictive power of the deal-specific and market-related variables is further tested in a regression context. Adding two dummy variables capturing the activeness of the CSPP and interactional effects, the difference between the regression coefficients is tested for significance. Thereby, the potential influence of the CSPP on the explanatory power of the economic predictors is visualised. The results are displayed in the table below:

Table 9: Regression Analysis - Effects of the CSPP

This tables displays the regression coefficients and the respective t-statistics of several regressions aiming to identify whether the CSPP has an impact on the explanatory power of economic predictors. The statistical significance is indicated by ***/**/* for the 1%/5%/10% level respectively.

Variable	Intercept	Predictor Coefficient	Condition Coefficient	Interaction Coefficient	Adjusted R Squared
Credit Rating	5.596*** (6.31)	2.715** (2.39)	0.819 (0.81)	-1.739 (-1.33)	0.009
Issue Size	7.182*** (5.38)	0.000 (0.06)	-5.310*** (-3.43)	0.007*** (3.65)	0.050
Tenor	7.324*** (6.13)	-0.008 (-0.07)	-2.316 (-1.61)	0.229 (1.55)	0.008
Credit Spread Level	2.254 (1.63)	0.066*** (3.95)	2.830* (1.76)	-0.040** (-2.05)	0.023
Credit Spread Momentum	7.410*** (13.49)	0.303*** (3.52)	-0.474 (-0.75)	-0.082 (-0.80)	0.029
Stock Market Volatility	-3.424 (-1.59)	0.640*** (5.12)	5.762** (2.28)	-0.364** (-2.48)	0.040

In this context, the *Predictor Coefficient* describes the relationship between the economic variables and its influence on bond underpricing. Controlling for the status of the CSPP, only the three market-related variables seem to be statistically influential. Simultaneously, the *Condition Coefficient* explains the overall change in underpricing caused by the status of the CSPP. Here, positive values suggest a higher level of bond underpricing when the ECB actively purchases bonds. However, most are not statistically significant and there is no clear direction across the different regressions. Lastly, the *Interaction Coefficient* captures the differences in explanatory power of the economic predictors associated with the activeness of the CSPP. In this case, negative values indicate that the CSPP has caused a decline in explanatory power of the respective variable. Again, the directional signs vary, and half of the coefficients are not significant. At a 95% confidence level, the CSPP appears to cause a decline in influence of the market credit spread level and stock market volatility.

Subsequently, testing for robustness, the CSPP's effect on the economic predictors of underpricing is studied using ex-post measures of underpricing. Appendices 15 and 16 summarise the degree of underpricing across the various subsamples as well as the results of the two-sample t-tests. The findings for the iBoxx-based ex-post measures contain few additional insights. Although the *Active* subsamples appear to experience less underpricing than the *Inactive* ones, the differences are not statistically significant for any subsample across the panels. Interestingly, the ex-post results based on secondary bonds point towards a meaningful influence of the CSPP on the economic predictors. Firstly, the means between the *Active* and *Inactive* subsamples differ from each other. They are statistically significant for rating and tenor at a 90% confidence level as well as for issue size and stock market volatility at a 95% confidence level. Here, the CSPP leads to a decline in underpricing for the respective higher subsamples as indicated by Hypotheses 4 and 5. Secondly, the strongest measurable difference (99% confidence level) occurs in the low subsample of credit spread momentum which represents an environment of credit spread compression.

Summarising the results of the t-tests and modified regression analyses as well as the robustness checks, there is not enough evidence in support of Hypotheses 4 and 5. From an ex-ante perspective, the first analysis only yields significant differences for two predictors, namely issue size and stock market volatility, and their respective smaller/lower subsamples. Furthermore, the regression analyses indicate no material change in the explanatory power of the economic predictors related to the CSPP, except for credit spread level and stock market volatility. Contrarily, the ex-post measures based on secondary bonds imply that the CSPP leads to a more profound decrease of underpricing in the higher subsamples as predicted by the hypotheses. Overall, the CSPP does not appear to meaningfully reduce the magnitude of underpricing for riskier bonds as characterised by the deal-specific features. Neither, does the programme soundly decrease the influence of predictors relating to the market environment. Hypotheses 4 and 5 are therefore rejected.

7   Discussion

Following the empirical analyses and results outlined above, this section aims to discuss and interpret the findings and put them into broader economic perspective.

Firstly, the differences between the calculation methods with regards to the existence of underpricing and its determinants are discussed. Moreover, several explanations why the CSPP's effects are only boundedly visible in the empirical results are explored. From there, practical implications are drawn relating to the issuance activity of corporate borrowers. Finally, the limitations of this thesis are outlined, and potential areas for further research are identified.

7.1 Difference between Ex-Ante and Ex-Post Results

While the existence of bond underpricing can be confirmed from both an ex-ante and ex-post perspective, its magnitude depends on the calculation method. The slightly lower results of the index-based approach could be explained by maturity discrepancies. While the average bond in the sample is issued with a tenor of 8.8 years, the iBoxx indices' modified duration, which serves as a proxy for years to maturity, lies between 5.1 and 6.1 years. In line with explanatory concepts of valuation uncertainties, longer dated bonds should be underpriced to a larger extend. Contrarily, the amount of ex-post underpricing observed when comparing to secondary bonds is higher than the ex-ante results indicate. Being the most liquid and recent data point, investors might use the newly issued bond, which in most cases is priced at a premium, as pricing reference and adjust their views on the seasoned bonds accordingly. Hence, while the spread of the newly issued bonds tightens, the seasoned bonds experience widening credit spreads. These opposing movements lead to a greater relative spread compression of the newly issued bond. Notably, for both ex-post measures the magnitude of underpricing increases over time. This finding provides further support for the pseudo-underwriter hypothesis postulated by Goldberg & Ronn (2013) and is consistent with the observations made by Rischen & Theissen (2018) in their broader set of EUR-denominated bonds.

Taking an ex-ante view, this study shows that the magnitude of underpricing relates positively to the issue-specific variables credit rating and tenor which both capture the riskiness of a bond. The size of the offering also bears explanatory value – an observation in support of liquidity-based explanations of underpricing. Of these deal-specific determinants, the credit rating is the most influential. Moreover, economic predictors representing the broader market sentiment inhibit explanatory power with regards to bond underpricing. Hence, information uncertainties on an issue- and market-level seem to be the main drivers of underpricing. These results

confirm the observations about the nature of underpricing made in previous studies from an ex-post perspective (e.g. Cai et al. (2007), Goldberg & Ronn (2013), Goh & Yang (2015), Rischen & Theissen (2018)). In this study, though, the determinants of underpricing experience a decline in statistical significance when the ex-post approach is followed. The secondary market liquidity of corporate bonds serves one possible explanation. Since bonds are not as frequently traded as other securities (e.g. stocks) and ex-post measures are based on quoted bond prices, illiquidity might reduce the visibility of the determinants and cause less significant results. A second possible explanation relates to the ECB's bond purchase behaviour. Although the ECB has a mandate to engage on the primary market and participate in new bond issuances, most of its purchases under the CSPP are conducted on the secondary market. As of March 31st, 2020, approximately 82% of the CSPP's holdings have been purchased on the secondary market (European Central Bank, 2020). If the ECB is not constrained by bond-specific factors or sensitive with regards to the market sentiment, its buying activity could dilute the observable variation in underpricing associated with information asymmetries and valuation uncertainty.

Simultaneously, the question arises why there is only limited visibility on the CSPP's influence in this study. The CSPP has a well-documented effect on secondary bond prices and Rischen & Theissen (2018) even provide early evidence for the programme's impact on bond underpricing. However, the effects do not materialise extensively in this study. In the given context, three possible explanations come to mind.

The first explanation relates to the conceptualisation of underpricing and the ECB's bond purchase activities. Statistically relevant effects of the CSPP are only visible when underpricing is defined from an ex-post perspective using secondary bonds as calculation basis. As mentioned, the ECB purchases most of the corporate bonds on the secondary market. Moreover, if the ECB participates in a bond issuance, there are no data available on how much of the final allocation it receives and whether the Central Bank plays a meaningful role in the bookbuilding process. Therefore, measuring bond underpricing from an ex-ante perspective could fail to fully capture the ECB's influence which is more likely to unfold on the secondary market post issuance. While an ex-post approach towards underpricing might be better suited to investigate the influence of the ECB, effects are still not visible when underpricing is calculated using iBoxx indices.

Representing the broader bond market, the iBoxx indices are immune to issuer-specific developments and thus potentially not sensitive enough to fully capture underpricing. Albeit subject to liquidity issues and limited data availability, ex-post measures based on secondary bonds proof to be the best approach in order to study the effects of the CSPP on bond underpricing.

Secondly, bonds in the sample appear to be evenly split between times when the CSPP was active and periods when it was on hold. However, the observation period of this sample might, in retrospect, not be ideal to fully capture the CSPP's effects on underpricing. The observations of inactivity were made between January and June 2016 as well as between January and October 2019. These periods might be flawed for two reasons. First, the CSPP announcement was made already in March 2016 which might have impacted the market prior to the official launch. Second, when Mario Draghi, former president of the ECB, publicly announced the end of the asset purchase programmes in December 2018, he emphasized that the ECB was watching economic conditions carefully and would not hesitate to again engage unconventional monetary policy tools if necessary. Hence, it is plausible that the ECB continued to provide implicit support through a signalling channel while the programme was officially on hold. Moreover, proceeds from maturing bonds and coupon payments have been reinvested in the bond market, meaning that the ECB's buying activity did not come to a complete stillstand. Thus, the CSPP could have continued to influence corporate bond markets during the time of formal inactivity.

The third explanation relates to the scope of this thesis which, in comparison to other studies, is based on a relatively homogeneous sample. This thesis focuses exclusively on EUR-denominated bonds, issued by non-financial corporations which have an investment grade rating. These features are a close match to the eligibility criteria the ECB formulated for its corporate bond programme. Since 75% of all bonds within this sample meet the eligibility criteria, differences between eligible and non-eligible bonds might be difficult to detect.

7.2 Practical Implications

Depending on the measurement, underpricing amounts to 5-11bps for EUR-denominated bonds issued by non-financial companies with an investment grade rating. The ex-ante average New Issue Premium of 7bps compares to an average reoffer spread of 80bps over EUR Mid-Swaps, meaning that bond underpricing comprises

8.75% of the issuance cost of borrowers. Hence, New Issue Concessions should be considered an important factor in the issuance decision of companies. While issue-specific variables contain some explanatory value, bond underpricing is mostly driven by economic predictors capturing the market environment. The ability to successfully manoeuvre credit markets and choose a favourable time of issuance therefore plays a critical role. Figure 2 displays the total amount issued as well as the average New Issue Premium (ex-ante measure) per quarter over the observation period.

Figure 2: Development of Issuance Volumes and New Issue Concessions
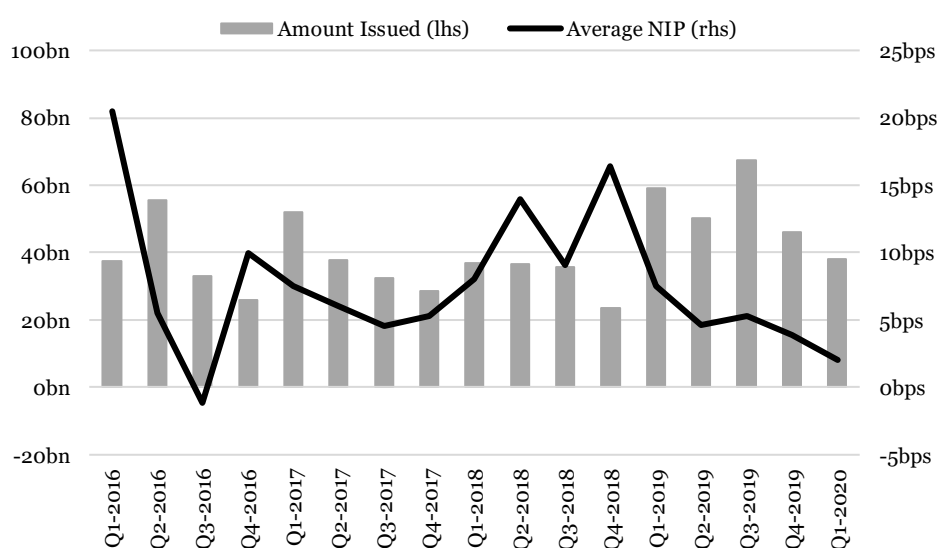
As the preparation of a bond issuance frequently takes up to three months, the issuance volume does not necessarily rise in times of lower New Issue Concessions and borrowers might miss favourable issuance windows. Consequently, the capability to opportunistically access the bond market is beneficial for issuers who should therefore favour issuances under EMTN-documentation. Under an EMTN-framework, issuers can place bonds within one or two working days.

As discussed, the influence of the ECB is hardly visible. The observation that – from an ex-ante perspective – there is no evident difference in bond underpricing associated with the status of the CSPP can be explained by a signalling channel. In fact, the signalling channel is one of the transmission channels which the ECB explicitly names in the context of its asset purchase programmes and is closely linked to its forward guidance on short-term interest rates. Here, the CSPP strengthens the credibility of the ECB to keep interest rates low for a prolonged period since otherwise the Central Bank would experience profound losses in its bond portfolio (Andrade et

al., 2016). The decision of the ECB to reinvest the proceeds of its CSPP portfolio can be considered an implicit commitment towards a prolonged environment of low interest rates. Hence, the fact that the activeness of the CSPP does not influence underpricing can be interpreted in that the signalling channel also unfolds on the primary bond market.

Contrarily, looking at bond underpricing from an ex-post perspective using secondary bonds as reference, the ECB, through its CSPP, accounts for a decline of 3bps in underpricing. Based on this observation it can be concluded that the ECB's monetary intervention in the bond market has not only lowered secondary bond yields but also eased the financing conditions on the primary market. Here, the ECB mainly contributes by lowering the impact of an adverse market environment on the magnitude of bond underpricing. In fact, the primary bond market could develop into an even more important playing field for the Central Bank. If its activities on the secondary market are subject to decreasing marginal utility, allocating more of the programme's purchase volumes towards primary markets might represent a useful channel to further improve the financing conditions for corporations in the Eurozone.

7.3 Limitations and Further Research

Throughout this thesis, it was successfully assessed which economic predictors determine underpricing and how the ECB has influenced underpricing. Yet, critically reflecting the work evinces several limitations and highlights potential areas for future research which will be elaborated in the following.

Starting with the limitations, three main factors come to mind. The first limitation relates to the quality of the ex-ante data on underpricing which are sourced through a combination of quantitative analyses and qualitative interviews. This interview-based approach suffers from the drawback that it is a subjective estimation of underpricing and since interviewees might be biased, the IGM data on New Issue Concessions could already internalise some of the effects this thesis attempts to identify. For instance, a large magnitude of underpricing could be interpreted as a sign of weak placement capabilities of the respective syndicate bank. Consequently, interviewed bankers might be incentivised to underestimate the New Issue Premium.

Secondly, as previously noted, the observation period of this thesis might not be ideal to fully capture the CSPP's effects on underpricing. Constrained by the availability of ex-ante data on underpricing from the IGM database, the observation period begins

in January 2016. Therefore, the sample of this study includes merely 25 bonds which have been issued before the CSPP was formally announced in March 2016 and consequently comprises limited information.

The third limitation relates to the selection of explanatory variables which simultaneously highlights an interesting area for future research. This thesis considers a couple of deal-specific and market-related predictors which inhibit explanatory value with regards to underpricing. Concurrently, there exist several factors which could possibly further explain the nature of underpricing that have not been examined in this study. Krylova (2016) shows that corporate bond spreads vary across individual countries as well as different industrial segments. Moreover, following the financial crisis, cross-country and cross-sector heterogeneity increased in EUR-denominated corporate bonds. It is therefore plausible to assume that the issuer's industry and country of risk[5] might also influence the magnitude of underpricing. In this context, it would be interesting to investigate whether the ECB's engagement in bond markets has smoothed the cross-country variation. In addition to examining supplementary factors that could impact the degree of underpricing, two further areas for future research are identified.

The first one relates to the total issuance size. In this thesis the degree of underpricing is calculated for each bond individually. However, there are occasions when borrowers issue multiple bonds at the same time in order to maximise the total issuance size. For the US bond market Helwege & Wang (2016) provide evidence that mega-bond offerings experience negative effects of price pressure resulting in higher underpricing. Although this thesis considers the issue size as one economic predictor, a focus on multi-tranche offerings could yield further insights into the capability of the EUR corporate bond market to absorb large issuances. Additionally, practical implications on how to effectively structure multi-tranche offerings could be drawn from such an analysis.

Secondly, another area for further research relates to the question why the effects of the CSPP on underpricing are hardly visible from an ex-ante perspective. The syndicate structure and the allocation principles serve as one potential explanation

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[5] Some corporations issue bonds through dedicated subsidiaries responsible for the financing activities of the firm. These entities sometimes reside in other countries than the respective parent company. The country of risk, though, is determined by the parent company.

which could be studied in greater detail. As pointed out, syndicate banks have some discretion in the allocation of the newly issued bond, although regulations require to follow pre-defined allocation principles. Given that most syndicate banks also act as market makers in the secondary market, they might be incentivised to allocate bonds to closely affiliated investors in expectation of future trading business. In contrast, little secondary trading business can be expected from bonds allocated to the ECB as bonds purchased under the CSPP are usually held until maturity. If the ECB participates in a primary transaction, it might receive only a small fraction of the amount issued and material effects of the Central Bank's primary activities might therefore not be visible. In fact, Nagler & Ottonello (2017) provide evidence that in the US market underwriters systematically allocate the most underpriced bonds to closely associated investors – a practise which has caused an overall increase in underpricing. A similar study on the EUR market would allow to make statements about the effectiveness of the existing regulations.

8   Conclusion

The phenomenon of underpricing is well-documented for equity offerings. On the debt side, most research concentrates on the US market. Here, explanatory approaches relate to (i) information asymmetries and valuation uncertainty or (ii) post-issuance bond liquidity. Based on an extensive sample of 946 EUR-denominated bonds, this thesis is among the first studies to examine the corporate investment grade space thoroughly in the Eurozone. Moreover, this thesis links the existing literature on bond underpricing with investigations on the CSPP's mechanism and contributes to understanding how the ECB's monetary policy impacts New Issue Concessions. Thereby, ultimately more light is shed on the question what influence the ECB's quantitative easing has on the determinants of bond underpricing. The insights are complemented by a novel conceptualisation of underpricing. Contrarily to previous research, this study measures underpricing on the day of issuance and thereby from an ex-ante, rather than an ex-post perspective.

From an ex-ante perspective, the average New Issue Premium on the day of issuance amounts to 7bps. In this context, deal-specific and market-related variables which mostly serve as proxy for information asymmetries and valuation uncertainties, inhibit explanatory value. Specifically, underpricing relates to the credit rating of the

bond, the size of the offering and its tenor as well as the market level of credit spreads, the momentum in credit spreads, and stock market volatility. Of these, the latter three predictors capturing the market sentiment appear to be of greater influence.

Surprisingly, the ECB's impact on bond underpricing is merely visible and depends on the perspective taken. From an ex-ante perspective, the ECB's engagement in the corporate bond market does not cause significantly lower underpricing. In this context, it is plausible to assume that the ECB continued to provide implicit support through a signalling channel while the programme was officially on hold. Contrarily, looking at bond underpricing from an ex-post perspective using secondary bonds, the CSPP leads to a decline in underpricing. Here, the ECB mainly contributes by lowering the impact of an adverse market environment on the magnitude of bond underpricing.

The findings of this thesis are relevant for issuers as underpricing accounts for 8.75% of their total cost of borrowing and critical determinates of underpricing in the corporate investment grade space are identified. Furthermore, this study contributes to understanding how unconventional monetary policy tools affect bond underpricing. However, as the CSPP is still active, it remains to be seen which long-term impact the programme will have.

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10 Appendix

Appendix 1: List of Figures and Tables

Appendix 2: Roles among the Syndicate Group

This table present the different workstreams which need to be taken care of during a bond issuance process. Usually, each investment bank within the syndicate fulfils one dedicated role (Thomson Reuters Practical Law, 2020).

Role	Description
Documentation Agent	The documentation agent supports the issuer in drafting the required documentation. This includes liaison with the issuer's legal counsel as well as the syndicate's lawyer. Furthermore, the documentation agent coordinates the approval process with the respective financial authority.
Roadshow & Logistics	One bank facilitates the marketing activities associated with the bond issuance (e.g. roadshow, global investor call). Main tasks include the organising investor meetings in the respective locations and arranging the travel logistics.
Book Runner	The book runner manages the incoming orders on the day of pricing and constantly updates the order book.
Paying Agent	The paying agent is responsible for listing the bonds on the respective exchange and managing payments.

Appendix 3: CSPP Eligibility Criteria

The issuer (or its parent company) is (European Central Bank, 2016):
- established in the Euro area, defined as the location of incorporation;
- not a credit institution or subject to banking supervision outside the Eurozone;
- an investment firm or asset management vehicle or national asset management and divestment fund according to the respective EU regulations.

Notably, bonds issued by entities incorporated in the Eurozone whose ultimate parent companies reside outside the monetary union are also eligible for purchase under the CSPP. Moreover, the ECB specified several criteria the bonds must meet on an issue level in order to qualify for the CSPP. The bond must (European Central Bank, 2016):
- meet the eligibility criteria of collaterals for the Eurosystem's credit operations;
- be denominated in EUR;
- have a minimum first-best credit assessment of at least BBB- or equivalent (obtained from an external rating agency);
- have a minimum remaining maturity of six months and a maximum remaining maturity of 30 years at the time of purchase.

To ensure that bonds with lower volumes (often those issued by small firms) could also be purchased, there is no minimum issuance volume for eligible bonds. However, a maximum issue share limit of 70% per ISIN is applied based on the amount outstanding. Furthermore, there are limits per issuer group in accordance with a predefined benchmark to guarantee a balanced allocation of bond purchases across issuers (European Central Bank, 2016).

Appendix 4: Overview of Empirical Research on Underpricing in Corporate Bond Markets

This table provides and overview of 17 empirical studies presented in this thesis. It summarises the examined markets, the time period analysed, the sample size, the level of analysis which was used to calculate underpricing, the pricing source for the bonds, indices used for excess return calculations, the observation window, as well as the resulting respective magnitude of underpricing.

Study	Market	Time Period	Sample Size	Variable	Data Source	Benchmark	Observation Period	Indicative Results
Ederington (1974)	USD	1964-1971	611	YTM	Weekly Bond Buyer'	Corporate Bond Index	20 days	30.9bps
Lindvall (1977)	USD	1867-1972	103	YTM	S&P's Bond Guide	Corporate Bond Index	60 days	17.5bps
Weinstein (1978)	USD	1962-1974	179	Price	N/A	Matched Bond Portfolio	20 days	38.3bps
Sorenson (1982)	USD	1974-1980	880	YTM	Institutional Investor	Corporate Bond Index	15 days	8.4bps
Wassefallen et al. (1988)	CHF	1980-1982	328	Price	Zurich Stock Exchange	Matched Corporate Bond	3 days	53.0bps
Datta et al. (1997)	USD	1976-1992	50	Price	DRI / Tradeline	Matched US Treasuries	60 days	IG: -2.88% Non-IG: 1.86%
Helwege & Kleiman (1998)	USD	1993-1994	55	Price	Trader Quotes	HY Bond Index	30 days	39.0bps
Hale & Santos (2006)	USD	1995-2002	817	Spreads	NAIC	Moody's Yield Indices	1 year	IG: 6bps Non-IG: 25bps
Cai et al. (2007)	USD	1995-1999	2957	Price	NAIC	Lehman Brother's Indices	1 week	IG: N/A Non-IG: 47bps
Goldberg & Ronn (2013)	USD	2008-2012	1494	YTM	TRACE	BAML Indices	8 weeks	22.5bps
Zaremba (2014)	PLN	2010-2013	142	Price	Bloomberg	N/A	60 days	90.0bps
Goh & Yang (2015)	USD	2005-2012	2380	Price	TRACE	BAML Indices	2 days	58.0bps
Helwege & Wang (2016)	USD	2003-2011	1384	Price	TRACE	N/A	1 week	115bps
Aronsson & Tano (2016)	SEK	2009-2016	256	Price	Bloomberg	BAML Indices	1 week	IG: -17bps Non-IG: 22bps
Mietzner et al. (2017)	EUR (DE)	2010-2013	118	Price	Local Exchanges	N/A	1 day	67.0bps
Rischen & Theissen (2018)	EUR (EU)	2002-2017	5703	Price	Bloomberg	IHS Markit iBoxx Indices	40 days	59.0bps
Maitra et al. (2018)	EUR (EU)	2008-2017	1700	Spreads	Bloomberg	Matched Corporate Bond	2 days	9.0bps

Appendix 5: Data Sources

This table displays the variables examined in this thesis, the indices used (if applicable) and the respective data sources.

Variable	Index	Data Source
Ex-Ante Data of Bond Underpricing	N/A	IGM Database
Ex-Post Measure of Underpricing Based on iBoxx Indices	iBoxx EUR Non-Financial Index Family	IHS Markit Database
Ex-Post Measure of Underpricing Based on Secondary Bonds	N/A	Bloomberg
Credit Rating	N/A	IGM Database
Issue Size	N/A	Bloomberg/ IGM Database
Tenor	N/A	Bloomberg/ IGM Database
Credit Spread Level	iBoxx EUR Non-Financial Index Family	IHS Markit Database
Credit Spread Momentum	iBoxx EUR Non-Financial Index Family	IHS Markit Database
Stock Market Volatility	VSTOXX Index	Bloomberg
ECB Eligibility	N/A	Bloomberg

Appendix 6: Summary Statistics of Economic Predictors

This table displays the number of observations (N), the mean, the median, the maximum and minimum values as well as the standard deviation of the economic predictors used in this thesis.

Variable	N	Mean	Median	Max	Min	StDev
Issue Size (EURm)	946	735.8	650.0	3000.0	300.0	324.2
Tenor (Years)	946	8.8	8.0	30.1	0.0	4.1
Credit Spread Level (bps)	946	74.0	71.0	183.5	5.2	31.6
Credit Spread Momentum (bps)	946	0.0	0.2	20.5	-27.4	6.0
Stock Market Volatility (Index Value)	946	16.7	15.5	35.7	11.1	4.2

Appendix 7: Correlations Between Different Measures of Underpricing

This table displays the correlation between the various measures of underpricing from an ex-ante and ex-post perspective. Ex-post figures have been calculated for several observations periods.

		Ex-ante	iBoxx Based				Secondaries Based			
			1W	2W	3W	4W	1W	2W	3W	4W
Ex-ante		1.00	0.09	0.10	0.09	-0.03	0.28	0.17	0.10	0.04
iBoxx Based	1W	0.09	1.00	0.85	0.79	0.65	0.31	0.19	0.13	0.07
	2W	0.10	0.85	1.00	0.91	0.74	0.29	0.24	0.16	0.09
	3W	0.09	0.79	0.91	1.00	0.84	0.26	0.20	0.17	0.09
	4W	-0.03	0.65	0.74	0.84	1.00	0.18	0.14	0.13	0.08
Seconaries Based	1W	0.28	0.31	0.29	0.26	0.18	1.00	0.44	0.29	0.16
	2W	0.17	0.19	0.24	0.20	0.14	0.44	1.00	0.77	0.81
	3W	0.10	0.13	0.16	0.17	0.13	0.29	0.77	1.00	0.85
	4W	0.04	0.07	0.09	0.09	0.08	0.16	0.81	0.85	1.00

Appendix 8: Bond Underpricing per Credit Rating

This table displays the number of observations (N), the sample mean, the standard error (SE), the 99% confidence interval, the t-statistic, and the percentage of bonds with positive magnitude of underpricing for various rating categories from an ex-ante perspective. The statistical significance is indicated by ***/**/* for the 1%/5%/10% level respectively.

Average Rating	N	% of Total	Mean	SE	99% Conf. Interval	t-stat	Positive NIC (%)
AA+	6	0.63%	4.67**	1.82	[-0.02; 9.35]	2.56	66.7%
AA	17	1.80%	3.12**	1.29	[-0.22; 6.45]	2.41	64.7%
AA-	49	5.19%	5.24***	0.99	[2.70; 7.79]	5.31	69.4%
A+	112	11.85%	5.13***	0.46	[3.94; 6.31]	11.13	79.5%
A	101	10.69%	8.46***	1.07	[5.69; 11.23]	7.88	82.2%
A-	168	17.78%	7.93***	0.65	[6.25; 9.61]	12.15	82.1%
BBB+	255	26.98%	7.67***	0.52	[6.33; 9.01]	14.71	80.0%
BBB	177	18.73%	6.24***	0.72	[4.38; 8.11]	8.62	76.3%
BBB-	60	6.35%	8.10***	1.25	[4.87; 11.33]	6.46	75.0%

Appendix 9: Robustness Check: Underpricing for Different Subsamples

This table displays the number of observations (N), the sample mean, the t-statistic, and the percentage of bonds with positive magnitude of underpricing for various subsamples based on economic predictors. Underpricing is measured form an ex-post perspective based on iBoxx indices and secondary bonds. The statistical significance is indicated by ***/**/* for the 1%/5%/10% level respectively.

	N	% of Total	Based on iBoxx Indices			Based on Secondary Bonds		
			Mean	t-stat	Pos. NIC (%)	Mean	t-stat	Pos. NIC (%)
Complete Sample	946	100.0%	5.46	20.80	77.9%	9.68	13.38	83.9%
Panel A: Credit Rating								
A- or above	399	42.2%	4.96***	15.45	80.7%	9.26***	6.41	86.2%
BBB+ or below	547	57.8%	5.83***	14.99	75.9%	9.98***	14.79	82.3%
Difference	-	-	0.87*	-1.72	-	0.72	-0.46	-
Panel B: Issue Size								
<= EUR 650m	482	51.0%	5.17***	15.26	77.2%	9.17***	7.19	81.3%
EUR 650m+	464	49.0%	5.76***	14.29	78.7%	10.21***	15.75	86.6%
Difference	-	-	0.59	-1.11	-	1.04	-0.73	-
Panel C: Tenor								
<= 8yrs	474	50.1%	5.28***	13.82	78.3%	11.33***	8.80	85.9%
8yrs+	472	49.9%	5.64***	15.65	77.5%	8.02***	12.35	82.0%
Difference	-	-	0.36	-0.68	-	-3.31**	2.29	-
Panel D: Credit Spread Level								
Low	477	50.4%	5.16***	15.31	77.4%	7.23***	10.26	80.3%
High	469	49.6%	5.77***	14.29	78.5%	12.17***	9.65	87.6%
Difference	-	-	0.61	-1.16	-	4.94***	-3.42	-
Panel E: Credit Spread Momentum								
Low	478	50.5%	5.20***	13.57	75.9%	8.72***	7.01	79.3%
High	468	49.5%	5.72***	15.98	79.9%	10.66***	14.71	88.7%
Difference	-	-	0.52	-1.00	-	1.94	-1.35	-
Panel F: Stock Market Volatility								
Low	473	50.0%	5.06	15.38	78.9%	8.79	7.24	81.6%
High	473	50.0%	5.86	14.34	77.0%	10.57	13.45	86.3%
Difference	-	-	0.80	-1.51	-	1.78	-1.23	-

Appendix 10: Robustness Check:

Cross-Sectional Regressions (Based on iBoxx Indices)

This tables displays the regression coefficients for eight cross-sectional regressions. Standard errors (shown in parentheses) are heteroskedasticity robust. Underpricing is measured from an ex-post perspective based on iBoxx indices. The statistical significance is indicated by ***/**/* for the 1%/5%/10% level respectively.

Regression	1	2	3	4	5	6	7
No. of Obs.	946	946	946	946	946	946	946
Variable							
Credit Rating	0.87* (0.50)	-	-	-	-	-	1.26* (0.75)
Amount Issued	-	0.003*** (0.001)	-	-	-	-	0.002*** (0.001)
Years to Maturity	-	-	0.08 (0.07)	-	-	-	0.11* (0.06)
Spread Level	-	-	-	0.02* (0.01)	-	-	0.002 (0.01)
Spread Momentum	-	-	-	-	-0.02 (0.05)	-	0.01 (0.05)
Stock Market Volatility	-	-	-	-	-	0.18** (0.08)	0.18** (0.08)
Intercept	4.96*** (0.32)	3.47*** (0.69)	4.76*** (0.67)	4.08*** (0.69)	5.46*** (0.26)	2.38** (1.26)	-1.42 (1.63)
Adjusted R Squared	0.002	0.011	0.001	0.004	-0.001	0.008	0.021

This tables displays the regression coefficients for eight cross-sectional regressions. Standard errors (shown in parentheses) are heteroskedasticity robust. Underpricing is measured from an ex-post perspective based on secondary bonds. The statistical significance is indicated by ***/**/* for the 1%/5%/10% level respectively.

Regression	1	2	3	4	5	6	7
No. of Obs.	946	946	946	946	946	946	946
Variable							
Credit Rating	0.73 (1.59)	-	-	-	-	-	-3.13 (2.51)
Amount Issued	-	0.01*** (0.002)	-	-	-	-	0.01** (0.002)
Years to Maturity	-	-	-0.19* (-1.08)	-	-	-	-0.13 (0.13)
Spread Level	-	-	-	0.06*** (0.02)	-	-	0.10*** (0.03)
Spread Momentum	-	-	-	-	0.07 (0.16)	-	0.12 (0.17)
Stock Market Volatility	-	-	-	-	-	0.36* (0.19)	0.09 (0.23)
Intercept	9.26*** (1.44)	5.10*** (1.98)	11.38*** (1.38)	4.89*** (1.83)	9.68*** (0.72)	3.63 (3.47)	-0.69 (5.84)
Adjusted R Squared	-0.001	0.007	0.000	0.007	-0.001	0.004	0.016

Appendix 12: Robustness Check:

Structural Changes in Underpricing Associated with the CSPP

This table displays the number of observations (N), the sample mean, the standard error (SE), the 99% confidence interval, the t-statistic, and the percentage of bonds with positive magnitude of underpricing for various subsamples based on the status of the CSPP and eligibility criteria. Underpricing is measured from an both ex-post perspectives. The statistical significance is indicated by ***/**/* for the 1%/5%/10% level respectively.

Based on iBoxx Indices	N	% of Total	Mean	SE	99% Conf. Interval	t-stat	Positive NIC (%)
Complete Sample	946	100%	5.46***	0.26	[4.78; 6.14]	20.80	77.9%
Panel A: Activeness							
Active	561	59.3%	5.30***	0.31	[4.51; 6.09]	17.30	79.1%
Inactive	385	40.7%	5.69***	0.47	[4.49; 6.89]	12.22	76.1%
Difference	-	-	0.39	-	-	-0.71	-
Panel B: Eligibility							
Eligible	705	74.5%	5.20***	0.27	[4.50; 5.91]	18.95	78.3%
Non-Eligible	241	25.5%	6.21***	0.64	[4.55; 7.87]	9.64	76.8%
Difference	-	-	1.01	-	-	-1.44	-
Based on Secondary Bonds							
Complete Sample	946	100%	9.68***	0.72	[7.81; 11.54]	13.38	83.9%
Panel A: Activeness							
Active	561	59.3%	8.40***	0.65	[6.72; 10.08]	12.88	83.2%
Inactive	385	40.7%	11.54***	1.50	[7.68; 15.40]	7.70	84.9%
Difference	-	-	3.14*	-	-	-1.92	-
Panel B: Eligibility							
Eligible	705	74.5%	9.27***	0.60	[7.73; 10.80]	15.56	85.0%
Non-Eligible	241	25.5%	10.88***	2.24	[5.10; 16.65]	4.85	80.9%
Difference	-	-	1.61	-	-	-0.69	-

Appendix 13: Robustness Check:

Difference-in-Difference Regressions (Based on iBoxx Indices)

This tables displays the regression coefficients for four specifications of the difference-in-difference regressions. Standard errors (shown in parentheses) are heteroskedasticity robust. Underpricing is measured from an ex-post perspective based on iBoxx indices. The statistical significance is indicated by ***/**/* for the 1%/5%/10% level respectively.

Regression	1	2	3	4
No. of Obs.	946	946	946	946
Variable				
CSPP Active	1.20 (1.28)	1.31 (1.27)	2.12 (1.29)	1.98 (1.30)
CSPP Eligible	0.09 (1.06)	0.22 (1.05)	-0.04 (1.06)	0.09 (1.06)
Active x Eligible	-2.03 (1.42)	-2.07 (1.41)	-1.98 (1.41)	-2.04 (1.41)
Credit Rating	-	1.27** (0.50)	-	0.98 (0.83)
Issue Size	-	0.002*** (0.001)	-	0.003*** (0.001)
Tenor	-	0.11* (0.07)	-	0.12* (0.06)
Credit Spread Level	-	-	0.02 (0.01)	0.01 (0.02)
Credit Spread Momentum	-	-	-0.01 (0.06)	0.01 (0.05)
Stock Market Volatility	-	-	0.17** (0.08)	0.18** (0.08)
Intercept	5.63*** (0.93)	1.68 (1.33)	1.19 (1.82)	-2.02 (2.13)
Adjusted R Squared	0.003	0.019	0.012	0.025

Appendix 14: Robustness Check:

Difference-in-Difference Regressions (Based on Secondary Bonds)

This tables displays the regression coefficients for four specifications of the difference-in-difference regressions. Standard errors (shown in parentheses) are heteroskedasticity robust. Underpricing is measured from an ex-post perspective based on secondary bonds. The statistical significance is indicated by ***/**/* for the 1%/5%/10% level respectively.

Regression	1	2	3	4
No. of Obs.	946	946	946	946
Variable				
CSPP Active	-8.99**	-9.01**	-7.10	-6.17
	(4.32)	(4.40)	(5.08)	(4.72)
CSPP Eligible	-5.42	-5.19	-5.52	-5.50
	(4.15)	(4.26)	(4.18)	(4.31)
Active x Eligible	8.18*	8.22*	7.95*	7.98*
	(4.51)	(4.55)	(4.76)	(4.81)
Credit Rating	-	0.81	-	-3.02
		(1.88)		(2.06)
Issue Size	-	0.006***	-	0.006**
		(0.002)		(0.003)
Tenor	-	-0.19	-	-0.13
		(0.13)		(0.13)
Credit Spread Level	-	-	0.04	0.09
			(0.03)	(0.03)
Credit Spread Momentum	-	-	0.07	0.10
			(0.15)	(0.16)
Stock Market Volatility	-	-	0.21	0.10
			(0.20)	(0.23)
Intercept	15.20***	11.58*	7.40	3.62
	(4.01)	(6.96)	(8.15)	(10.08)
Adjusted R Squared	0.012	0.015	0.012	0.020

Effects of the CSPP on Economic Predictors (Based on iBoxx Indices)

*This table displays the number of observations (N), the sample mean, and the t-statistic for various subsamples based on economic predictors and the status of the CSPP. Underpricing is measured from an ex-post perspective based on iBoxx indices. The statistical significance is indicated by ***/**/* for the 1%/5%/10% level respectively.*

	CSPP Active			**CSPP Inactive**			**Comparison**	
	N	Mean	t-stat	N	Mean	t-stat	Diff.	t-stat
Panel A: Credit Rating								
A- or above	239	4.95***	14.02	160	4.97***	8.24	0.02	-0.03
BBB+ or below	322	5.56***	11.95	225	6.21***	9.25	0.65	-0.79
Panel B: Issue Size								
≤ EUR 650m	290	5.09***	12.67	192	5.29***	8.86	0.20	-0.28
EUR 650m+	271	5.52***	11.83	193	6.09***	8.52	0.57	-0.67
Panel C: Tenor								
≤ 8yrs	277	5.08***	11.39	197	5.56***	8.27	0.48	-0.59
8yrs +	284	5.51***	13.10	188	5.83***	9.05	0.32	-0.42
Panel D: Credit Spread Level								
Low	448	5.39***	15.68	29	1.60	1.10	-3.79**	2.52
High	113	4.95***	7.30	356	6.03***	14.47	1.08	-1.28
Panel E: Credit Spread Momentum								
Low	248	4.94***	10.96	230	5.48***	8.68	0.54	-0.70
High	313	5.58***	13.39	155	6.01***	7.81	0.43	-0.53
Panel F: Stock Market Volatility								
Low	320	5.29***	14.05	153	4.58***	7.11	-0.71	0.95
High	241	5.31***	10.42	232	6.42***	10.01	1.11	-1.36

Appendix 16: Robustness Check:

Effects of the CSPP on Economic Predictors (Based on Secondary Bonds)

This table displays the number of observations (N), the sample mean, and the t-statistic for various subsamples based on economic predictors and the status of the CSPP. Underpricing is measured from an ex-post perspective based on secondary bonds. The statistical significance is indicated by ***/**/* for the 1%/5%/10% level respectively.

	CSPP Active			CSPP Inactive			Comparison	
	N	Mean	t-stat	N	Mean	t-stat	Diff.	t-stat
Panel A: Credit Rating								
A- or above	239	7.69	9.28	160	11.60	3.43	3.91	-1.12
BBB+ or below	322	8.93	9.35	225	11.50	12.76	2.57*	-1.96
Panel B: Issue Size								
≤ EUR 650m	290	7.77	7.92	192	11.28	3.98	-3.79	-1.17
EUR 650m+	271	9.08	10.70	193	11.80	11.85	2.72**	-2.08
Panel C: Tenor								
≤ 8yrs	277	9.74	9.21	197	13.55	5.00	3.81	-1.31
8yrs +	284	7.09	9.27	188	9.43	8.22	2.34*	-1.70
Panel D: Credit Spread Level								
Low	448	7.33	10.00	29	5.78	2.30	-1.55	0.59
High	113	12.65	9.30	356	12.01	16.77	-0.64	0.31
Panel E: Credit Spread Momentum								
Low	248	5.37	5.87	230	12.32	5.21	6.95***	-2.74
High	313	10.80	12.07	155	10.38	3.60	-0.42	0.28
Panel F: Stock Market Volatility								
Low	320	8.04	9.45	153	10.35	3.13	2.31	-0.67
High	241	8.88	8.75	232	12.33	10.29	3.45**	-2.20