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Market Effects of Central Bank Credit Markets Support Programs in Europe*

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Abstract

Using responses of credit default swap indexes to ECB monetary policy announcements, we isolate a novel credit policy component of monetary policy surprises. We examine how such unconventional monetary policy surprises affect investor perceptions of credit risk and the functioning of primary corporate debt markets. Favorable credit surprises cause declines in uncertainty about credit risk and suggest a more stable outlook on its dynamics over the following months. Both net and gross corporate bond issuance increase as a result of favorable credit surprises, with the largest response in investment grade issuance. We argue that this provides evidence for the efficacy of a local channel of unconventional monetary policy.

Keywords: central banks, credit programs, credit derivatives, CDS, uncertainty, debt issuance.

JEL Codes: E58, G1.

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1 Introduction

The onset of the Covid pandemic in early 2020 triggered a spike in economic uncertainty and threw global financial markets into turmoil. In response, central banks around the world introduced a plethora of market support and monetary stimulus programs. The former included asset purchase facilities designed to support corporate bond markets through acquisition of corporate bond exchange-traded funds (ETFs), as well as direct corporate bonds purchases in primary and secondary bond markets. Such purchase programs, together with broader monetary and fiscal stimulus measures, arguably stabilized corporate credit markets, as their announcements were associated with increases in prices of corporate bonds and corporate-bonds ETFs, accompanied by tightening of corporate credit spreads.

While for some central banks, corporate bond purchases and credit support programs were a part of the pre-Covid toolkit, such programs received new prominence during the Covid crisis. The legacy programs were rekindled and extended, for example by the European Central Bank (ECB) and Bank of England (BoE), and new programs were introduced, for example by the Fed. This led to an increasing demand for understanding of how such policies affect financial markets and firms' access to financing, as well as quantifying such effects.

In this paper, we propose a novel approach to isolate a *credit factor* using the responses of credit default swap (CDS) index spreads to ECB monetary policy announcements (pre- and post-onset of Covid). Following this approach, we examine how credit policy surprises affected option-implied measures of credit spread uncertainty, as well as debt issuance in Europe.

A credit policy surprise is the component of CDS index spread moves left unexplained by policy rate, forward guidance and sovereign bond purchases surprises generated by ECB communications. We proxy the latter surprises by the first principal component of the ECB Governing Council *press-release* window overnight index swap (OIS) rate changes and the first 3 principal components of *press-conference* window OIS rate changes. We augment

the set of events by relevant announcements that were not part of the Governing Council scheduled meetings – on such days, credit policy surprises are simply raw CDS index spread moves. The credit policy surprise is measuring what unconventional policy does to CDS spreads, whether it comes from corporate bond purchases (likely the most important), or funding facilities, or lending programs.[1]

Options on iTraxx CDS indexes yield a set of option-implied measures of credit spread uncertainty. Specifically, they are at-the-money (ATM) implied volatilities and the term-structure of the implied volatility surface. ATM implied volatilities measure overall forward-looking uncertainty about credit spreads. The term structure of the implied volatility surface captures investor expectations about the dynamics of uncertainty over the following months. By analyzing all these measures jointly, we form a complete picture of current uncertainty, and how these sentiments are likely to change in the near future. Derivatives-based quantities have the advantage of being forward-looking, but we recognize that we do not disentangle the risk premium component of these measures, which we leave for future research. Having seen that credit policies affect spreads in part via a reduction in uncertainty and risk premia, we then turn to the effects on bond issuance. We consider both the *net* non-financial Euro corporate bond issuance data provided by the ECB, as well as *gross* non-financial corporate bond issuance data from Refinitiv Workspace for Investment Banking. The latter data also allow us to break out investment-grade and high-yield issuance and, thus, examine how credit policy shocks are related to bond issuance in sectors of various riskiness and whether changes in issuance were more pronounced in the market segments targeted by the ECB's corporate bond purchases.

We find that adverse corporate bond purchase surprises, which indicate greater tightening in credit policy than expected, are accompanied by increases in uncertainty around credit spreads, as well as a flattening of the implied volatility term structure.[2] Moreover this

[1] For convenience, throughout the text we use the terms *credit-policy* surprise and *corporate-bond-purchase* surprise interchangeably.

[2] We define flattening of the term structure as the 1-month implied volatility increasing more than the 3-month implied volatility. This may even result in an 'inverted' term structure, with the 1-month volatility exceeding its 3-month counterpart.

translates into issuance: adverse corporate bond purchase surprises lead to lower net and gross corporate bond issuance. For gross non-financial corporate issuance, the response is statistically significant for investment grade issuance, but not for high-yield issuance. This observation is consistent with the ECB's focus on the purchases of investment-grade bonds, coupled with a narrow transmission mechanism. Throughout estimated effects are linear by assumption and so unexpected easings have opposite effects of equal magnitude. Thus we conclude that unconventional ECB monetary policy geared towards supporting corporate credit markets significantly affected investor perceptions of credit risk and improved the functioning of primary corporate debt markets in Europe.

The rest of the paper is organized as follows. Section 2 reviews the related literature. Section 3 provides background on the ECB's policies targeting corporate credit markets, including those introduced and expanded after the onset of the Covid crisis. Sections 4, 5 and 6 discuss data, methodology and results, respectively. Section 7 concludes.

2 Related Literature

Our study contributes to voluminous literature on effects of central bank asset purchases on asset prices and economic activity. A number of papers focused on large-scale purchases of Treasury securities and MBS by the Federal Reserve and tried to identify the channels through which such purchases affect prices of both eligible/purchased securities and securities in broader financial markets, as well as to separate the effects of these purchases from those of various forms of forward guidance adopted at around the same time. Studies discussing implications for corporate bonds are particularly relevant to our work and include Krishnamurthy and Vissing-Jorgensen (2011) and Gilchrist and Zakrajsek (2013) among others. The main conclusion of this literature is that such purchases boosted prices of Treasuries and MBS, as well as those of other long-term securities such as corporate bonds. ECB's purchases of government securities following the central bank's introduction of the Securities

Market Programme in May 2010 and the Outright Monetary Transaction Programme in August 2012 also came to the attention of researchers. Although these ECB programs had some important differences from those of the Fed with respect to both objectives and implementation, the corresponding studies documented qualitatively similar effects: the programs exerted downward pressure on sovereign yields, particularly on those of peripheral European countries, and contributed to easing of financial conditions more generally (see, for example, Rogers et al. (2014), Krishnamurthy et al. (2018) and DePooter et al. (2018)).

Our study is most directly related to the literature that focuses on the effects of central banks' corporate bond purchase. Prior to the COVID-19 pandemic crisis, this literature focused on the effects on asset prices and debt issuance of the ECB's 2016 Corporate Sector Purchase Program (CSPP) and the Bank of England's 2009/2016 purchases under the "Corporate Bond Purchase Scheme". Notable representatives of this strand of research include De Santis et al. (2018), Abidi and Miquel-Flores (2018), D'Amico and Kaminska (2019), Todorov (2020), Makinen et al. (2020) and Pegoraro and Montagna (2021).

More recently, several papers investigated the effects of central bank purchases of corporate securities during the COVID-19 pandemic. In particular, Gilchrist et al. (2020), Nozawa and Qiu (2020), D'Amico et al. (2020), among others, examine the impact of the U.S. corporate bond purchase programs on prices of corporate bonds, corporate-bond ETFs and CDX indexes. In general, these studies find that program announcements contributed to declines in corporate bond spreads and improvements in liquidity. While these changes are most pronounced for program-eligible securities, they apply more broadly, particularly after the Fed indicated the intent to conduct purchases in the "fallen angels" subset of the high-yield bond market segment. Studies focusing on the effects of ECB's pandemic-era corporate-bond purchase announcements, e.g. Demirgüç-Kunt et al. (2020), document similar results: asset prices broadly increased following announcements, although these responses where stronger for securities eligible for the ECB purchases.

In general, studies on the effects of corporate bond purchases compare announcement re-

sponses of either security-level prices of bonds that were close to the borderline of central bank purchase eligibility criteria or aggregate prices (and/or aggregate bond issuance) within sectors broadly eligible for purchases (e.g. investment-grade vs high-yield corporate bonds). Our paper contributes to this literature by using responses in both credit spreads and OIS rates to isolate *credit surprises* in ECB announcements. This allows us to quantify the effect of a unit of surprise easing of credit accommodation associated with the ECB announcements on the quantities of interest, net of concurrent general/non-credit-specific surprise monetary easing. In particular, we examine the effects on option-implied measures of uncertainty and on debt issuance. This allows us to shed additional light on monetary policy transmission mechanisms.[3] Our approach to identifying *credit* surprises is reminiscent of the method used to identify surprise changes in the federal funds rate, forward guidance, and large-scale asset purchases (an early example is Gürkaynak et al. (2005)). To our knowledge, our study is the first paper to attempt this.

Perhaps the closest related approach is by Lhuissier and Nguyen (2021) who measures the ECB asset purchase surprises as the difference between announced asset purchases and survey expectations as an external instrument in a structural vector autoregression. A drawback of this approach is that there are dimensions to the credit policy beyond the Euro value of assets being bought, such as the pace of purchases, collateral rules, and other lending programs. All of these can be subsumed in our credit surprise, to the extent that they impact CDS rates.

Finally, our paper contributes to the burgeoning literature using options on CDS indexes for various purposes. A recent example is Collin-Dufresne et al. (2020), which studies the integration of equity and credit markets and, as a by-product, documents the evolution of quantities implied by CDX options during the pandemic crisis. Our paper takes a more granular approach to corporate asset purchase program announcements and quantifies a response of option-implied measures per unit of credit policy surprise.

[3] An example of a paper that focuses on responses of option-implied tail risk perceptions to unconventional monetary policy is Hattori et al. (2016).

3 Background on ECB's programs supporting corporate debt markets.

This section provides a brief overview of the ECB's actions directed to support credit markets, including those introduced in response to global pandemics, with a focus on the programs supporting corporate debt markets.

Corporate bond purchases, as well as programs aiming to stimulate lending to corporations, were a part of ECB's pre-pandemic toolkit. The initial ECB asset purchase programs were introduced in 2014 and focused on euro area sovereign bonds. However, on March 10, 2016, the ECB established a new corporate securities purchase programme (CSPP), targeting longer-term euro-denominated corporate securities. The Governing Council indicated that the purchases under this program would commence at the end of Q2:2016 and that they would be included into the overall asset purchases, the amount of which was increased from €60 billion to €80 billion at the same meeting. This program expired in December 2018, but was then restarted the following September.

Another measure included in the announcement and targeting the corporate sector, albeit less directly than CSPP, was a new round of targeted long-term refinancing operations (TLTRO II). TLTRO II followed TLTRO I, an example of funding for lending program, which was introduced in 2014 to mitigate banks' deleveraging and encourage banks to lend to the real economy.

The March 10, 2016, package of easing measures also included reductions in ECB's key benchmark rates, expansion of asset purchase eligibility criteria under the extant purchases programs and the aforementioned accelerating of pace of asset purchases. However, market participants reportedly took particular note of the introduction of both CSPP and TLTRO II and reportedly viewed it as an expansion of the policy toolkit toward credit easing at the time of already ultra-low and, in some cases negative, interest rates, as well as sovereign-bond purchase programs approaching their purchase limits. Our measure of corporate-bond

purchase/credit-policy surprises could be capturing the effects of both CSPP and TLTRO II. However, it is likely to mostly reflect the effects of the CSPP, as CSPP directly affects larger companies that issue eligible bonds and are more likely to be included into the iTraxx indexes used to identify the surprises, while TLTRO aims to support lending in the broader economy.

Further information on the implementation aspects of the corporate sector purchase program, including bond eligibility criteria was announced on April 21, 2016, after the Bank President's press conference.[4]

At the end of February 2020, global financial markets came under stress in response to the rapid spread of the COVID-19 virus. Early measures to stabilize the economy included a multi-faceted response comprising (i) rate cuts, (ii) expansion/relaunch of existing asset-purchase programs and liquidity facilities, and (iii) easing of regulatory requirements. We list select ECB announcements in Table 1, and focus specifically on programs aimed to support of the credit market through purchases of corporate bonds and ETFs, and not a "blow-by-blow" account of all central banks' actions.[5]

The ECB never included corporate "fallen angels" in its asset purchase programs. European programs focused on the investment grade sector, with the exception of the debt issued by the Hellenic Republic. Also, the ECB PEPP program allowed for bond maturities of up to 30 years, while the Federal Reserve's SMCCF capped bond maturity at 5 years.

[4]Eligible corporate securities included euro-denominated bonds that were (1) eligible as collateral for Eurosystem credit operations, (2) issued by non-bank corporations established in the euro area and (3) had an investment rating of BBB- or higher. A full description of technical criteria can be found at `https://www.ecb.europa.eu/press/pr/date/2016/html/pr160421_1.en.html`.

[5]A detailed U.S.-focused timeline could be found in, among others, Timeline of Events Related to the COVID-19 Pandemic of the St. Louis Fed, https://fraser.stlouisfed.org/timeline/covid-19-pandemic. Haas et al. (2020) contains a comprehensive overview of responses of international central banks to the COVID-19 crisis.

4 Data

Underlying credit index data and implied volatilities (including implied volatility calendar spreads) in our sample are courtesy of J.P. Morgan Chase & Co. – Morgan Markets. We focus on the 5-year on-the-run CDS indexes and standardized options on these indexes (with 1 and 3 months to expiration). iTraxx Main and Crossover indexes consist of one hundred twenty five and forty five of the most liquid European entities with investment grade and high yield credit ratings, respectively.[6]

We consider two option-derived variables: at-the-money implied volatility, and the implied volatility calendar spread. The implied volatility calendar spread is defined as the 3-month at-the-money implied volatility less the 1-month at-the-money implied volatility.

Our sample starts on January 1 2016 and ends on December 31 2021. Figures 1 and 2 illustrate the dynamics of credit spot and option market indicators. Since for some dates data are not available, we replace missing values for implied volatility with predicted values, based on regressions of daily changes in implied volatility measures on changes in the underlying CDS index spreads. During the COVID-19 crisis period, missing iTraxx options data occur on April 13 and May 8. Moreover, we have missing iTraxx spread data for April 13 and, thus, cannot fill the gap with the method outlined above.

For corporate debt issuance we use two sources of data. First, we use monthly data on nonfinancial corporate net debt issuance of all maturities by euro area residents compiled by the ECB.[7] Second, we use data on corporate bond issuance transactions from Refinitiv Workspace for Investment Banking to compute monthly gross bond issuance by nonfinancial corporations in euro area. In addition to letting us establish the robustness of our findings with an alternative data source and a different concept of issuance, this data set allows to consider issuance of bonds with various credit ratings.

[6] Additional information on CDS indexes and corresponding options is in the Appendix.

[7] The data are available at `https://www.ecb.europa.eu/stats/shared/download/stats/download/sec_debt_net/sec_debt_net/sec_historical_net.csv`.

5 Questions and Methodology

5.1 New Monetary Policy Shock

As central bankers developed forward guidance and tools for use at the zero lower bound, the dimensions of monetary policy announcements identified by researchers have increased. The seminal paper of Kuttner (2001) considered just surprises in the policy interest rate. Gürkaynak et al. (2005) distinguished between target and path surprises in the funds rate. Moving forward to the period at the ZLB, Swanson (2021) identifies three dimensions to US monetary policy announcements that he interprets as target, forward guidance and asset purchase surprises. And Altavilla et al. (2019) cleverly use intradaily data and the fact that ECB announcements consist of a press release followed by a press conference to identify a total of four factors in ECB announcements; one from the press release and three from the press conference. Inoue and Rossi (2021) identify shocks to the yield curve around monetary policy announcements and they treat these as exogenous shocks to the entire function represented by the yield curve. All of these papers are identifying monetary policy surprises using financial market asset prices that are essentially risk-free, such as OIS rates or Treasury yields.

In this paper, we want to identify credit policy surprises for the ECB. This is a new kind of monetary policy surprise, because it is only since 2016 that the ECB has been purchasing corporate bonds. But in March 2016 the ECB announced at its Governing Council meeting that it would begin purchases of non-bank corporate bonds, and many subsequent meetings have contained news about their corporate bond purchases. The program was stopped in December 2018 only to start up again the next year. Thus for about 6 years the ECB Governing Council meetings have contained an element that is news about corporate bond purchases.

These announcements of course contain other information about more standard aspects of monetary policy. This includes surprises to the policy rate, forward guidance and sovereign

bond purchases, and these may affect credit spreads through their effects on the economic outlook and not because such policies directly target credit markets. Therefore, for all ECB announcement days since the start of 2016, we regress daily changes in the 5-year on-the-run iTraxx index spreads on (i) the first principal component of the press-release window OIS rate changes and (ii) the first 3 principal components of press-conference window OIS rate changes. We obtain these intradaily OIS rate changes from the database of Altavilla et al. (2019). Table 2 reports the results of these regressions. The R^2 values are around 50 percent, indicating that while changes in index spreads are related to more conventional monetary policy surprises, there is also a substantial separate component. We treat residuals from these regressions as credit policy shocks. Not all meetings have corporate bond purchase announcements (or even potential expectations for such announcements) but there was a steady drip of corporate bond purchase and other credit policy announcements associated with Governing Council meetings over the entire period.

Although most announcements related to corporate bond purchases by the ECB came out as part of Governing Council meetings, there were four announcements at the start of the COVID crisis that were stand-alone. These were:

- March 18, 2020 (announced post market close and so treated as being as of the next day). The ECB announced the Pandemic Emergency Purchase Program (PEPP) with an overall envelope of 750 billion Euros. All assets eligible under the asset purchase programme (APP) are eligible for PEPP, including purchases on non-financial commercial paper. PEPP allows purchases of only investment grade assets, with the exception of the sovereign debt of the Hellenic Republic. On the same day, the ECB announced a Corporate Sector Purchase Programme (CSPP) expansion by extending the range of eligible maturities.

- March 25, 2020. The ECB announced, in a legal decision, that asset purchases under PEPP are not subject to many of the constraints imposed in its other asset purchase programs. Most notably, PEPP is not subject to the issuer limit, which was imposed to

prevent it from *de facto* funding national governments. ECB also signaled its greater flexibility, which may balance the requirement to purchase assets in proportion to countries' economies and contributions to the ECB's capital (Arnold and Stubbington, 2020). The ECB also expanded individual security eligibility criteria by allowing for shorter maturity bonds.

- April 07, 2020. The ECB announced a portfolio of collateral measures "to facilitate an increase in bank funding against loans to corporates and households". This objective is achieved by facilitating "the availability of eligible collateral for Eurosystem counterparties to participate in liquidity providing operations, such as the targeted longer-term refinancing operations (TLTRO-III)". These measures included acceptance of lower credit quality and foreign currency loans as collateral. The ECB also increased the 'maximum share of unsecured debt instruments issued by any single other banking group in a credit institution's collateral pool'. Finally, the ECB opted to 'temporarily increase its risk tolerance level in credit operations through a general reduction of collateral valuation haircuts by a fixed factor of 20%. [8]

- April 22, 2020. "Fallen angels" made eligible collateral for Eurosystem credit operations. For some time, this prompted market participants to speculate that the ECB may extend PEPP to allow for high yield debt, analogous to actions already taken by the Federal Reserve (Arnold et al., 2020). However, such expectations subsequently did not materialize.

For these four days we simply take the daily change in the 5-year iTraxx index spreads as there is no more standard monetary policy announcement coming out at the same time. All in all, this leaves use with 52 events for consideration.

Figure 3 plots the time series of ECB credit policy announcement surprises obtained in this way. Three are highlighted. The first is March 10, 2016, when the CSPP was first

[8] https://www.bundesbank.de/en/tasks/monetary-policy/outright-transactions/corporate-sector-purchase-programme-cspp-831132

announced although expectations for it had been set up at the previous Governing Council meeting. This appears as a negative surprise. The second is March 12 2020, when there were expectations for more corporate bond purchases at the Governing Council meeting, but no such announcement was made. Indeed, ECB President Lagarde at the Press Conference remarked that "we are not here to close spreads".[9] The third is March 18, 2020 when the PEPP was announced after all. These cases generally illustrate that our surprise series is giving a reasonable measure of the difference between the announced policy and that which investors had expected as of the night before the announcement.

Our main credit surprise measure is based on changes in the main 5-year on-the-run iTraxx Main index spread that is composed of 125 investment grade firms. Since there is also a Crossover index that is based on CDS for 45 speculative grade firms, we can construct our surprise measure based on the Crossover index, converted into spread. While the two are naturally correlated, they may contain incremental information relative to one another. Thus, we consider both separately in various regression model specifications, as described below.

5.2 Impact of Credit Surprises on CDS Market Moves and Bond Issuance

Having constructed our measure of credit surprises, we use standard "event-study" approaches to examine its effects on options implied quantities, as well as on debt issuance.

We first consider regressions of the form:

$$Y_{it} = \beta C_t + \varepsilon_{it} \tag{1}$$

[9] Although that remark was reportedly interpreted as referring to spreads on European peripheral sovereign bonds, one can reasonably assume that investors also interpreted it as suggesting that purchases of riskier corporate bonds became less likely.

where Y_{it} is the daily change in implied volatility, or the implied volatility calendar spread; C_t is our credit surprise measure. The regression is run over all announcement days. The credit surprise measure can be obtained from either the Main index or the Crossover index.

We also consider the effects of credit surprise on debt issuance. Because issuance data are available at lower frequency, we first aggregate the credit surprise to the monthly frequency, by summing all the surprises within that month. For any month without any announcement, the surprise is set to zero. We then take various measures of corporate bond issuance in month t, I_t and consider regressions of the form:

$$I_{t+h} = \beta_0 + \beta_1 C_t^{monthly} + \beta_2 I_{t-1} + \varepsilon_{t+h} \tag{2}$$

where $C_t^{monthly}$ is the monthly surprise using either the Main or Crossover index. This involves estimating the effects of these surprises on issuance by a local projections method (Jordà, 2005).

6 Results

6.1 Option-Implied Measures of Uncertainty

In this section, we begin by examining observed responses in CDS index and option quantities around important credit-policy announcement dates. Figure 4 depicts daily changes in CDS index spreads, as well as measures of the implied volatility surface and its term structure. We focus on the 1- and 3-month horizons. Quite a few announcements were associated with reductions of stress in credit markets. For example, the establishment of the CSPP on March 10, 2016, was accompanied by a decline in corporate spreads, implied volatilities and steepening of the volatility term structure (1-month volatility declined more than its 3-month counterpart) for both Main and Crossover iTraxx indexes. The next event with directionally

and quantitatively similar changes in iTraxx quantities, suggesting notable stress reduction in credit markets, was on September 12, 2019, when the parameters of TLTRO III were changed.

The Covid crisis brought renewed focus to policies supporting corporate bond and credit markets. Several announcements of such measures were accompanied by pronounced moves in credit spreads and option-implied risk and uncertainty measures. That said, early policy actions undertaken at the beginning of Covid pandemic amid a collapse of many asset markets were not necessarily accompanied by reductions in credit markets' stress, as indicated by increases in CDS index spreads and volatilities, as well as flattening of volatility term structure.

This situation was observed in the markets following the initial boost to ECB's extant asset purchase program on March 12, 2020.

However, soon thereafter stresses in credit markets started to abate. Credit spreads and implied volatilities declined on 03/19, 03/25, 04/07, and 04/22/2020, after the announcement and modification of PEPP, as well as the introduction of the collateral measures that were initially interpreted as signalling potential future purchases of high-yield bonds by the ECB.Also, on those dates, 1-month volatility measures generally declined more than their 3-month counterparts, thereby steepening the volatility term structure.

At more than 50 basis points, the decline in the iTraxx Main spread on 03/25 was particularly pronounced. More generally, higher-quality (Main) spread posted larger declines around these dates than its lower-credit-quality (Crossover) counterparts, consistent with the investment-grade bonds being eligible for ECB's purchases. However, the declines in Crossover implied volatilities were comparable to or even more pronounced than those in Main volatilities, indicating that, in addition to affecting prices of eligible assets, the announcements led to declines in overall uncertainty.

Having documented declines in credit spreads and spread uncertainty around important

corporate-bond credit policy announcements, we next quantify such changes per unit of policy surprise. Table 3 contains results of regressions of the form of equation (1). These estimates suggest that adverse corporate bond purchase surprises, which indicate more tightening in credit policy than expected, are accompanied by increases in uncertainty around credit spreads.

Adverse corporate bond purchase surprises, based on the Main index, are associated with statistically significant increases in 1-month and 3-month implied volatilities of both Main and Crossover spreads. In particular, when considering the magnitudes of coefficients, one must bear in mind that Crossover-based surprises are larger in absolute value than their counterparts derived from the Main index. Corporate-bond-purchase surprises constructed based on the Crossover index contain incremental information relative to the ones constructed based on the Main index. This manifests itself in a notably better fit in the model for Crossover implied volatility when the explanatory variable is the corporate-bond-purchase surprises constructed based on the Crossover index relative to the specification which relies on its Main-based counterpart.

A surprise tightening of credit policy is also accompanied by flattening of the volatility term structure since increases in 1-month volatilities are larger than their 3-month counterparts. The negative impact of more hawkish surprises is also evident in the negative coefficients in the model for calendar spreads of both Main and Crossover indexes. Volatility processes commonly exhibit mean reversion: a tendency to decrease (increase) after a sharp rise (fall) away from the long-run level. This feature of volatility helps explain the flattening (1-month volatility increasing more than 3-month volatility) of the implied volatility term structure as a consequence of pronounced hawkish surprises: a large spike in volatility is not expected to have a permanent impact.

6.2 Corporate Bond Issuance

We next transition to seeing how lower spreads and lower uncertainty may translate into more issuance of corporate bonds. In this subsection, we document the effects of policy surprises on some measures of net and gross non-financial Euro corporate bond issuance.

Tables 4 and 5 display results of regressions of the form of equation (2), where measures of corporate bond issuance are regressed on lagged credit surprises (aggregated at the monthly level). Using data on net issuance of non-financial corporate bond issuance compiled by the ECB (Table 4), we document that adverse corporate-bond purchase surprises (less accommodative policy) are associated with significant declines in corporate-bond issuance one to two months ahead, regardless of which credit-spread measure is used to construct the surprises.

We obtain similar results when we consider gross non-financial corporate bond issuance data from Refinitiv Workspace (Table 5), with the main difference that the credit surprises also lower issuance contemporaneously. Refinitiv data also allow us to break out issuance by market segments and examine the relative importance of corporate-bond-purchase surprises. In addition to the overall gross non-financial corporate bond issuance, we consider investment-grade and high-yield issuance. Consistent with only high-grade bonds being eligible for ECB purchases, the explanatory power of credit surprises is concentrated in the investment-grade sector, with both Main and Crossover-based surprises having negative and statistically significant coefficients in the local projections specification with $h = 0, 1, 2$. Credit surprises are generally statistically insignificant and R^2 values are very low in regressions explaining high-yield issuance.

Our results tie into a large literature finding the effects of unconventional monetary policy, but operating through a rather "local" or "narrow" channel in which purchases in a given market affect that market, but have limited spillovers to other markets. For example, Di Maggio et al. (2020) find that Fed mortgage backed security purchases affected yields

and loan originations, and that this effect could not be generated by purchases of Treasuries alone. In this same spirit, we are finding that actions that credit policy surprises are having an impact on corporate bond issuance, with the effect concentrated in the investment grade sector that is the target of ECB corporate bond purchases.[10]

7 Conclusion

Corporate bond purchases are a relatively new instrument in central bankers' toolkit that received a renewed prominence during the Covid crisis. In this paper, we contribute to the literature studying the informational content of central bank communications and identify a credit-policy surprise embedded in ECB's announcements. This is a new policy surprise because it is only since 2016 that the ECB has been purchasing corporate bonds, and to our knowledge our paper is the first to try to identify and quantify such a surprise.

We shed light on the efficacy of corporate bond purchase programs by examining how corporate-bond purchase surprises affect derivative asset prices and primary debt market functioning. In particular, we find that negative (favorable) corporate bond purchase surprises, which indicate more easing in credit policy than expected, are accompanied by declines in option-implied measures of uncertainty around credit spreads. This finding supports the conjecture that in addition to potentially reducing probabilities of corporate defaults by lowering corporate borrowing costs, corporate bond purchases also reduced uncertainties associated with future corporate spreads. This decrease in uncertainty (quantity of risk) may be one of the channels through which central bank programs contributed to declines in total compensation investors demanded for carrying credit risk. As for the price of risk, it may also have been reduced due to the stabilizing nature of the central banks' actions. More precisely, a reduction in implied volatility may reflect both a decrease in uncertainty and a fall in the associated price of volatility risk. Since prices of risk are likely to co-move, this

[10]That said, our results indicating that more accommodative credit policy reduces uncertainty around higher-credit-risk spreads and not just around their investment-grade counterparts also point to broader and less direct spillovers to high-yield credit market segment.

may suggest a reduction in the price of credit risk.

Furthermore, corporate bond purchase surprises drive non-financial corporate bond issuance, with the relationship concentrated in the investment-grade sector. This is important because the main motivation for the purchase programs is to enable corporations to borrow and rollover existing debt. The issuance results complement findings from the earlier (pre-Covid) studies taking an alternative approach and relating firm-level debt issuance to individual firms' debt eligibility to central bank purchases and security-level bond purchases. Our findings lend support to efficacy of corporate bond purchases in reducing market stress and facilitating funding flows into corporate sector. A question then arises as to how firms used such funding, and what impacts it had on their investment, and how the funding uses differed across firms. The answer will prove important both for future episodes and the time when policy makers begin to remove monetary policy accommodation but is beyond the scope of our paper.

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Table 1: Select ECB Announcements

Date	Description
2016-03-10	announcement of CSPP and targeted longer-term refinancing operations, TLTRO II
2016-06-02	announcement of specific date for commencement of CSPP and TLTRO II
2019-03-07	launch of targeted longer-term refinancing operations, TLTRO III
2019-09-12	changing modalities of the new series of quarterly targeted longer-term refinancing operations (TLTRO III)
2020-03-12	additional long term refinancing operation (LTROs); more favorable terms for TLTRO III; temporary envelope of additional net asset purchases of €120 billion - contribution from the private sector purchase programmes
2020-03-18	announcement of the Pandemic Emergency Purchase Programme (PEPP), a Corporate Sector Purchase Programme (CSPP) expansion; (announced post market close and so treated as being as of the next day)
2020-03-25	decision to remove certain limits on PEPP
2020-04-07	announcement of a portfolio of collateral measures
2020-04-22	'Fallen angels' made eligible collateral for Eurosystem credit operations
2020-04-30	easing TLTRO III conditions; new series of non-targeted pandemic emergency longer-term refinancing operations (PELTROs); statement of the Governing Council's preparedness to increase the size of the PEPP and adjust its composition
2020-06-04	expansion of PEPP: amount increased by €600 billion to a total of €1,350 billion
2020-12-10	expansion of PEPP: amount increased by €500 billion to a total of €1,850 billion; horizon lengthened to at least the end of March 2022
2021-03-11	increase in the pace of purchases under the PEPP over the following quarter

Table 2: Regression Results of changes in iTraxx spreads on OIS principal components

Dependent Variable	Main Index	Crossover Index
Press Release PC1	1.06***	5.12 ***
	(0.28)	(1.25)
Press Conference PC1	-0.85	-1.95
	(1.14)	3.92
Press Conference PC2	-0.38	-1.55
	(0.37)	(1.76)
Press Conference PC3	-0.07	-2.43
	(1.19)	(4.25)
R^2	0.47	0.60

Notes: This table reports the results of regressions of the daily changes in iTraxx Main and Crossover indexes on days of ECB Governing Council meetings onto the first principal component of OIS changes around the press release and the first three principal components of OIS changes around the press conference, where OIS changes are taken from the database of Altavilla et al. (2019) and are at maturities 1, 3 and 6 months, and 1, 2, 5 and 10 years. Heteroskedasiticity-robust standard errors are shown in parentheses. *, ** and *** denote significance at the 10, 5 and 1 percent levels respectively.

Table 3: Option-implied credit spread moments and corporate bond purchase surprises

	Dependent variable:			
	Main.IV	Crossover.IV	Main.Calendar	Crossover.Calendar
Main surprises				
1-month option-implied moments				
Main_t	0.55^{***}	0.38^{**}	-0.24^{***}	-0.20^{***}
	(0.16)	(0.15)	(0.09)	(0.07)
R^2	0.44	0.36	0.25	0.24
Adjusted R^2	0.43	0.34	0.23	0.23
3-month option-implied moments				
Main_t	0.31^{***}	0.19^{**}		
	(0.08)	(0.09)		
R^2	0.50	0.31		
Adjusted R^2	0.49	0.30		
Crossover surprises				
1-month option-implied moments				
Crossover_t	0.15^{***}	0.11^{***}	-0.06^{***}	-0.05^{***}
	(0.03)	(0.03)	(0.02)	(0.02)
R^2	0.45	0.46	0.25	0.25
Adjusted R^2	0.44	0.45	0.24	0.24
3-month option-implied moments				
Crossover_t	0.08^{***}	0.06^{***}		
	(0.01)	(0.01)		
R^2	0.51	0.49		
Adjusted R^2	0.50	0.48		

Notes: This table reports the results of estimating equation (1) with heteroskedasticity-robust standard errors. Main.IV and Crossover.IV are at-the-money implied volatilities of swaptions written on the on-the-run 5-year iTraxx Main index and iTraxx Crossover index, correspondingly. Main.Calendar and Crossover.Calendar are implied volatility calendar spreads (3-month vs. 1-month, at-the-money) inferred from swaptions written on the on-the-run 5-year iTraxx Main index and iTraxx Crossover index, correspondingly. The explanatory variables are surprises measured from the iTraxx Main, Main_t, or iTraxx Crossover indexes, Crossover_t. *p<0.1; **p<0.05; ***p<0.01 denote significance at the 10, 5 and 1 percent levels respectively.

Table 4: Net nonfinancial corporate bond issuance in euro zone and corporate bond purchase surprises

	Dependent variable:							
	Nonfinancial net issuance							
	$h = 0$		$h = 1$		$h = 2$		$h = 3$	
Main_t	-0.09		-1.67^{***}		-1.11^{***}		-0.16	
	(0.69)		(0.32)		(0.19)		(0.25)	
Crossover_t		-0.18		-0.46^{***}		-0.27^{***}		-0.05
		(0.25)		(0.09)		(0.07)		(0.07)
I_{t-1}	0.00	0.02	0.07	0.09	0.02	-0.01	-0.03	-0.00
	(0.20)	(0.20)	(0.10)	(0.10)	(0.13)	(0.14)	(0.13)	(0.13)
Constant	7.06^{***}	6.46^{***}	5.32^{***}	5.25^{***}	6.60^{***}	6.69^{***}	7.16^{***}	7.12^{***}
	(1.76)	(1.70)	(1.16)	(1.17)	(1.00)	(1.02)	(2.20)	(2.18)
R^2	0.000	0.269	0.121	0.003	0.045	0.291	0.101	0.004
Adjusted R^2	-0.028	0.248	0.095	-0.028	0.017	0.270	0.074	-0.026

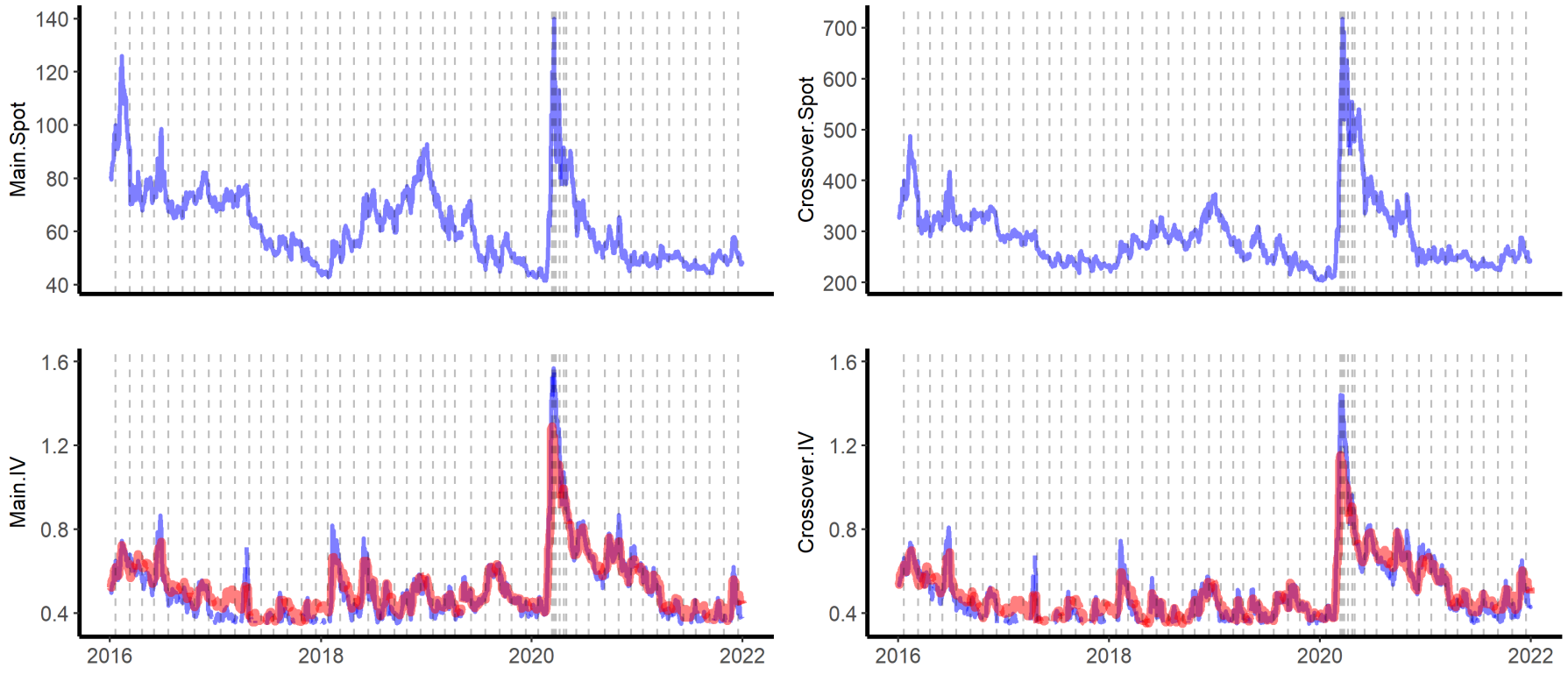
Notes: This table reports the results of estimating equation (2) with ECB net issuance of nonfinancial corporate debt in h months as the dependent variable and a lagged dependent variable the surprises measured from the iTraxx Main, Main_t, or iTraxx Crossover indexes, Crossover_t, on the right hand side. Newey-West standard errors are reported in parentheses with a lag truncation parameter of $1.5h$, rounded up to the next integer. *p<0.1; **p<0.05; ***p<0.01 denote significance at the 10, 5 and 1 percent levels respectively.

Table 5: Gross corporate bond issuance in the Euro zone and corporate bond purchase surprises

	Dependent variable:							
	$h = 0$		$h = 1$		$h = 2$		$h = 3$	
	Nonfinancial gross total issuance							
Main_t	-0.64^{***}		-0.45^{**}		-0.70^{***}		-0.35	
	(0.19)		(0.20)		(0.17)		(0.30)	
Crossover_t		-0.18^{***}		-0.15^{***}		-0.23^{***}		-0.04
		(0.05)		(0.04)		(0.04)		(0.09)
I_{t-1}	-0.02	-0.04	0.07	0.06	-0.19^{*}	-0.22^{**}	0.23^{***}	0.21^{**}
	(0.12)	(0.12)	(0.11)	(0.10)	(0.12)	(0.10)	(0.08)	(0.09)
Constant	18.31^{***}	18.74^{***}	16.93^{***}	17.16^{***}	21.85^{***}	22.23^{***}	14.09^{***}	14.52^{***}
	(2.60)	(2.55)	(2.23)	(2.07)	(2.19)	(2.02)	(2.04)	(2.17)
R^2	0.06	0.07	0.03	0.05	0.12	0.16	0.07	0.05
Adjusted R^2	0.03	0.04	0.004	0.02	0.10	0.14	0.04	0.02
	Nonfinancial gross IG issuance							
Main_t	-0.69^{***}		-0.43^{***}		-0.68^{***}		-0.08	
	(0.18)		(0.16)		(0.15)		(0.17)	
Crossover_t		-0.20^{***}		-0.14^{***}		-0.19^{***}		0.005
		(0.04)		(0.03)		(0.04)		(0.05)
I_{t-1}	-0.09	-0.14	0.12	0.09	-0.24^{**}	-0.28^{***}	0.20^{**}	0.20^{**}
	(0.12)	(0.12)	(0.09)	(0.08)	(0.10)	(0.10)	(0.09)	(0.09)
Constant	11.30^{***}	11.78^{***}	9.28^{***}	9.56^{***}	13.00^{***}	13.48^{***}	8.51^{***}	8.62^{***}
	(1.59)	(1.57)	(1.27)	(1.16)	(1.31)	(1.32)	(1.49)	(1.53)
R^2	0.13	0.15	0.06	0.09	0.18	0.20	0.05	0.05
Adjusted R^2	0.10	0.12	0.03	0.06	0.16	0.18	0.02	0.02
	Nonfinancial gross HY issuance							
Main_t	0.01		-0.01		-0.05		-0.26^{*}	
	(0.07)		(0.05)		(0.12)		(0.14)	
Crossover_t		0.003		-0.003		-0.05		-0.05
		(0.02)		(0.01)		(0.04)		(0.04)
I_{t-1}	0.18	0.18	-0.02	-0.02	-0.04	-0.03	0.22^{***}	0.21^{***}
	(0.11)	(0.11)	(0.12)	(0.12)	(0.09)	(0.09)	(0.07)	(0.07)
Constant	6.27^{***}	6.26^{***}	7.92^{***}	7.92^{***}	8.11^{***}	7.89^{***}	5.96^{***}	6.14^{***}
	(1.10)	(1.10)	(1.17)	(1.18)	(1.07)	(1.07)	(0.83)	(0.83)
R^2	0.03	0.03	0.001	0.001	0.004	0.02	0.08	0.06
Adjusted R^2	0.005	0.005	-0.03	-0.03	-0.03	-0.01	0.05	0.03

Notes: This table reports the results of estimating equation (2) with Refinitiv gross issuance of nonfinancial corporate bonds (total, as well as broken out by credit quality: investment grade, IG, and high-yield, HY) as the dependent variable and the surprises measured from the iTraxx Main, Main_t, or Crossover indexes, Crossover_t as explanatory variables. For $h = 0$, standard errors are heteroskedasticity-robust. Newey-West standard errors are reported in parentheses with a lag truncation parameter of $1.5h$, rounded up to the next integer. *p<0.1; **p<0.05; ***p<0.01.

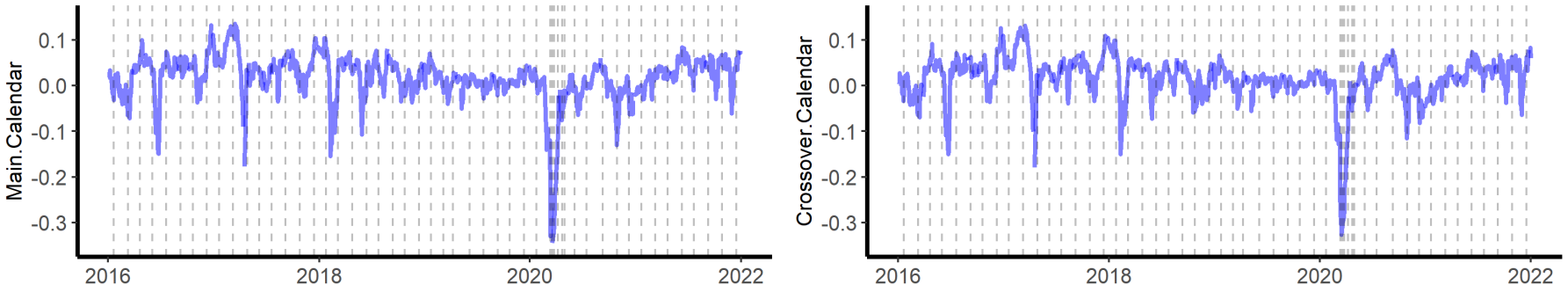
Figure 1: Time series of Main and Crossover Index spreads and ATM implied volatility



Data: courtesy of J.P.Morgan Chase & Co., Copyright 2022 - Morgan Markets

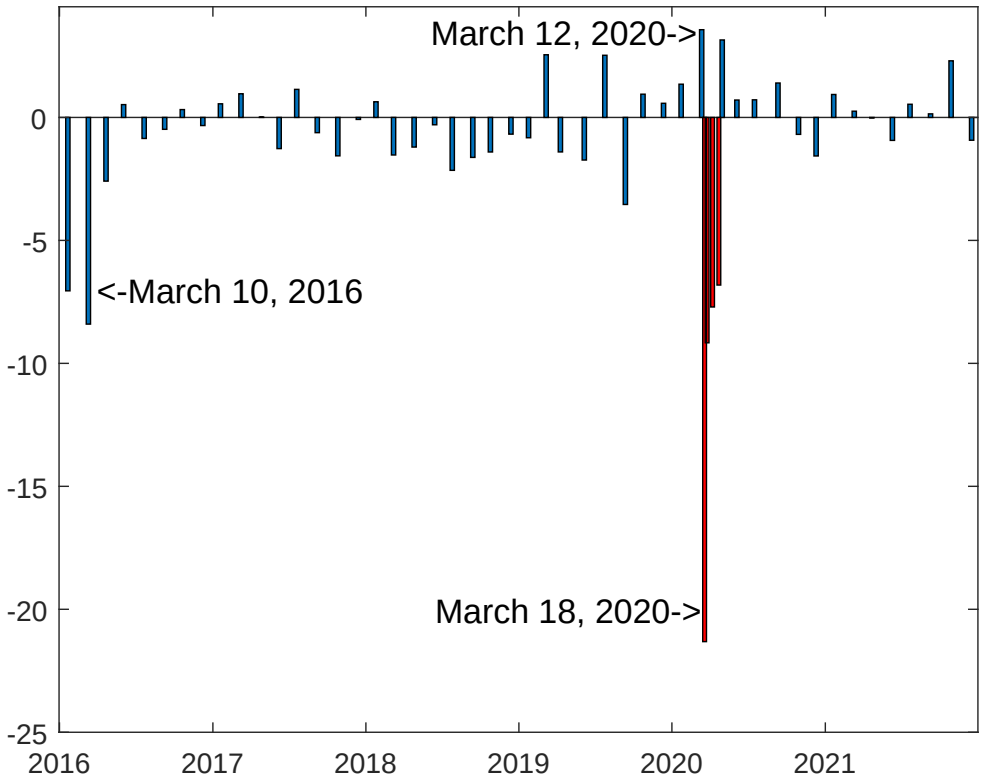
NOTE: This figure shows the time series of iTraxx indexes and implied volatilities of ATM options. For implied volatilities, the blue lines correspond to the 1 month tenor, while the red lines plot the 3 month tenor implied volatilities.

Figure 2: Time series of Main and Crossover implied volatility calendar spread



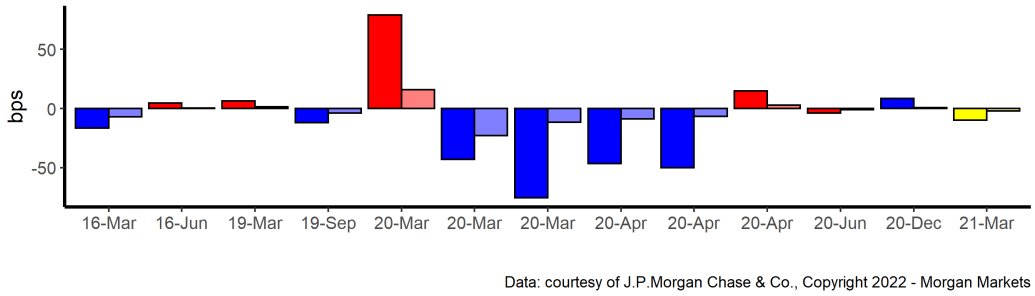
NOTE: This figure shows the time series of iTraxx implied volatility calendar spreads of ATM options.

Figure 3: Credit Surprise Measures.

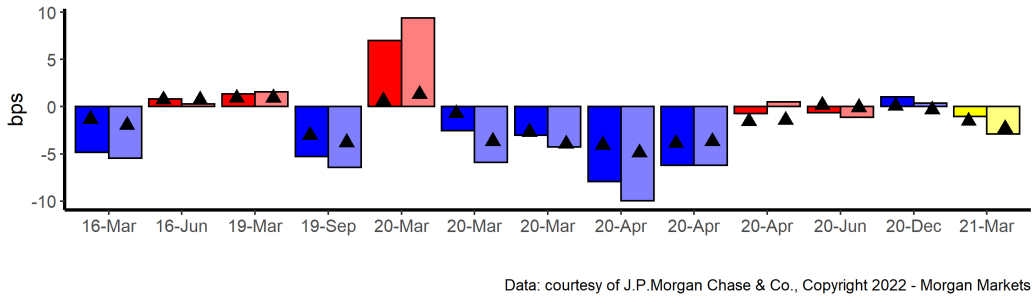


NOTE: This figure shows the time series of the credit surprise measures. For all days of Governing Council meetings from January 2016 to December 2021, we regress daily changes in 5-year iTraxx index spreads on (i) the first principal component of the press-release window OIS rate changes and (ii) the first 3 principal components of press-conference window OIS rate changes and the residual is our measure, plotted in blue. For the days of four announcements about corporate bond purchases that were not Governing Council meetings, the raw daily change in 5-year iTraxx spreads is our measure, plotted in red. In all, we have data on the credit surprises on 52 days.

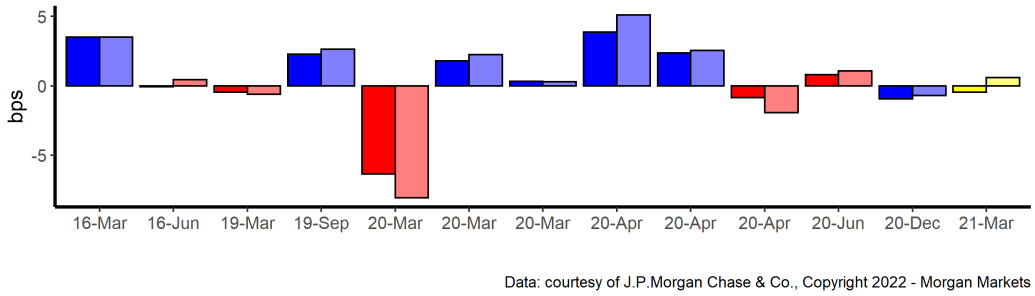
Figure 4: Reaction of iTraxx Indexes and Option Quantities to Select Events



(a) Reaction of iTraxx Indexes



(b) Reaction of Implied Volatilities



(c) Reaction of Implied Volatility Calendar Spreads

NOTE: This figure shows the reactions, as measured by the market moves on the corresponding days, of iTraxx indexes and option quantities (bars) to select hawkish (red) / dovish (blue) / mixed (yellow) monetary policy surprises. When applicable, bars show quantities for the 1 month tenor, while triangular marks indicate the responses of the corresponding 3 month tenor quantities. For each event on the horizontal axis, the left (right) bar and marker depict reactions of the Crossover (Main) quantities.

A Background on credit index derivatives and data description

A.1 Credit Default Swaps

Single-name (SN) CDS. In an SN CDS contract, a credit protection buyer makes "insurance premium" payments to a seller and, in exchange, in case of a credit event (e.g. default) the protection buyer either receives a cash settlement or delivers eligible bonds of specified notional amount in exchange for full repayment. The "insurance premium" payments are quarterly fixed coupon payments plus an upfront fee paid at the initiation of the contract. For quotation purposes, the coupons and upfront fee determine an equivalent spread via the ISDA Standard model (see ISDA (2009)). The seller of a corporate SN CDS has exposure to credit risk similar to that offered by a direct purchase of the reference entity's debt. In absence of liquidity differences between the CDS and corporate bond markets and peculiarities of the auction process, CDS spreads would accurately reflect the credit spreads of the reference entity's corporate bonds.

CDS Index. CDS indexes are in effect portfolios of individual CDS contracts. They allow investors to express a view on credit risk of credit market segments, e.g., investment grade or high yield. Similar to SN CDS, a protection buyer makes "insurance premium" payments based on the notional amount of the index, for which it obtains protection against credit events associated with each of the index constituents. The position of the protection seller is the reverse. A credit event, such as default, associated with an index constituent, triggers the following events. The protection buyer receives a payment determined via *cash settlement*, i.e. establishing the recovery price via an auction. The reference entity is removed from the index and its notional is adjusted accordingly.

The popularity of CDS indexes relative to SN CDS contracts grew in recent years. SN CDS have been in almost continuous decline from the Global Financial Crisis (GFC) of

2008. The outstanding open interest of index CDS also decreased from about $3 trillion in August 2014 to about $1.5 trillion in July 2019 (see Coughlan et al. (2019)), with most of the decline occurring in the dealer-to-dealer market segment. Following the central clearing mandate of CDS index products, associated compression greatly reduced the outstanding open interest without changing the economics of the positions (beyond reducing counterparty risk and optimizing regulatory capital). However, the traded notional of CDS index products skyrocketed from less than $2 trillion in February 2020 to $4.6 trillion in March 2020 (see Fekete and Janosik (2020)). The key drivers of CDS index proliferation, according to Markit (2014), are: (i) relative ease of trading (including operational efficiency), (ii) liquidity, (iii) transparency and industry support. Liquidity played the key role at the height of the COVID crisis in March 2020, when the traded notional of CDS indexes spiked. Thus, it is this sector of the CDS market which played the dominant role during the COVID crisis in terms of price discovery, hedging, and directional trading.

Next, we outline the fundamental features of the CDS index products. Each reference entity in an index basket is equally (or approximately equally) weighted. The composition of an index changes every six months through a process, known as the *roll*. A panel of dealers decides on the index composition by following certain policies and procedures, specific to particular indexes. At that time, the index is rolled, an *on-the-run (OTR)* index is issued. Most of the trading activity is in the OTR index, although the old indexes continue to be traded until their maturity. A typical index is rolled twice a year. CDS indexes are available for a variety of reference entity baskets and maturities. Among the most popular indexes are CDX North American Investment Grade (CDX.NA.IG), CDX North American High Yield (CDX.NA.HY), and their European counterparts – iTraxx Main Europe (iTraxx Crossover) and iTraxx Crossover Europe indexes (iTraxx Crossover). IHS Markit owns and operates these indexes.

The iTraxx Europe Main indexes (iTraxx Main) comprises one hundred twenty five of the most liquid (in terms of SN CDS) European reference entities with investment grade credit ratings (see Markit (2020)). Its high yield counterpart is the iTraxx Crossover Europe index

(iTraxx Crossover), which consists of forty five underlying CDS on European entities that must have a non-investment grade rating.[11] iTraxx Main index is quoted in spread terms and iTraxx Crossover index is quoted in price terms (with price being inversely related to the spread). iTraxx indexes roll dates are March 20 and September 20 of each calendar year.

The pricing of CDS indexes depends on the likelihood of credit events, correlations among reference entities, and loss given default. There are two broad groups of models for pricing CDS contracts - intensity models and fundamental value process models. Since the quantitative aspect of pricing is not crucial to this paper, we refer the reader to specialized literature, e.g., Schönbucher (2003) and Brigo and Morini (2005).

A.2 CDS Options

The market of options on CDS indexes traces back its origin to 2003. It experienced an increase in investor interest since the second half of 2009, and particularly since 2011. In 2019 the traded notional amount of CDX and iTraxx options was $4.8 trillion, and fell somewhat in 2020 to a still very significant $4.4 trillion (see Godec and Masabathula (2021)). iTraxx index options are European style and are mainly traded OTC.

Receiver/Call Credit Index Option gives its holder the right to enter into a *short* CDS position (i.e., buy the underlying credit risk – *receive* spreads) at the specified strike on the expiration date. *Payer/Put Credit Index Option* gives its holder the right to enter into a *long* CDS position (i.e., sell the underlying credit risk – *pay* spreads) at the specified strike on the expiration date. Moreover, options provide their holders with the *Front End Protection (FEP)* – it entitles the option holder to receive compensation for all qualifying credit events that occur in the period from the inception to the expiration of the option, conditional on the option being exercised.

Options on CDS, just like any other kind of options, are quoted in terms of implied volatilities.

[11] In general, reference entities must also satisfy other criteria to be included in the index. Markit (2020) contains a detailed exposition.

The key underlying process is the forward CDS spread (adjusted for FEP), e.g., for a 1-month option on a 5-year CDS index - it is the 1-month starting CDS spread that matures in 5-years and 1 month from now. Then, the *implied volatility* is the diffusion coefficient in the Geometric Brownian motion process for the forward CDS spread that equalizes the model and market prices of the option. As for other options, the implied volatility forms a surface that is a function of strike and maturity. The strike dimension of the implied volatility surface reflects the *skew* - greater risk-neutral (pricing) probability of widening spreads. The term structure of the implied volatility surface reflects how risk neutral probability of spreads depends on the horizon: the difference between longer and shorter maturity implied volatilities defines the *calendar spread*. For both, the skew and calendar, the distribution of the index spread is under the risk-neutral (pricing) probability measure. Consequently, skew and calendar reflect not only forward-looking investor sentiment, but also the credit volatility risk premium. For the goal of this paper, it suffices to obtain measures of market expectations via quoted option prices, and a deep excursion into pricing of CDS options is not required (e.g., Morini and Brigo (2011) contains a modern exposition of CDS option pricing).