Monetary Policy and Corporate Bond Returns*

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Abstract

We investigate the impact of monetary policy shocks on excess corporate bonds returns. We obtain a significant negative response of returns to policy shocks, which is especially strong among low-grading bonds. The largest portion of this response is related to higher expected bond returns (risk premium news), while the impact on expectations of future interest rates (interest rate news) plays a secondary role. However, the interest rate channel is dominant among high-grading bonds and Treasury bonds. Considering the two components of bond premia news, we find that the dominant channel for high-rating (low-rating) bonds is term premia (credit premia) news.

Keywords: Corporate Bond Market, Bond Returns, Return Decomposition, Monetary Policy, Bond Premia, Present-Value Relation, Credit Risk.
JEL classification: E44, E52, G10, G12.

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1 Introduction

While the impact of monetary policy actions on the stock and Treasury bond markets has been widely studied, previous research in the area of corporate bonds is considerably less dense.[1] Given the relevance of debt financing for firms and the size of the market for corporate debt, it is important to understand how monetary policy affects the pricing of corporate bonds.[2] Especially more so, since the Federal Reserve (Fed) is normalising monetary conditions in recent years, following a prolonged period of ultra-loose monetary policy.

In this paper, we conduct an empirical analysis of the effects of unanticipated monetary policy actions on the contemporaneous excess returns of corporate bonds. The main contribution of the paper lies on identifying the channels through which monetary policy shocks affect corporate bond returns. In order to get an insight into the observed reaction, we utilise a return decomposition framework that relates current realized unexpected excess bond returns to revisions in expectations ("news") about the future excess bond return (bond risk premium news), the future short-term interest rate (interest rate news), and future coupon payments (cash-flow news). The decomposition of returns to news about macro-fundamentals and expected risk premia was pioneered in bond market studies by Campbell and Ammer (1993) using Treasury bond returns. The methodology is flexible enough to allow for the incorporation of monetary policy shifts in the analysis. This enables us to decompose the response of corporate bond returns to monetary policy shocks into the effects on each of the three fundamental news components. Specifically, according to this present-value model, a tightening policy shock has a negative effect on current corporate bond excess returns, because it leads to an increase in future bond risk premia, a rise in future short-term interest rates, a decline in future coupon payments, or a combination of these three effects.

Although monetary policy proxies have been included in studies of corporate bond return predictability and empirical investigation of the determinants of the corporate-government bond

[1] Stock market studies typically find that the contemporaneous response of returns to a monetary tightening shock is negative (Thorbecke, 1997; Bernanke and Kuttner, 2005; Kurov, 2010; Kontonikas and Kostakis, 2013; Maio, 2014a; Chortareas and Noikokyris, 2017). Analyses of Treasuries show that bond yields respond significantly to shifts in the policy rate (Kuttner, 2001; Cochrane and Piazzesi, 2002; Gurkaynak *et al.*, 2005; Hanson and Stein, 2015). The literature on corporate bonds is overall less voluminous, and even thinner with regards to the impact of monetary policy actions. Previous studies tend to focus on two issues—the predictability of corporate bond returns (Fama and French, 1989; Jensen *et al.*, 1996; Baker *et al.*, 2003; Greenwood and Hanson, 2013) and the factors that determine the credit spread (Collin-Dufresne *et al.*, 2001; Elton *et al.*, 2001; Driessen, 2005; Avramov *et al.*, 2007; Gertler and Karadi, 2015; Javadi *et al.*, 2017; Nozawa, 2017). With the exception of a small number of studies that we discuss later in this section, the role of monetary policy actions in general, and policy rate shocks in particular, has been under-explored in the case of corporate bonds.

[2] The U.S. market for corporate debt is the largest in the world. The value of outstanding U.S. corporate debt at the end of 2014 was about 7.8 trillion dollars according to data from the Securities Industry and Financial Markets Association.

yield spread, we are the first to examine the contemporaneous response of corporate bond realized returns to monetary policy shocks and its decomposition into the components of excess bond returns. Our analysis focuses on monetary policy shocks. Specifically, we use surprises derived from the eight-quarter ahead Eurodollar futures contract ($MP1$) and the three-month ahead Fed funds futures contract ($MP2$). The latter measure has been utilised by Gurkaynak *et al.* (2005) in the calculation of their path factor. The former measure ($MP1$) is employed by Hausman and Wongswan (2011) and Kurov and Gu (2016). We use monthly return data on both long-term and intermediate corporate bond indices, each of them associated with six different credit ratings (AAA, AA, A, BBB, BB, and B).

By conducting simple regressions over the 1989.06–2015.12 period, we obtain a negative and significant response of excess returns on corporate bonds to monetary policy shocks. This conclusion remains valid across both medium and longer maturities as well as across different credit ratings. However, lower rating bonds are significantly more responsive to monetary shocks. Similar results are obtained when we examine monetary policy effects on unexpected excess bond returns, which are obtained from a first-order VAR.

The central part of the paper is in explaining what drives those bond return responses to monetary policy shocks by employing the return decomposition described above. To achieve that goal, we use a VAR approach, similar to the methods employed in Bernanke and Kuttner (2005) and Maio (2014a) for the case of stock returns. We provide evidence that bond premia news constitute the key driving force that explains the response of bond returns to monetary shocks, in line with previous evidence for stock market returns (see Bernanke and Kuttner (2005)). In other words, the largest share of the contemporaneous negative response of corporate bond returns to monetary policy tightening can be attributed to higher future expected excess bond returns (higher bond risk premia). The effects of monetary policy shocks on the expectations of future short-term interest rates (interest rate news) assume smaller magnitudes, albeit significant in many cases, when it comes to explaining the negative effect of policy tightening on current excess bond returns. Therefore, the bond premia channel represents an important mechanism through which monetary policy affects corporate bonds. Critically, the policy effect on bond premia news tends to be quantitatively more important for low-grade bonds and is also more statistically significant among intermediate bonds. On the other hand, the interest rate channel is more important for high-grade bonds, especially among the long-term categories. Further, the effect of policy shocks on future coupon payments (cash-flow news) tends to be quite small and insignificant in nearly all cases. In comparison, the impact of monetary shocks on the residual component of bond returns assumes a large magnitude and significance in the case of the intermediate B index. This suggests that liquidity effects, captured by the residual component of excess bond returns, play an important role in explaining the policy impact on the returns of intermediate bonds with high credit risk, exactly those that should have, a priori, lower liquidity. This result is in line with previous evidence (Friewald *et al.*, 2012; Dick-Nielsen *et al.*, 2012).

We also compute VAR-based responses to policy shocks for intermediate and long-maturity Treasury bonds. The goal is to put in perspective the results obtained for corporate bonds. The results suggest that Treasury bonds behave in a similar way to corporate bonds with low credit risk when assessing the impact of monetary policy shocks, that is, interest rate news represents the main channel of affecting bond returns. Hence, the effects of policy shocks on Treasuries are quite different from those observed for low-rating corporate bonds.

In the last part of the paper, we compute an alternative bond return decomposition, which disentangles bond premia news into one component related to term premia news (which is related to the slope of the Treasury yield curve) and another component related with credit premia news. The results indicate that credit premia news is the most important channel (in explaining the return responses to policy shocks) among low-rating bonds. On the other hand, the term premia channel tends to dominate the credit premia channel for high-quality categories, especially among intermediate bonds. These results concerning the policy effect mix among the components of bond risk premia are not totally surprising. Bonds with higher credit risk should be more sensitive to shocks in credit premia (that is, expected returns in excess to premia associated with default-free bonds), and hence that channel should play a more important role in explaining the reaction to monetary policy shocks. On the other hand, bonds with lower credit risk act more like Treasury bonds, and thus, both the corresponding returns and the policy effects on those returns, should be more sensitive to shocks in the risk premia of Treasury bonds (term premia news).

Methodologically, this paper is closely linked to the stock market study of Bernanke and Kuttner (2005), who decompose the total stock return reaction to monetary policy shocks into the components of realized stock returns. Critically, our paper extends their analysis to corporate bonds and provides additional evidence supporting their insight about an increase in risk premia in response to tight money shocks. Thus, the relation between monetary shocks and future risk premia is not confined to the stock market and also holds in the corporate bond market.[3]

[3] The study of Jensen *et al.* (1996) is one of the few papers that examine the relationship between monetary policy and expected corporate bond returns using a predictability framework. They characterise monetary policy

In related work, Nozawa (2017) decomposes yield spreads for corporate bonds into changing expected returns and changing expectation of credit losses and finds that they are both significant in explaining the variance of credit spreads. Our work differs in two main ways: first, we conduct a decomposition for excess corporate bond returns; second, and perhaps more importantly, our paper's emphasis lays on the monetary policy effects on bond risk premia.

Our work also relates to a recent study by Gertler and Karadi (2015) who find that monetary policy shocks affect private credit costs through changes in both term premia and credit spreads, consistent with the presence of financial market imperfections. In the conventional model of the transmission mechanism financial markets are frictionless and monetary policy actions transmit to private credit costs via the yield curve only. With a credit channel in operation, though, policy tightening also increases the external finance premium, thereby amplifying the overall effect.[4] Gertler and Karadi (2015) proxy the external finance premium using the method proposed by Gilchrist and Zakrajsek (2012). Our approach is conceptually linked to the aforementioned study, since the credit channel theory also underpins the main explanation for our key findings (see the discussion below). However, it is very different methodologically since we model corporate bond returns, instead of spreads, and utilise a variance decomposition framework that arises directly from the definition of bond returns. Importantly, our empirical approach enables a better comparison with previous studies that analyze the impact of monetary policy actions into the components of stock market returns, such as Bernanke and Kuttner (2005) and Maio (2014a).[5]

This paper is also related to a broad literature that studies the interaction between macro variables and corporate bond returns (Elton *et al.*, 1995; Bessembinder *et al.*, 2009; Giesecke *et al.*, 2011; Bali *et al.*, 2019). Finally, our analysis of the ZLB period using the returns decomposition approach extends the literature on the bond market effects of the Fed's unconventional policies, which typically relies upon event studies (Gagnon *et al.*, 2011; Christensen and Rudebusch, 2012; Wright, 2012; Krishnamurthy and Vissing-Jorgensen, 2011).[6]

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using a dummy variable, based on previous changes in the Fed's discount rate, which captures monetary regimes (expansive vs. restrictive cycles) rather than policy shocks. After controlling for the effect of the business conditions variables of Fama and French (1989), they find no evidence for a direct monetary effect on expected returns and only weak evidence for an indirect effect.

[4]Imperfect financial markets are characterised by frictions, such as asymmetric information or costly enforcement of contracts. The external premium is the cost differential between funds raised externally (by issuing equity or debt) and funds generated internally. It reflects the deadweight costs associated with the principal-agent problem that characterises the relationship between lenders and borrowers (Bernanke and Gertler, 1995). For example, costs related to evaluation, monitoring and collection that the lender is expected to face.

[5]It should also be noted that credit spreads are based on yields, which represent the return if the bond is held until maturity. This is relevant mainly for long-term investors. However, for investors with shorter horizon the relevant metric should be holding realized returns.

[6]The recent study by Guidolin *et al.* (2017) is an exception, in that it uses a Markov switching VAR model

Our study provides additional evidence supporting the significant role that news about expected returns play in explaining asset price fluctuations. The primacy of risk premia news is typical in previous return decomposition studies that examine stocks at the market level (Campbell, 1991; Campbell and Ammer, 1993; Bernanke and Kuttner, 2005), but not in studies that analyse Treasury bonds.[7] The latter tend to identify other components (inflation news) as the key driver of excess bond returns (Campbell and Ammer, 1993; Engsted and Tanggaard, 2007; Kontonikas *et al.*, 2019). Hence, the type of borrower (sovereign versus corporations) seems to play an important role on the reaction of investors to fundamental news. In this particular dimension (i.e., the correlation of contemporaneous unexpected excess returns with risk premium news), corporate bonds with relatively high credit risk seem to behave more like stocks, rather than Treasuries. Thus, our results also contribute towards a better understanding of the similarities and differences that corporate bonds exhibit in comparison to other major asset classes.

We now discuss how the effects of monetary policy actions may be interpreted and rationalised. Tight money can have a positive effect on expected returns by increasing the riskiness of firms, through a rise in the interest burden and the weakening of balance sheets (Bernanke and Kuttner, 2005), which can also translate into an increase in the credit spread. This adjustment is in line with the credit channel of monetary policy transmission mechanism (Bernanke and Gertler, 1995). The balance sheet component of the credit channel predicts that monetary policy tightening increases the external finance premium via a reduction in the creditworthiness of borrowers, driven by changes in their assets' values and cash flows (Bernanke and Gertler, 1989; Kiyotaki and Moore, 1997).[8] In line with the credit channel theory, several studies find that the credit spread increases (decreases) when monetary policy gets tighter (easier) (Avramov *et al.*, 2007; Chun *et al.*, 2014; Gilchrist *et al.*, 2015; Gertler and Karadi, 2015), with the effect becoming stronger as the firms' credit rating deteriorates (Cenesizoglu and Essid, 2012; Javadi

instead of an event study approach. They identify three regimes (pre-crisis, crisis, post-crisis) and find that unconventional (conventional) policy surprise, modelled as a negative shock to long-term (short-term) Treasury yields, were effective (ineffective) in reducing corporate yields during the crisis.

[7]Moreover, if we move from the market level to individual stocks (or portfolios of stocks) level, cash-flows news become the main component of unexpected excess stock returns (Vuolteenaho, 2002; Maio, 2014a).

[8]In a frictional financial market characterised by information asymmetry, the firm's balance sheet serves as the collateral in the issuance of corporate bonds; hence, a balance sheet deterioration implies a higher probability of default and lower recovery rate (Zhu, 2013). Bernanke (2007) argues that the decline in the financial health of potential borrowers during the Great Depression, due to declining output and falling prices, impeded the efficient allocation of credit. This collateral-based mechanism provides a formal rationale for the idea of "debt-deflation" (Fisher, 1933): due to an unanticipated fall in the price level there is a decline in borrowers net worth making them suddenly un-creditworthy and leading to a decrease in investment (Bernanke and Gertler, 1989). Recent models of monetary policy consider its impact on the incentives of a corporation to default through expected inflation changes (Bhamra *et al.*, 2011), and exhibit a positive link between monetary tightening and credit spreads (Gertler and Karadi, 2013).

et al., 2017). Thus, our results are consistent with the predictions of imperfect financial market theories whereupon the bonds of riskier firms are more sensitive to monetary policy shocks.

Such risk-based explanation is also consistent with asset pricing models in which the (innovation) in a short-term interest rate (and specifically, the innovation in FFR) is a priced risk factor that helps to explain cross-sectional equity risk premia (Brennan *et al.*, 2004; Petkova, 2006; Lioui and Maio, 2014; Maio and Santa-Clara, 2017). In these multifactor models, the interest rate factor earns a negative price of risk, and thus stocks that have negative interest rate factor loading (that is, negative return responses against positive changes in interest rates) earn a higher risk premium, which translates into higher expected stock returns, relative to stocks that are uncorrelated with short-term interest rates. Moreover, stocks with more negative interest rate betas enjoy higher expected returns than stocks with less negative interest rate loadings. Since the interest rate factor should price all risky assets, it follows that bonds with more negative interest betas should earn higher expected returns than bonds with less negative loadings, which is consistent with our empirical evidence. In fact, according to our results, bonds that show larger magnitudes of the total (negative) return responses to positive policy shocks also tend to have greater positive impacts on expected future returns. In particular, the policy effects on bond returns and expected returns tend to be larger among low-rating bonds, that is, those bonds have should have larger monetary policy/interest rate risk. In fact, Lioui and Maio (2014) and Maio and Santa-Clara (2017) show that value stocks, stocks of firms that underinvest, or stocks that have underperformed in the long-term past tend to have larger interest rate risk, thus justifying their higher risk premia, in comparison to stocks with the opposite characteristics (growth stocks, stocks of firms that invest more, or stocks that performed well in the past). Typically, the former types of firms are in financial distress and should issue bonds with relatively large credit risk. Hence, this explains why the realized returns and expected returns of those bonds should be more sensitive to interest rate/monetary policy shocks in comparison to bonds with lower credit risk.

The paper proceeds as follows. Section 2 describe the data and variables employed in the empirical analysis. In Section 3, we measure the contemporaneous effect of monetary policy shocks in corporate bond returns. Section 4 shows the results for a VAR-based decomposition of the total bond return response to policy shocks into the effects on the components of excess bond returns. Section 5 shows the results from an alternative VAR-based decomposition. Section 6 concludes.

2 Data and variables

2.1 Corporate bond returns and state variables

U.S. corporate bond indices constructed by Barclays are used to calculate corporate bond returns. The Barclays indices, formerly maintained by Lehman Brothers, are often used in academic studies as proxies for the U.S. corporate bond market and represent standard benchmarks for managing bond portfolios in the asset management industry (Sangvinatsos, 2005; Abhyankar and Gonzalez, 2009). These indices capture the total holding period return, by reflecting capital gains and coupon payments, and incorporate USD-denominated, fixed-rate, taxable bonds that are publicly issued by both U.S. and non-U.S. industrial, utility, and financial firms (minimum issue size is USD 250 million). The indices are value-weighted and rebalanced at the end of each month. All component bonds are marked by Barclays market-makers at the middle and end of each month.[9] Bonds with fixed-to-floating coupon rate are only included during their fixed-rate term, while inflation-linked bonds, bonds with equity type features (e.g., warrants and convertibles), and bonds with less than one year to maturity are excluded. Finally, in addition to bullet bonds, the indices include bonds with embedded put and call options and sinking fund provisions. The inclusion of bonds with embedded options in the Barclays indices is a non-trivial matter when it comes to analysing the impact of monetary policy actions on corporate bond returns. Due to changes in the value of the option, the price of such bonds is less sensitive to interest rate changes, as opposed to comparable option-free bonds. The incorporation of callable and putable bonds in the analysis should generally attenuate the reaction of corporate bond returns to the interest rate shocks that the Fed initiates. Hence, it is likely that the monetary policy elasticities that we capture in the next sections would have been stronger in the absence of bonds with embedded options.[10]

The twelve Barclays indices that we use represent portfolios of corporate bonds with different maturity and credit rating characteristics. Specifically, we consider indices of investment grade long-term (L) and intermediate (I) maturity corporate bonds (AAA, AA, A and BBB ratings)

[9]The use of model/matrix-based pricing is limited to a minority of the bonds that enter the Barclays indices. Specifically, up to 3,000 actively traded benchmark corporate bonds are priced by Barclays Capital traders on a daily basis, while the remaining less liquid bonds are priced using an Option Adjusted Spread model or issuer curve that is generated using these actively quoted benchmark bonds. For more details on the construction of the Barclays indices see Goltz and Campani (2011) and the information that accompanied the rebranding of the Lehman indices in November 2008, available at https://index.barcap.com/download?rebrandingDoc.

[10]Callable bonds constitute the majority of bonds with embedded options. Their share in the market for corporate bonds has fluctuated significantly over time. It was very high until the late 1980s, decreasing to a historical low by the mid-1990s, and then increasing again over the past decade. As Gilchrist and Zakrajsek (2012) argue, limiting the sample to non-callable corporate bonds would significantly limit the available time-span. Nozawa (2017) makes the same argument to support the inclusion of callable bonds in the sample and finds that his main results are not driven by the callability feature.

as well as non-investment grade corporate bonds (BB and B ratings). Bond ratings are assigned using the middle rating of Moodys, S&P and Fitch, or the lowest rating if only two ratings are available. Bonds included in the intermediate maturity indices have maturity of one to less than ten years, while long-term indices are based on bonds with maturity of ten years and more. Monthly data on the Barclays indices (end of month observations) is collected over the period 1989.05–2015.12 from Datastream. The bond data sample commences during the early years of the Great Moderation period, while its latter part contains the recent global financial crisis and its aftermath.[11]

To compute monthly excess corporate bond returns (x_n), we take the first difference in the log of the Barclays index and subtract the continuously compounded one-month Treasury bill rate (y) that we obtain from the Centre for Research in Security Prices (CRSP).[12] The descriptive statistics in Table 1 indicate that both the mean and standard deviation of excess returns on long-term corporate bonds are higher than those of intermediate maturity bonds. As the rating declines, average returns tend to increase, although not fully monotonically. Non-investment grade bonds (BB and B) also tend to have more volatile returns than investment grade bonds. These patterns are also consistent with the graphical evidence in Figure 1, which plots the (normalised) level of the Barclays indices. The maximum and minimum values of excess bond returns, shown in Table 1, in almost all cases materialise at the peak of the last financial crisis, between September and December of 2008.

Table 2 reports the correlation coefficients between excess corporate bond returns across different maturities and ratings. Two stylised facts can be identified. First, correlations are stronger between bond returns of similar maturity. For example, while the correlation between long-term AAA and AA excess bond returns is 0.92, it declines to 0.78 for when the latter are replaced with intermediate maturity AA returns. Second, the magnitude of the correlation coefficients increases when the bonds that we consider are more alike in terms of credit quality. For instance, the correlation coefficient between intermediate maturity AAA and AA excess bond returns is 0.94, dropping to 0.15 when we use, instead of the latter, intermediate maturity B returns.

In addition to corporate bond excess returns, the Treasury bill rate, and proxies for monetary policy shocks, the empirical analysis conducted in the following sections requires data on several other variables. $\Delta q_t \equiv q_t - q_{t-1}$, with $q = \ln(Q)$, is the log growth in the recovery coupon rate.

[11]By the mid-1980s, Volcker's disinflation was largely accomplished with inflation declining sharply from 10% (per annum) at 1980 to 3% at 1983. This development allowed interest rates to decline and ushered the Great Moderation era that was characterised by lower macroeconomic volatility.

[12]n denotes the average maturity of the bond index.

The latter is defined as $Q = 1 - L$, where L represents the default or loss rate (i.e., the fraction of the fixed coupon that is not paid by the borrower). In the absence of monthly data, annual data on corporate default rate per rating category is obtained from S&P and transformed into monthly frequency by dividing by twelve and maintaining the same value over the calendar year.[13] The data on default losses are not provided for different maturities. For the high quality bonds (AAA and AA), the historical average annual default rate is either zero or close to zero, while at the riskiest category of our cross-section (B-rated bonds) annual default rates reached 18% in 2001, and also recorded double-digit values in several other instances of our sample. The index-specific default spread (def) is equal to the corporate bond yield associated with the given index minus the twenty-year (five-year) Treasury bond yield for the case of long-term (intermediate) bonds. Hence, each of the 12 bond indices has a different measure of def. As shown in Table 1, both the mean and the volatility of the default spread increase monotonically as the credit quality deteriorates.

The term spread ($term$) represents the difference between the twenty-year (five-year) Treasury bond yield and the one-month Treasury bill rate for the case of long-term (intermediate) bonds. Thus, the term spread varies across long-term ($term^L$) and intermediate ($term^I$) bonds. The inflation rate (π) is calculated as the log difference of the Consumer Price Index. Treasury bond yield and CPI data are obtained from the Federal Reserve Bank of St Louis database (FREDII).[14] Finally, returns on Treasuries are obtained from CRSP; $Tr5y$ ($Tr20y$) denotes five-year (twenty-year) Treasury bond excess returns. The results in Table 1 indicate that both the mean and volatility of the excess returns of the two Treasury bonds are not very different from the corresponding sample moments associated with the highest-rating corporate bonds (AAA and AA) with similar maturity.

2.2 Monetary policy shocks

Monetary policy conducted during the period that we investigate is characterised by targeting of the Fed Funds rate (FFR), the interest rate on overnight loans of reserves between banks, but also by increasing transparency and reliance on forward guidance (Bernanke and Blinder,

[13]The S&P data is available at: https://www.capitaliq.com. Monthly data on default rates per rating category is not publicly available. Essentially, this frequency conversion procedure assumes that the default rate is stable across the year and also that the number of available bonds in each category does not change substantially from one month to another.

[14]Due to lack of data availability at FREDII, for the period prior to January 1993 data on the twenty-year Treasury bond yield is obtained from the zero-coupon bond yield dataset of Gürkaynak *et al.* (2007) available at https://www.federalreserve.gov/pubs/feds/2006/200628/200628abs.html. All the variables that we use are stationary according to the results from Augmented Dickey-Fuller and Phillips Perron unit root tests (results available upon request).

1992; Bernanke and Mihov, 1998; Romer and Romer, 2004). While in conventional analyses of the monetary policy transmission mechanism the central bank adjusts the current short-term interest rate, over time Fed has increasingly relied on communication to influence market beliefs about the expected path of short-term rates (Gurkaynak *et al.*, 2005; Gertler and Karadi, 2015; Nakamura and Steinsson, 2018). The idea that monetary policy is, at least partly, about managing expectations came to be accepted by both academics and policymakers and has generated a large literature on the effects of central bank communication (Blinder et al., 2008). During the recent financial crisis, the Fed cut interest rates several times.[15] Once the ZLB was reached in December 2008 and until the end of the sample in December 2015, there were no further FFR changes. Forward guidance became the only way the Fed could affect market expectations about future interest rates in the absence of unconventional credit market interventions (Gertler and Karadi, 2015).[16]

Our measures of monetary policy surprises (MP) allow us to capture shocks in forward guidance. They are based on changes in the path of future interest rates in response to FOMC announcements. In particular, we use surprises derived from the eight-quarter ahead Eurodollar futures contract ($MP1$) and the three-month ahead Fed funds futures contract ($MP2$). The latter measure has been utilised by Gurkaynak *et al.* (2005) and Nakamura and Steinsson (2018) in the calculation of their path factor. Gertler and Karadi (2015) highlight the importance of $MP2$ as an external instrument in their VAR analysis. The former measure ($MP1$) is employed by Hausman and Wongswan (2011) and Kurov and Gu (2016). Changes in the implied rate of Fed funds and Eurodollar futures contracts, that expire at a subsequent date in the future, around FOMC announcements can be considered as a proxy for new information about the path of monetary policy.[17] The window around FOMC announcements should be narrow to ensure that changes in the futures rates reflect only news about the FOMC decision. Since January 1995 for the case of Fed funds futures, and January 1994 for Eurodollar futures, we use intraday

[15] The start of the financial crisis is dated to August 2007 when doubts about financial stability emerged and the first major central bank interventions in response to increasing interbank market pressures took place (Brunnermeier, 2009; Kontonikas *et al.*, 2013). Following that, on September 2007 the Fed proceeded to the first major FFR cut (0.5%) since 2003, initiating a long cycle of monetary expansion.

[16] The Fed put significant effort in assuring the public and financial markets about its intention to keep the policy rate at near zero in the future. Initially, the language was qualitative with post-meeting statements of the Federal Open Market Committee (FOMC) including phrases such as the FFR will remain near zero for "an extended period" (FOMC statement of March 18, 2009). It then evolved to date-based guidance, specifying future dates such as "at least through mid-2015" (September 13, 2012). Finally, a threshold-based approach was adopted linking the first rate increase to developments in inflation and unemployment.

[17] The implied futures rate is 100 minus the contract price. The 30-day Federal funds futures contracts that we use are traded on the Chicago Board of Trade (CBOT). The futures settlement price is based upon the monthly average effective FFR which follows very closely the target rate (Bernanke and Kuttner, 2005). Eurodollar futures are also traded on the CBOT and reflect market beliefs about the three-month LIBOR expected to prevail at expiration of the futures contract.

data, sourced from CBOT, and calculate changes over a thirty-minute window (-10,20). In the earlier sample, due to the absence of intraday data, we use a daily window which considers the closing price at the FOMC announcement day relative to the previous day's close (Bloomberg source).[18]Figure 2 plots our measures of monetary policy surprises. Some of the largest shocks occurred during, or near, periods of economic slowdown. These pronounced shocks were typically of monetary expansionary nature, that is, associated with negative values of the MP indicator. $MP1$ is more active during the ZLB period, compared to $MP2$, capturing revisions in relatively longer-term interest rate expectations.

Monetary policy surprises are included as an exogenous variable in the VAR model of Section 4. The exogeneity assumption would not be valid if the Fed responds contemporaneously to developments in the market for corporate bonds (reverse feedback) and/or if the Fed and corporate bonds jointly and contemporaneously respond to economic news (simultaneity). With respect to reverse feedback, while modifications of the Taylor rule have been recently proposed, whereby the Fed responds to measures of financial stress including credit spreads (Taylor, 2008; Curdia and Woodford, 2010), these rules refer to a systematic response involving actual and expected FFR changes, as opposed to unexpected changes (Cenesizoglu and Essid, 2012). The use of shocks is important not only to ameliorate endogeneity concerns, but also because anticipated policy actions should be already priced in the bond market.

In order to examine whether policy surprises react to economic news, we follow Bernanke and Kuttner (2005) and regress these surprises on variables that capture news about nonfarm payrolls, industrial production growth, retail sales growth, core and headline CPI inflation,

$$MP_{t+1} = \alpha + \boldsymbol{\beta}'\boldsymbol{\psi}_{t+1} + \varepsilon_{t+1}, \tag{1}$$

where $\boldsymbol{\psi}$ denotes the vector of economic indicators. Economic news are calculated as the difference between the actual value that was released for a given key macroeconomic variable and the median forecast from Reuters Economic Polls. To save space, the results are reported in the internet appendix.[19] We do not find a significant contemporaneous monetary policy response to macroeconomic surprises. Hence, the exogeneity assumption should not be significantly restric-

[18]Following Gertler and Karadi (2015), we convert the futures' surprises on FOMC days into monthly average surprises before proceeding to the monthly estimations. To account for the fact that the day of the FOMC meetings can vary over the month, and that surprises occurring at the end of the month are expected to have smaller influence, we proceed in two steps. First, for each day of the month, surprises on any FOMC days during the last 31 days are cumulated (e.g., on February 2015, we cumulate all the FOMC day surprises since January 2015). Second, these monthly surprises are averaged across each day of the month.

[19]Due to data availability on the macroeconomic surprises, the sample period for these regressions commences in 1991.10.

tive in our case.

We employ two additional measures of monetary policy shocks derived from changes in the two-year Treasury yield ($MP3$) and the 30-day Fed funds futures contract ($MP4$). The former is the monetary policy shocks proxy proposed by Hanson and Stein (2015). Specifically, we measure news about the expected medium-term path of interest rates using the change in the two-year nominal Treasury yield on FOMC announcement dates.

Finally, we use $MP4$, which is based on the methodology proposed by Kuttner (2001) and also used in several studies which focused on the pre-ZLB reaction of bonds to monetary surprises (Bernanke and Kuttner, 2005; Bredin *et al.*, 2010; Cenesizoglu and Essid, 2012). In particular, $MP4$ for month $t+1$ is calculated as follows,

$$MP4_{t+1} = \frac{1}{D}\sum_{d=1}^{D} i_{t+1,d} - f^{1}_{t,D}, \tag{2}$$

where $i_{t+1,d}$ denotes the target FFR on day d of month $t+1$ and $f^{1}_{t,D}$ is the rate corresponding to the one-month futures contract on the last (D^{th}) day of month t. The implied futures rate is 100 minus the contract price.

3 Monetary policy effects on corporate bond returns: a simple regression approach

In this section, we estimate the contemporaneous reaction of monthly excess corporate bond returns to the two main measures of monetary policy shocks ($MP1$ and $MP2$). We start with the following baseline regression model,

$$x_{n,t+1} = \gamma_0 + \gamma_1 MP_{t+1} + u_{t+1}, \tag{3}$$

where x_n denotes excess returns on the Barclays corporate bond index with average maturity of n, MP represents the monetary policy shock, and u denotes the component of excess returns that is not explained by monetary policy surprises.

The model is estimated by ordinary least squares (OLS), for each of the twelve Barclays indices that we consider, that is, long-term and intermediate maturity bonds with AAA, AA, A, BBB, BB and B ratings. The t-statistics are calculated using heteroskedasticity-consistent standard errors (White, 1980). The results in Table 3 show that the slope coefficient, γ_1, exhibits a negative sign across both monetary policy proxies, and all corporate bond ratings and maturities. The effect of monetary policy surprises is strongly significant (5% or 1% level) in most cases, especially when the three-month ahead Fed funds futures-based proxy ($MP2$) is considered. Thus, the results indicate that excess corporate returns respond negatively to a tightening shock. The responsiveness of intermediate corporate bond returns to monetary policy shocks tends to be stronger in comparison to that of long maturity bonds, as indicated by the statistical significance of the slopes estimates, especially when we consider $MP1$. Moreover, there is a clear tendency for the reaction of returns to MP to increase in magnitude, albeit not always fully monotonically, as we move from higher grade towards lower grade bonds. Hence, lower rating bonds are more responsive to monetary shocks.

To benchmark our results, we re-estimate Equation (3) replacing corporate bond excess returns with those of five-year and twenty-year Treasuries. The results are reported in the final two columns of Table 3. They show that the reaction of excess Treasury returns to a tightening surprise is negative and statistically significant only when $MP2$ is employed along with five-year Treasury bonds ($Tr5y$). Not surprisingly, the Treasury bonds behave similarly to high-rating corporate bonds (AAA and AA) regarding the reaction to monetary policy shocks. Previous studies also show that the effect of monetary policy shocks on Treasuries tends to decline at longer maturities (Kuttner, 2001; Hanson and Stein, 2015; Nakamura and Steinsson, 2018).[20]

We proceed by adding several business conditions controls to the regression above in order to assess the robustness of the baseline findings. These controls include two important indicators of business conditions proposed by Fama and French (1989), the default spread (def) and the term spread ($term$).[21] We also include the inflation rate (π). Thus, the following augmented regression model is estimated:

$$x_{n,t+1} = \gamma_0 + \gamma_1 MP_{t+1} + \gamma_2 def_{t+1} + \gamma_3 term_{t+1} + \gamma_4 \pi_{t+1} + v_{t+1}, \tag{4}$$

The results in Table 4 indicate that the main findings from the baseline estimations remain robust. The impact of monetary policy shocks on excess bond returns is negative and statistically significant in most instances, which is consistent with the evidence from the univariate regressions discussed previously. As the rating and maturity declines, the sensitivity of bond

[20] We also considered the effects of monetary policy shocks on expected inflation and find that five-year and twenty-year ahead inflation expectations react negatively to tightening surprises using $MP2$ (results available upon request). Expected inflation is obtained from the Cleveland Fed model which uses Treasury yields, inflation data, inflation swaps, and survey-based measures of inflation expectations (https://www.clevelandfed.org/our-research/indicators-and-data/inflation-expectations.aspx). Finding that longer-term inflation expectations decline in response to a contractionary monetary policy shock is consistent with previous studies, including Gürkaynak *et al.* (2010) and Nakamura and Steinsson (2018).

[21] These variables are also used as risk factors that help to price cross-sectional bond risk premia (see Fama and French, 1993 and Gebhardt *et al.*, 2005).

returns to policy surprises tends to rise (as indicated by the significance and magnitude of the slope estimates), also in line with the results for the single-explanatory factor regressions.

Results tabulated in the internet appendix show that the effect of monetary policy shocks, when using the $MP3$ metric, is statistically significantly across almost all ratings and maturities. In line with the baseline results, there is a tendency for the reaction of returns to $MP3$ to increase in magnitude as the credit rating deteriorates. On the other hand, the results associated with $MP4$ indicate that the return responses to monetary shocks are not significant (at the 10% level) among the majority of long-term bonds. The exception is the case of B^L, in which the slope estimate is negative and largely significant (1% level). However, we find a significant (5% level) negative effect of policy shocks on the excess returns of most intermediate bonds.

Overall, the empirical findings in this section are indicative of a negative contemporaneous reaction of excess corporate bond returns to monetary tightening shocks.

4 Monetary policy effects on corporate bond returns: a VAR-based approach

In this section, we use an empirical framework that decomposes corporate bond excess returns into their fundamental components in an effort to explain the negative reaction of bond returns to monetary policy shocks, which was documented in the last section.

4.1 Components of realized excess bond returns

By modifying the zero-coupon bond framework of Campbell and Ammer (1993) for the case of coupon paying bonds, we can decompose current period unexpected excess bond returns into news about future excess bond returns, news about future short-term interest rates, and news about future coupon payments (recovery rates),

$$\begin{aligned}\tilde{x}_{n,t+1} &\approx -(E_{t+1}-E_t)\sum_{j=1}^{n-1}\rho^j x_{n-j,t+1+j} - (E_{t+1}-E_t)\sum_{j=1}^{n-1}\rho^j y_{t+1+j} + (E_{t+1}-E_t)\sum_{j=0}^{n-1}\rho^j \Delta q_{t+1+j} \\ &\equiv -\tilde{x}_{x,t+1} - \tilde{x}_{y,t+1} + \tilde{x}_{q,t+1}, \end{aligned} \tag{5}$$

where the last equality defines the variables of interest. $\tilde{x}_{n,t+1} \equiv (E_{t+1}-E_t)x_{n,t+1}$ represents the unexpected one-period log return on a n-period bond (or equivalently a bond index with an average maturity of n periods) in excess of the continuously compounded one-period nominal risk-free rate; $\tilde{x}_{x,t+1}$ denotes revisions in expectations regarding future excess bond returns (risk premium news); $\tilde{x}_{y,t+1}$ denotes revisions in expectations about the future log nominal short-term interest rate (interest rate news); and $\tilde{x}_{q,t+1}$ represents revisions in expectations on future coupon payments (cash-flow news).

In the internet appendix, we provide more details on the derivation of the present-value relation presented above.[22] The intermediate maturity Barclays corporate bond index has an average maturity of five years, while that of the long-term index is 24 years. Hence, for intermediate maturity bonds we set $n = 60$ months, while for long-term bonds $n = 288$. ρ is the linearization constant, a number marginally smaller than one, which is linked to the average yield to maturity of each bond index. The estimates of ρ are in a tight range, varying between 0.992 (B index) and 0.995 (AAA and AA indices) in the case of long-maturity bonds. In the case of intermediate bonds, the corresponding range is 0.992-0.996.[23]

Equation (5) is a dynamic accounting identity that arises from the definition of bond returns and imposes internal consistency on expectations. It is not a behavioural model containing economic theory and asset pricing assumptions and implications. The decomposition implies that negative unexpected excess bond returns must be associated with increases in expected future excess returns during the life of the bond, rises in expected future short-term interest rates, declines in expected future coupon payments, or a combination of these three effects. Since this present-value relation is based on a first-order Taylor approximation, it does not hold exactly. A priori, the cash-flow news term should be relatively small in most cases since our empirical analysis focuses on relatively high quality corporate bonds. Specifically, for the AAA, AA, and A rating categories under consideration the historical average default rates are either zero (AAA) or very close to zero (as discussed in Section 2). However, for the bonds with lower credit rating (especially, BB and B) the cash-flow component can be non trivial.

We account for the fact that Equation (5) does not hold exactly. First, there is approximation error derived from the first-order Taylor equation, which can be substantial in some cases. For example, the coupon payments of the bond indices are not directly observed. Instead, we provide indirect estimates of the coupon recovery rates by using the S&P expected loss rates for bonds with similar credit rating. This can originate considerable estimation error in the cash-flow news component. Second, there might be other effects in bond prices (e.g., illiquidity of corporate bonds that originate stale prices) that prevent the above approximation to hold relatively well. Hence, we account for a residual term ($\tilde{x}_{r,t+1}$) that makes the decomposition to be exactly

[22]For a decomposition of the excess returns of consol bonds, see Engsted and Tanggaard (2001) and Abhyankar and Gonzalez (2009).

[23]We set $\rho = \frac{1}{1+\overline{Y_n}}$, where $\overline{Y_n}$ is the average yield to maturity of a given bond index. This definition of ρ gives a good approximation for returns on bonds selling close to par (Campbell *et al.*, 1997).

satisfied:

$$\tilde{x}_{n,t+1} = -\tilde{x}_{x,t+1} - \tilde{x}_{y,t+1} + \tilde{x}_{q,t+1} + \tilde{x}_{r,t+1}. \tag{6}$$

The implementation of the return decomposition requires empirical proxies for the unobserved components of excess bond returns. Following Campbell (1991) and Campbell and Ammer (1993), we link these multiperiod expectations to the stationary dynamics of a vector autoregressive model (VAR). Specifically, a first-order VAR is employed, which contains excess bond returns, the one-month Treasury bill rate, the log growth in coupon recovery rates, and other variables that help to forecast these three variables,

$$\mathbf{z}_{t+1} = \mathbf{A}\mathbf{z}_t + \mathbf{w}_{t+1}, \tag{7}$$

where all the variables in the VAR are demeaned.

In the above equation, $\mathbf{z}_t$ is a vector of endogenous state variables; $\mathbf{A}$ denotes a matrix of VAR parameters; and $\mathbf{w}_{t+1}$ is a vector of forecasting errors. In the benchmark six-variable VAR, the state vector is given by $\mathbf{z}_t = [def_t, term_t, inf_t, \Delta q_t, y_t, x_{n+1,t}]'$, where all the variables are defined as in Section 2.[24] We choose to have a parsimonious VAR specification given the relatively small size of our sample.[25] The VAR model that is used to extract news is assumed to contain all relevant information that investors may have when forming expectations about the future. If investors have additional information that is not present in the state vector, the relative importance of the residual component may be overstated.[26] The presence of the default spread and the term spread in the state vector is consistent with previous work (Chen and Zhao, 2009; Keim and Stambaugh, 1986; Fama and French, 1989; Greenwood and Hanson, 2013).[27] From a theoretical background, these two variables should forecast an increase in bond risk premia (see Campbell *et al.*, 1997). In the robustness analysis, we show that our baseline findings are robust to the incorporation of stock market predictor variables in the VAR state vector.

The forecast errors and the estimated parameters from the VAR model can be used to

[24]In our benchmark analysis, we follow most of the literature on asset return decompositions by specifying a first-order VAR (Campbell, 1991; Campbell and Ammer, 1993; Bernanke and Kuttner, 2005; Maio and Philip, 2015). The case of higher-order VARs is discussed in the internet appendix.

[25]Similar to the regression analysis in Section 3, the VAR state vector associated with each bond index contains a different version of def. Likewise, we use $term^L$ and $term^I$ in the VAR specifications associated with long-term and intermediate bonds, respectively.

[26]Campbell and Ammer (1993) point out that the sign of the possible bias is uncertain since it will depend on the covariances between state variables and any omitted variables.

[27]Baker *et al.* (2003), Abhyankar and Gonzalez (2009), and Lin *et al.* (2018) add inflation and/or the real interest rate in the list of potential predictors. On the other hand, Maio (2014b) uses the change in the Fed funds rate to forecast excess bond returns.

compute unexpected excess bond returns and the first three news components identified in Equation (5) as follows,

$$\tilde{x}_{n,t+1} = \mathbf{s}_x'\mathbf{w}_{t+1}, \quad (8)$$

$$\tilde{x}_{x,t+1} = \mathbf{s}_x'(\rho\mathbf{A} - \rho^n\mathbf{A}^n)(\mathbf{I} - \rho\mathbf{A})^{-1}\mathbf{w}_{t+1}, \quad (9)$$

$$\tilde{x}_{y,t+1} = \mathbf{s}_y'(\rho\mathbf{A} - \rho^n\mathbf{A}^n)(\mathbf{I} - \rho\mathbf{A})^{-1}\mathbf{w}_{t+1}, \quad (10)$$

$$\tilde{x}_{q,t+1} = \mathbf{s}_q'(\mathbf{I} - \rho^n\mathbf{A}^n)(\mathbf{I} - \rho\mathbf{A})^{-1}\mathbf{w}_{t+1}, \quad (11)$$

where $\mathbf{I}$ is the identity matrix and $\mathbf{s}_x' = [0, 0, 0, 0, 0, 1]$ is an indicator vector that picks the position of $x_{n+1,t}$ in the VAR. $\mathbf{s}_y' = [0, 0, 0, 0, 1, 0]$ and $\mathbf{s}_q' = [0, 0, 0, 1, 0, 0]$ are defined in an analogous way.

The residual component is given by

$$\tilde{x}_{r,t+1} = \tilde{x}_{n,t+1} + \tilde{x}_{x,t+1} + \tilde{x}_{y,t+1} - \tilde{x}_{q,t+1}. \quad (12)$$

These equations state that unexpected excess bond returns represent the residuals from the VAR forecasting model for excess returns. Risk premium news, interest rate news, and cash-flow news are computed directly from the VAR estimates using the formulas above. Hence, none of these three major return components is backed up as the residual of the return decomposition. This avoids the potential problem of allocating excessive weight to one of these components by making it the residual component (see Chen and Zhao, 2009). Under this identification, the residual component will capture only measurement error in the main news components (e.g., cash-flow news), as well as other effects not captured by the present-value model (e.g., liquidity in the bond market).[28]

In the case of the AAA bond indices, $\Delta q_t = 0$ for all months in our sample. Hence, the state vector is given by $\mathbf{z}_t = [def_t, term_t, inf_t, y_t, x_{n+1,t}]'$. This implies that there is no cash-flow news component ($\tilde{x}_{q,t+1} = 0$), and the unobserved components of the return decomposition are

[28] Previous studies that conduct bond returns' decompositions typically identify one of the fundamental news components (e.g., interest rate news) as the residual component (e.g., Engsted and Tanggaard, 2001; Abhyankar and Gonzalez, 2009; Bredin *et al.*, 2010).

estimated as follows,

$$\begin{aligned}
\tilde{x}_{n,t+1} &= \mathbf{s}'_x \mathbf{w}_{t+1}, \\
\tilde{x}_{x,t+1} &= \mathbf{s}'_x (\rho \mathbf{A} - \rho^n \mathbf{A}^n)(\mathbf{I} - \rho \mathbf{A})^{-1} \mathbf{w}_{t+1}, \\
\tilde{x}_{y,t+1} &= \mathbf{s}'_y (\rho \mathbf{A} - \rho^n \mathbf{A}^n)(\mathbf{I} - \rho \mathbf{A})^{-1} \mathbf{w}_{t+1}, \\
\tilde{x}_{r,t+1} &= \tilde{x}_{n,t+1} + \tilde{x}_{x,t+1} + \tilde{x}_{y,t+1}.
\end{aligned}$$

with $\mathbf{s}'_x = [0, 0, 0, 0, 1]$ and similarly for the other indicator vectors.

From Equation (6), it follows that the total variance of unexpected excess bond returns can be decomposed into the sum of the four variances plus the covariance terms:

$$\begin{aligned}
Var\left(\tilde{x}_{n,t+1}\right) = \; & Var\left(\tilde{x}_{x,t+1}\right) + 2Cov\left(\tilde{x}_{x,t+1}, \tilde{x}_{y,t+1}\right) - 2Cov\left(\tilde{x}_{x,t+1}, \tilde{x}_{q,t+1}\right) - 2Cov\left(\tilde{x}_{x,t+1}, \tilde{x}_{r,t+1}\right) \\
& + Var\left(\tilde{x}_{y,t+1}\right) - 2Cov\left(\tilde{x}_{y,t+1}, \tilde{x}_{q,t+1}\right) - 2Cov\left(\tilde{x}_{y,t+1}, \tilde{x}_{r,t+1}\right) \\
& + Var\left(\tilde{x}_{q,t+1}\right) + 2Cov\left(\tilde{x}_{q,t+1}, \tilde{x}_{r,t+1}\right) + Var\left(\tilde{x}_{r,t+1}\right). \qquad (13)
\end{aligned}$$

In order to evaluate the relative importance of each of the components of excess bond returns, we normalise each of the variance and covariance terms in the previous equation by the total variability of excess returns ($Var\left(\tilde{x}_{n,t+1}\right)$). Hence, these estimates represent the fraction of $Var\left(\tilde{x}_{n,t+1}\right)$ attributed to each variance or covariance term. Following Maio (2014a), we use a bootstrap simulation to compute empirical p-values for the weights in the variance decomposition. This simulation assumes that the key variables in the VAR ($x_{n,t+1}$, y_{t+1}, and Δq_{t+1}) are not predictable by the six state variables in the system. The p-values associated with the variance terms represent the fractions of pseudo samples in which the estimate of a given share in the variance decomposition (e.g., $Var\left(\tilde{x}_{y,t+1}\right)$) is larger than the corresponding sample estimate. We use single-sided p-values because the signs of the weights associated with all the variance terms in the decomposition should be positive. To assess the significance of the weights corresponding to the covariance terms, we use double-sided p-values, as the respective signs are undetermined a priori. Full details on the bootstrap simulation are provided in the internet appendix.[29]

[29] Other studies have used the delta method in order to calculate the standard errors for the weights of the terms in the variance decomposition (see Campbell and Ammer, 1993; Barr and Pesaran, 1997; Bernanke and Kuttner, 2005). However, we argue that the bootstrap-based inference provides a more correct and robust inference in our case. First, our sample is relatively short. Second, some of the VAR state variables are quite persistent (e.g., y). Both issues make the asymptotic inference invalid. These problems might be magnified under the delta method, as the matrix of derivatives may be poorly estimated.

For both AAA^L and AAA^I, the variance decomposition stated above specializes to

$$\begin{aligned} Var(\tilde{x}_{n,t+1}) &= Var(\tilde{x}_{x,t+1}) + 2Cov(\tilde{x}_{x,t+1}, \tilde{x}_{y,t+1}) - 2Cov(\tilde{x}_{x,t+1}, \tilde{x}_{r,t+1}) \\ &\quad + Var(\tilde{x}_{y,t+1}) - 2Cov(\tilde{x}_{y,t+1}, \tilde{x}_{r,t+1}) + Var(\tilde{x}_{r,t+1}). \end{aligned}$$

Table 5 presents the estimates of the excess return forecasting equation in the benchmark VAR for the 12 bond indices. The statistical significance of the slope estimates is assessed by using t-ratios based on Newey and West (1987) standard errors (computed with one lag). The results can be summarised as follows. First, the one-month ahead forecasting power of the VAR is quite reasonable. Apart from the long-term AAA bond index (with an explanatory ratio around 2%), the adjusted R^2 values lie between 4% (for the intermediate AAA index) and 17% (for the long-term BB index), which is in line with previous evidence from bond return predictability studies.[30] Hence, the forecasting power tends to be slightly higher in the case of intermediate maturity bonds (compared to long maturity bonds), and also tends to decline with the bond rating. For example, the fit in the equations for B^L and B^I is 12% and 13%, respectively, which compare with explanatory ratios of 2% and 4% in the equations for AAA^L and AAA^I, respectively.

Second, the term spread predicts a significant rise in bond risk premia across most bond indices, in line with theory. The few exceptions occur for the lower rating intermediate bonds (BB^I and B^I), in which cases the positive slopes are not statistically significant. Hence, the predictability that stems from *term* tends to be somewhat larger among long-term maturity bonds and also among higher rating bonds, as indicated by the significance of the respective slope estimates. Third, the default spread also forecasts an increase in bond risk premia, in line with theory, but the statistical significance is clearly more modest in comparison with the term spread: only for half of the bond indices do we detect statistical significance (at the 10% or better level). Indeed, the predictive power associated with def tends to be significant only among lower rating bonds (BBB, BB, and B).

Fourth, in agreement with Chen and Zhao (2009) and Baker *et al.* (2003), we find that future excess bond returns are positively related to the level of the current short-term interest rate. Such predictability pattern is stronger among long maturity bonds, as indicated by the significance of the respective coefficient estimates. Fifth, there is relevant time-series momentum (positive auto-correlation) in the returns of middle-maturity bonds, while such effect is substantially

[30] This level of fit compares favorably with similar studies (based on multiple regressions) of one-month ahead predictability of the stock market return (Goyal and Santa-Clara, 2003; Campbell and Vuolteenaho, 2004; Welch and Goyal, 2008; Maio and Santa-Clara, 2012; Maio, 2013a,b).

weaker (or absent) among long-term bonds. This positive autocorrelation in returns is stronger among bonds with lower rating. Finally, the remaining two variables in the system (inf and Δq) add very little forecasting power to the predictors referred above. Specifically, the slope estimates associated with Δq_t are clearly insignificant in all cases. On the other hand, the negative coefficients estimates associated with inf are statistically significant (at the 10% or better level) for only three bond indices (BB^L, BBB^I, and BB^I).

The results from the forecasting equations of the other key variables in the VAR (y_{t+1} and Δq_{t+1}) are presented in the internet appendix. In short, these results indicate that the short-term interest rate is predicted mainly by its own lag, as indicated by the AR(1) coefficient estimates very close to one. However, $term$ (def) also helps forecasting an increase (decline) in the future short rate, and such predictability effects are mainly concentrated among intermediate bonds. The adjusted R^2 values in the forecasting equations for y_{t+1} are around 0.97 in all cases, which stems from the large persistence of such variable. The estimation results in the equations for Δq_{t+1} suggest that this variable is close to unpredictable. In fact, only in the cases of the lowest rating bonds (B) do we observe some statistically significant slope estimates: both def and lagged Δq help to forecast a decline in future Δq, whereas $term$ helps predicting an increase in Δq_{t+1}. The corresponding explanatory ratios in the equations for those two bond indices are in the 3-4% range, hence substantially smaller than in the equations associated with bond risk premia.

The variance decomposition results are shown in Table 6. The key finding is that across bonds with different maturities and credit ratings, bond premia news typically constitutes the major component of shocks in current excess bond returns, as indicated by the weights associated with $Var\left(\tilde{x}_{x,t+1}\right)$. More specifically, the shares of bond premia news vary between 49% (for intermediate B bonds) and 149% (for long-term BB bonds), and these estimates are strongly significant (1% or 5% level) in all cases. In fact, we observe bond premia shares above 100% for five bond indices (BBB^L, BB^L, B^L, BBB^I, and BB^I), which stems from the fact that the shares corresponding to some of the covariance terms are negative. Hence, the weights corresponding to risk premium news tend to be larger among lower rating bonds. We can also observe that the bond premia weights tend to be larger for long-maturity bonds in comparison to intermediate bonds.

The weights associated with $Var\left(\tilde{x}_{y,t+1}\right)$ are also statistically significant in all cases and vary between 8% (B^I) and 67-68% (AAA^I and AA^I indices). However, across the board it turns out that interest rate news assumes less importance than bond premia news in explaining variation in excess bond returns. In fact, only in the cases of the two intermediate bond indices mentioned above is the share associated with interest rate news larger than that associated with bond premia news, albeit the differences are relatively small. Thus, the importance of interest rate news tends to increase with the credit rating, and this pattern is especially evident among the intermediate bonds.

Turning to the remaining components of bond returns, it turns out that the share associated with cash-flow news is virtually zero and largely insignificant in all cases. In comparison, the share corresponding to the residual bond return component is quite sizeable for several bond indices, yet there is large statistical uncertainty as none of these estimates are statistically significant at the 10% level. On the other hand, the covariance terms play a secondary role, as either the economic or statistical significance is relatively small across the board. Among the relevant exceptions is the case of $Cov\left(\tilde{x}_{x,t+1}, \tilde{x}_{y,t+1}\right)$, which assumes non-negligible share estimates for several bond indices. Moreover, the weights corresponding to $Cov\left(\tilde{x}_{x,t+1}, \tilde{x}_{r,t+1}\right)$ are both economically and statistically significant for selected long-term bond indices. A similar pattern holds for $Cov\left(\tilde{x}_{y,t+1}, \tilde{x}_{r,t+1}\right)$ in the cases of high-grading bonds. This suggests that the residual component plays indirectly a relevant role in terms of driving returns for several bond indices. Some of the covariance terms involving cash-flow news are statistically significant, but the magnitudes are around zero.

In sum, our results for corporate bonds strongly support the importance of risk premium news as a driver of the total variation in returns, in agreement with studies that have conducted variance decomposition for stocks at the market level (Campbell, 1991; Campbell and Ammer, 1993; Bernanke and Kuttner, 2005; Maio, 2014a; Maio and Philip, 2015).

4.2 Explaining the impact of monetary policy shocks on bond returns

In order to explain the sources of the corporate bond market's reaction to monetary policy shocks, we estimate the effect of these shocks in unexpected excess bond returns and also their four components. To do so, we follow Bernanke and Kuttner (2005) and include the monetary policy shock as an exogenous variable in the VAR model,

$$\mathbf{z}_{t+1} = \mathbf{A}\mathbf{z}_t + \boldsymbol{\phi} MP_{t+1} + \boldsymbol{\omega}_{t+1}, \tag{14}$$

where $\boldsymbol{\phi}$ is a vector that contains the state variables response parameters to contemporaneous monetary policy shocks. The original VAR error vector ($\mathbf{w}_{t+1}$) is essentially decomposed in a component related to the monetary policy shocks ($\boldsymbol{\phi} MP_{t+1}$) and a component related to other information ($\boldsymbol{\omega_{t+1}}$).

Following Bernanke and Kuttner (2005) and Maio (2014a), we proceed by estimating the original VAR model to obtain estimates of $\mathbf{A}$ and then regress the VAR residuals vector on monetary policy shocks in order to estimate $\boldsymbol{\phi}$,

$$\mathbf{w}_{t+1} = \boldsymbol{\tau} + \boldsymbol{\phi} MP_{t+1} + \boldsymbol{\omega}_{t+1}, \tag{15}$$

where $\boldsymbol{\tau}$ is a vector of intercepts.

Given the estimates for $\mathbf{A}$ and $\boldsymbol{\phi}$, we compute the monetary policy impact on the contemporaneous unexpected excess bond returns as well as on the main three components of excess bond returns, as follows:

$$\tilde{x}_{n,t+1}^{MP} \equiv \frac{\partial \tilde{x}_{n,t+1}}{\partial MP_{t+1}} = \mathbf{s}_x' \boldsymbol{\phi}, \tag{16}$$

$$\tilde{x}_{x,t+1}^{MP} \equiv \frac{\partial \tilde{x}_{x,t+1}}{\partial MP_{t+1}} = \mathbf{s}_x' (\rho \mathbf{A} - \rho^n \mathbf{A}^n)(\mathbf{I} - \rho \mathbf{A})^{-1} \boldsymbol{\phi}, \tag{17}$$

$$\tilde{x}_{y,t+1}^{MP} \equiv \frac{\partial \tilde{x}_{y,t+1}}{\partial MP_{t+1}} = \mathbf{s}_y' (\rho \mathbf{A} - \rho^n \mathbf{A}^n)(\mathbf{I} - \rho \mathbf{A})^{-1} \boldsymbol{\phi}, \tag{18}$$

$$\tilde{x}_{q,t+1}^{MP} \equiv \frac{\partial \tilde{x}_{q,t+1}}{\partial MP_{t+1}} = \mathbf{s}_q' (\mathbf{I} - \rho^n \mathbf{A}^n)(\mathbf{I} - \rho \mathbf{A})^{-1} \boldsymbol{\phi}. \tag{19}$$

The policy effect on the residual return news is given by

$$\tilde{x}_{r,t+1}^{MP} \equiv \frac{\partial \tilde{x}_{r,t+1}}{\partial MP_{t+1}} = \tilde{x}_{n,t+1}^{MP} + \tilde{x}_{x,t+1}^{MP} + \tilde{x}_{y,t+1}^{MP} - \tilde{x}_{q,t+1}^{MP}. \tag{20}$$

Thus, the response of excess bond returns and their components to monetary policy shocks depends both on $\boldsymbol{\phi}$ and the dynamics of the VAR through the VAR coefficient matrix, $\mathbf{A}$. As in Maio (2014a), we use a bootstrap simulation to evaluate the statistical significance of these estimates. The simulation is similar to the bootstrap described in the previous subsection for the case of the variance decomposition of excess bond returns. The VAR residuals and monetary policy shock are simulated independently, that is, the data generating process assumes that the policy shocks are independent from the VAR state variables. As in the previous subsection, we use single-sided p-values, as the signs of the responses are theoretically constrained (that is, they are defined by the bond return decomposition). Hence, given the negative estimates of $\tilde{x}_{n,t+1}^{MP}$, as shown in the last section, the signs of both $\tilde{x}_{x,t+1}^{MP}$ and $\tilde{x}_{y,t+1}^{MP}$ should be positive, while the sign of $\tilde{x}_{q,t+1}^{MP}$ should be negative. This implies that the empirical p-values associated with the estimates of $\tilde{x}_{n,t+1}^{MP}$ and $\tilde{x}_{q,t+1}^{MP}$ represent the fractions of artificial samples in which each of these estimates is lower than the corresponding sample estimate. In the cases of $\tilde{x}^{MP}_{x,t+1}$ and $\tilde{x}^{MP}_{y,t+1}$, the p-values represent the fractions of pseudo samples in which each of these estimates is greater than the corresponding sample estimate. In the case of $\tilde{x}^{MP}_{r,t+1}$, we use double-sided p-values. The reason is that, being the innovations on a residual return that is not defined theoretically, such variable (and its response to policy shocks) can assume either positive or negative values. Full details on the bootstrap simulation are provided in the internet appendix.

In the cases of the AAA bond indices, the policy responses are estimated as follows:

$$\begin{aligned}
\tilde{x}^{MP}_{n,t+1} &\equiv \frac{\partial \tilde{x}_{n,t+1}}{\partial MP_{t+1}} = \mathbf{s}'_x \boldsymbol{\phi}, \\
\tilde{x}^{MP}_{x,t+1} &\equiv \frac{\partial \tilde{x}_{x,t+1}}{\partial MP_{t+1}} = \mathbf{s}'_x (\rho \mathbf{A} - \rho^n \mathbf{A}^n)(\mathbf{I} - \rho \mathbf{A})^{-1} \boldsymbol{\phi}, \\
\tilde{x}^{MP}_{y,t+1} &\equiv \frac{\partial \tilde{x}_{y,t+1}}{\partial MP_{t+1}} = \mathbf{s}'_y (\rho \mathbf{A} - \rho^n \mathbf{A}^n)(\mathbf{I} - \rho \mathbf{A})^{-1} \boldsymbol{\phi}, \\
\tilde{x}^{MP}_{r,t+1} &\equiv \frac{\partial \tilde{x}_{r,t+1}}{\partial MP_{t+1}} = \tilde{x}^{MP}_{n,t+1} + \tilde{x}^{MP}_{x,t+1} + \tilde{x}^{MP}_{y,t+1}.
\end{aligned}$$

Table 7 (Panel A) presents the results for the policy responses when the monetary policy proxy is $MP1$. The total response of unexpected excess bond returns to policy shocks is negative in all cases, which implies that unexpected excess bond returns respond negatively to a monetary tightening shock. Moreover, there is statistical significance in these return responses (at the 10% or better level) across most bond indices, the exceptions being the cases of long-maturity high-rating bonds (AAA^L and AA^L). This means that, in line with the results for realized excess bond returns (univariate regressions) in Section 3, the total return reaction to monetary policy shocks increases in magnitude as the credit rating deteriorates (and this pattern holds among both long-term and intermediate bonds). Moving on to the reaction of the components of excess bond returns, we can see that the effect of monetary policy shocks is mostly explained though the risk premia news channel. In other words, for all bond indices, tightening policy shocks negatively affect contemporaneous unexpected excess bond returns through an increase in expected excess bond returns (risk premia). In most cases, the estimates of $\tilde{x}^{MP}_{x,t+1}$ are strongly significant (1% or 5% level). The sole exception occurs for the long-term AAA index, in which case the corresponding estimate is not significant at the 10% level. Mirroring the direction observed in the magnitudes of the total return responses, the impact of monetary policy shocks on bond premia news is substantially more important among lower rating bonds, as indicated by the magnitudes of $\tilde{x}^{MP}_{x,t+1}$: the corresponding estimates in the cases of B^L and AAA^L are 7.31 and 0.12, respectively, while the corresponding estimates for B^I and AAA^I are 5.19 and 0.92, respectively.[31]

The policy impact on interest rate news assumes a secondary role for the majority of the bond indices. For example, the estimates of $\widetilde{x}_{y,t+1}^{MP}$ are negative (albeit insignificant) for all intermediate bonds, as well as in the case of A^L. This is inconsistent with the present-value relation for unexpected excess bond returns. For the remaining five bond indices, the policy responses assume the correct sign (positive) and are largely statistically significant. Yet, the magnitudes of $\widetilde{x}_{y,t+1}^{MP}$ tend to be substantially smaller than the corresponding magnitudes for $\widetilde{x}_{x,t+1}^{MP}$. The sole exception is the already mentioned case of AAA^L, in which the interest rate news channel is the dominant force in driving the return reaction to policy shocks. The remaining two components of unexpected excess bond returns do not play a relevant role in explaining the total return response to policy shocks: The estimates of $\widetilde{x}_{q,t+1}^{MP}$ are very close to zero and largely insignificant across all 12 bond indices.[32] On the other hand, the estimates of $\widetilde{x}_{r,t+1}^{MP}$ show large magnitudes for some bond indices, but there is also no statistical significance (at the 10% level) in any case.

The results when the monetary policy proxy is $MP2$, which are presented in Table 7 (Panel B), point to qualitatively similar results. The total return responses are negative and strongly significant (1% or 5% level) for all 12 bond indices. This shows a stronger return response in comparison to $MP1$, which is in line with the univariate regression results discussed in Section 3. Similar to the case of $MP1$, the estimates of $\widetilde{x}_{n,t+1}^{MP}$ tend to be stronger for lower rating bonds, and this is more evident among intermediate bonds. Turning to the components of excess returns, the estimates of $\widetilde{x}_{x,t+1}^{MP}$ are positive and largely significant (1% or 5% level) across most bond indices. The few exceptions hold for long-maturity high-rating bonds: in the case of AA^L, the positive estimate is only marginally significant (10% level), while in the case of AAA^L there is a negative estimate (although insignificant), which is inconsistent with the present-value relation for excess bond returns.

In contrast to the results associated with $MP1$, the policy effects on interest rate news assume the correct sign (positive) and are statistically significant in all 12 cases. However, the magnitudes of these estimates continue to be substantially smaller than the corresponding magnitudes associated with $\widetilde{x}_{x,t+1}^{MP}$. The few exceptions occur for the long bond indices mentioned

[31] We should note that larger weights of bond premia news on excess bond returns (as calculated in Table 6) does not necessarily imply larger estimates of $\widetilde{x}_{x,t+1}^{MP}$. For example, BB^L has the largest share of $Var(\widetilde{x}_{x,t+1})$, despite having smaller policy effects on bond premia news than both BBB^L and B^L.

[32] Some caution is needed when interpreting the results associated with the cash-flow component of bond returns. The reason hinges on the various limitations of our bond cash-flow data, as discussed in detail in Section 2. Indeed, compared to the other components of excess bond returns, cash-flow news have considerably higher measurement error. This can potentially imply muted monetary policy effects on cash-flow news, even for low-grading bonds.

above (AAA^L and AA^L), in which cases the interest rate news channel is dominant. Also in contrast with the results for $MP1$, we observe that the estimates for $\widetilde{x}_{q,t+1}^{MP}$ have the correct sign (negative) and are statistically significant (10% or 5% level) for selected bond indices (AA^L, BB^L, and BB^I). It is also the case that the estimated response of the residual component ($\widetilde{x}_{r,t+1}^{MP}$) is statistically significant (5% level), and actually represents the major channel of policy transmission, for B^I. These findings suggest that monetary policy effects on future bond cash-flows and other residual components (such as liquidity) are substantially more important for lower rating bonds. However, those effects are far from robust, as they only exist for a selected bond indices and using $MP2$ as monetary proxy.

Overall, the VAR-based results strongly favour risk premium news in being the key driver of the response of excess bond returns to monetary policy shocks, that is, monetary tightening negatively affects contemporaneous returns through higher expected returns. This dominant role of risk premium news in explaining the response of excess corporate bond returns to monetary policy actions is in agreement with the evidence of Bernanke and Kuttner (2005) for the stock market return.

We conduct an extensive sensitivity analysis to our benchmark VAR analysis. To keep the focus, all the results are tabulated and discussed in the internet appendix. First, we use alternative state vector specifications for the underlying VAR model. Second, we consider higher-order VARs. Third, we use the consol bond formulas (with infinite horizon) to estimate the decompositions for returns on long-term corporate bonds. Fourth, we use alternative monetary policy proxies. Fifth, we use an alternative sample that defines the pre-ZLB period. Sixth, we employ the methodology suggested by Romer and Romer (2004) to calculate monetary policy shocks. Seventh, we use an alternative estimation method in order to estimate the VAR-based return responses. Finally, we employ an alternative bond cash-flow measure.

Generally, we find that the main qualitatively results discussed above remain robust to these changes in the empirical design. Specifically, the bond premia channel represents the dominant role in explaining the bond return reaction to policy shocks. This is especially evident for intermediate bonds, in particular low-rating bonds. However, it is the case that for some empirical setups, the interest rate channel is also important (and in some cases dominant) in explaining the return responses to shocks for long-term bonds with high credit rating.

4.3 Treasury bonds responses to monetary policy shocks

We repeat the analysis in the previous subsections for the cases of the five-year ($Tr5y$) and 20-year ($Tr20y$) Treasury bonds. The goal is to put in perspective the results obtained for corporate bonds. A priori, we expect a pattern of responses to policy chocks that is more alike to that estimated for high-rating corporate bonds (e.g., AAA and AA) in comparison to the one estimated for low-rating bonds.

In the case of Treasury bonds, the default is zero, which implies that the coupon payments are fixed over time. Thus, we have $\Delta q_t = 0$ for all t, which in turn implies that the cash-flow news component, defined in the previous subsections, is zero for all periods. Consequently, the present-value relation for Treasuries specializes to

$$\begin{aligned} \tilde{x}^g_{n,t+1} &\approx -(E_{t+1} - E_t)\sum_{j=1}^{n-1} \rho^j x^g_{n-j,t+1+j} - (E_{t+1} - E_t)\sum_{j=1}^{n-1} \rho^j y_{t+1+j} \\ &\equiv -\tilde{x}_{xg,t+1} - \tilde{x}_{y,t+1}, \end{aligned} \tag{21}$$

where the last equality defines the variables of interest. This represents an analogous return decomposition to the case of AAA bonds in our sample period. In the expression above, $x^g_{n,t+1}$ represents the excess return on a Treasury bond with maturity of n periods, and $\tilde{x}_{xg,t+1}$ denotes bond risk premia news associated with a Treasury bond.[33] Hence, unexpected Treasury bond returns are decomposed into risk premium news and interest rate news, as in the case of AAA corporate bonds.

Accounting for the residual component, we have:

$$\tilde{x}^g_{n,t+1} = -\tilde{x}_{xg,t+1} - \tilde{x}_{y,t+1} + \tilde{x}_{r,t+1}. \tag{22}$$

In the forthcoming analysis with Treasury bonds, the VAR state vector is given by $\mathbf{z}_t = \left[term_t, inf_t, y_t, x^g_{n+1,t}\right]'$. In comparison to the AAA bond indices, we exclude def from the VAR, as this variable in principle should not add forecasting power for the excess returns of Treasury bonds. Indeed the results from Table 5 indicate that the credit spread does not tend to forecast the excess returns of high-rating corporate bonds (AAA, AA, and A). The estimation

[33] We use the notation g to make clear the distinction against corporate bonds.

of the VAR(1) associated with $Tr20y$ yields the following results,

$$\begin{pmatrix} term_{t+1} \\ inf_{t+1} \\ y_{t+1} \\ x^g_{n,t+1} \end{pmatrix} = \begin{pmatrix} 0.925 & -0.020 & -0.125 & 0.003 \\ (\mathbf{38.30}) & (-0.19) & (-0.72) & (0.35) \\ 0.004 & 0.380 & 0.211 & -0.003 \\ (0.30) & (\mathbf{3.38}) & (\underline{2.37}) & (-0.49) \\ 0.004 & 0.007 & 0.997 & -0.000 \\ (\underline{2.13}) & (0.92) & (\mathbf{81.50}) & (-0.43) \\ 0.372 & -0.844 & 1.739 & 0.016 \\ (\mathbf{2.86}) & (-0.71) & (1.56) & (0.26) \end{pmatrix} \begin{pmatrix} term_t \\ inf_t \\ y_t \\ x^g_{n+1,t} \end{pmatrix} + \begin{pmatrix} \widehat{w}_{term,t+1} \\ \widehat{w}_{inf,t+1} \\ \widehat{w}_{y,t+1} \\ \widehat{w}_{xg,t+1} \end{pmatrix},$$

with adjusted R^2 estimates of 0.89, 0.19, 0.97, and 0.01, respectively. The numbers in parentheses represent the t-ratios, with bold, underlined, and italic numbers denoting significance at the 1%, 5%, and 10%, respectively. In the case of $Tr5y$, the corresponding VAR estimates are as follows,

$$\begin{pmatrix} term_{t+1} \\ inf_{t+1} \\ y_{t+1} \\ x^g_{n,t+1} \end{pmatrix} = \begin{pmatrix} 0.836 & 0.003 & -0.147 & 0.002 \\ (\mathbf{26.12}) & (0.04) & (-1.12) & (0.10) \\ -0.003 & 0.378 & 0.188 & -0.016 \\ (-0.22) & (\mathbf{3.86}) & (\mathbf{2.96}) & (-1.64) \\ 0.011 & 0.005 & 0.999 & -0.003 \\ (\mathbf{4.72}) & (0.72) & (\mathbf{115.10}) & (\mathit{-1.67}) \\ 0.224 & -0.247 & 0.467 & 0.129 \\ (\mathbf{2.81}) & (-0.79) & (1.37) & (\underline{2.25}) \end{pmatrix} \begin{pmatrix} term_t \\ inf_t \\ y_t \\ x^g_{n+1,t} \end{pmatrix} + \begin{pmatrix} \widehat{w}_{term,t+1} \\ \widehat{w}_{inf,t+1} \\ \widehat{w}_{y,t+1} \\ \widehat{w}_{xg,t+1} \end{pmatrix},$$

with adjusted R^2 estimates of 0.73, 0.19, 0.97, and 0.03, respectively.

The results for the excess return forecasting regression are somewhat approximate to the results associated with the AAA bonds in Table 5. Specifically, the explanatory ratios (1% and 3% for $Tr20y$ and $Tr5y$, respectively) are similar to the fit obtained in the return forecasting equations corresponding to AAA^L and AAA^I, respectively. Moreover, *term* shows up as the only significant predictor in the return regression for $Tr20y$, similar to the case of AAA^L (although there is stronger significance in the case of the Treasury bond). In the same vein, both *term* and the current excess return help to forecast $x^g_{n,t+1}$ in the case of $Tr5y$, which is in line with the results for AAA^I discussed above. The key difference among the two intermediate bonds is that the short-term interest rate is not a significant predictor of the treasury excess return.

The unobserved components of unexpected bond returns are estimated as follows,

$$\tilde{x}^g_{n,t+1} = \mathbf{s}'_{xg}\mathbf{w}_{t+1}, \tag{23}$$

$$\tilde{x}_{xg,t+1} = \mathbf{s}'_{xg}(\rho\mathbf{A} - \rho^n\mathbf{A}^n)(\mathbf{I} - \rho\mathbf{A})^{-1}\mathbf{w}_{t+1}, \tag{24}$$

$$\tilde{x}_{y,t+1} = \mathbf{s}'_{y}(\rho\mathbf{A} - \rho^n\mathbf{A}^n)(\mathbf{I} - \rho\mathbf{A})^{-1}\mathbf{w}_{t+1}, \tag{25}$$

$$\tilde{x}_{r,t+1} = \tilde{x}^g_{n,t+1} + \tilde{x}_{xg,t+1} + \tilde{x}_{y,t+1}, \tag{26}$$

where $\mathbf{s}'_{xg} = [0, 0, 0, 1]$ and $\mathbf{s}'_y = [0, 0, 1, 0]$. The estimates of ρ are 0.995 and 0.996 for $Tr20y$ and $Tr5y$, respectively.

The corresponding variance decomposition for $\tilde{x}^g_{n,t+1}$ is given by

$$\begin{aligned} Var\left(\tilde{x}^g_{n,t+1}\right) = {} & Var\left(\tilde{x}_{xg,t+1}\right) + 2Cov\left(\tilde{x}_{xg,t+1}, \tilde{x}_{y,t+1}\right) - 2Cov\left(\tilde{x}_{xg,t+1}, \tilde{x}_{r,t+1}\right) \\ & + Var\left(\tilde{x}_{y,t+1}\right) - 2Cov\left(\tilde{x}_{y,t+1}, \tilde{x}_{r,t+1}\right) + Var\left(\tilde{x}_{r,t+1}\right), \end{aligned} \tag{27}$$

which is identical to that applied for the case of AAA bonds.

By dividing both sides of the previous equation by $Var\left(\tilde{x}^g_{n,t+1}\right)$, we obtain the following decomposition in the case of $Tr20y$,

$$1 = 0.55(0.01) + 0.13(0.00) + 0.01(0.97) + 0.29(0.00) - 0.03(0.00) + 0.05(1.00),$$

where the numbers in parentheses represent the bootstrap-based p-values. The corresponding decomposition for $Tr5y$ produces the following results:

$$1 = 0.34(0.00) + 0.19(0.00) - 0.19(0.32) + 0.64(0.00) - 0.04(0.00) + 0.04(1.00).$$

These results show that the weights associated with bond premia news and interest rate news are strongly significant (1% level) for both Treasury bonds. However, the relative importance of these two drivers of bond returns varies with maturity: while in the case of $Tr20y$ the risk premia channel is dominant, with a share of 55% (versus 29%), in the case of $Tr5y$ we observe an apposite pattern, with interest rate news representing the dominant force with a weight of 64% (versus 34%). Again, these patterns are consistent with the variance decompositions estimated for AAA^L on one hand, and AAA^I on the other hand, as discussed above.

The responses of the excess returns on the Treasury bonds, and the respective components, to monetary policy shocks are derived in a similar way to the cases of the AAA indices shown in the previous subsection:

$$\tilde{x}^{MP}_{n,t+1} \equiv \frac{\partial \tilde{x}^{g}_{n,t+1}}{\partial MP_{t+1}} = \mathbf{s}'_{xg}\boldsymbol{\phi}, \tag{28}$$

$$\tilde{x}^{MP}_{xg,t+1} \equiv \frac{\partial \tilde{x}_{xg,t+1}}{\partial MP_{t+1}} = \mathbf{s}'_{xg}(\rho\mathbf{A} - \rho^n\mathbf{A}^n)(\mathbf{I} - \rho\mathbf{A})^{-1}\boldsymbol{\phi}, \tag{29}$$

$$\tilde{x}^{MP}_{y,t+1} \equiv \frac{\partial \tilde{x}_{y,t+1}}{\partial MP_{t+1}} = \mathbf{s}'_{y}(\rho\mathbf{A} - \rho^n\mathbf{A}^n)(\mathbf{I} - \rho\mathbf{A})^{-1}\boldsymbol{\phi}, \tag{30}$$

$$\tilde{x}^{MP}_{r,t+1} \equiv \frac{\partial \tilde{x}_{r,t+1}}{\partial MP_{t+1}} = \tilde{x}^{MP}_{n,t+1} + \tilde{x}^{MP}_{xg,t+1} + \tilde{x}^{MP}_{y,t+1}. \tag{31}$$

The estimated responses are reported in Table 8. Regarding the total return responses, only in the case of $Tr5y$, and using $MP2$ as the policy proxy, do we obtain a significant (5% level) negative estimate of $\tilde{x}^{MP}_{n,t+1}$. This is consistent with the results from the simple regressions discussed in Section 3. Moreover, the estimates of $\tilde{x}^{MP}_{xg,t+1}$ have the wrong sign (negative) in all cases, although there is no statistical significance. In comparison, the estimates of $\tilde{x}^{MP}_{y,t+1}$ are positive and strongly significant (1% level) in all cases. Hence, the significant negative impact of policy shocks on the intermediate Treasury bond is due to a positive effect on interest rate news. In other words, only the interest rate channel matters when it comes to explaining the Treasury bond return reaction to monetary shocks. These results are partially consistent with the results for the AAA bond indices discussed in the last subsection. Specifically, as shown in Table 7, in the case of AAA^L, the estimates of $\tilde{x}^{MP}_{x,t+1}$ are largely insignificant and interest rate news is the dominant driving force (with these findings holding for both measures of monetary policy).

These findings are also consistent with previous studies on Treasuries, which find that bond premia news assumes a secondary role in comparison to other components of unexpected excess bond returns (Campbell and Ammer, 1993; Engsted and Tanggaard, 2007; Kontonikas *et al.*, 2019). Overall, the results of this subsection suggest that Treasury bonds behave in a similar way to corporate bonds with low credit risk when assessing the impact of monetary policy shocks. Hence, the effects of policy shocks on Treasuries are quite different from those observed for low-rating corporate bonds. This also suggests the existence of an approximate monotonic pattern in the reaction of asset returns to policy shocks—high-grading bonds acting very much like Treasury bonds, on one hand, and low-grading bonds acting very much like the average stock in the economy, on the other hand.

5 The role of term risk and credit risk premia news

In this section, we compute an alternative bond return decomposition, which disentangles bond premia news into one component related to term risk premia and another component related to credit risk premia. To do so, we express excess bond returns as

$$x_{n,t+1} = x^c_{n,t+1} + x^g_{n,t+1}, \tag{32}$$

where $x^c_{n,t+1}$ denotes the return on (a n-maturity) corporate bond in excess of the return on a Treasury bond with similar maturity.

By using the above definition, the present-value relation for the unexpected excess bond return is defined as follows,

$$\begin{aligned}
\tilde{x}_{n,t+1} &\approx -(E_{t+1} - E_t) \sum_{j=1}^{n-1} \rho^j x^c_{n-j,t+1+j} - (E_{t+1} - E_t) \sum_{j=1}^{n-1} \rho^j x^g_{n-j,t+1+j} \\
&\quad -(E_{t+1} - E_t) \sum_{j=1}^{n-1} \rho^j y_{t+1+j} + (E_{t+1} - E_t) \sum_{j=0}^{n-1} \rho^j \Delta q_{t+1+j} \\
&\equiv -\tilde{x}_{xc,t+1} - \tilde{x}_{xg,t+1} - \tilde{x}_{y,t+1} + \tilde{x}_{q,t+1},
\end{aligned} \tag{33}$$

where $\tilde{x}_{xc,t+1}$ refers to credit premia news. Basically, in this augmented return decomposition, bond premia news ($\tilde{x}_{x,t+1}$) is decomposed into a quantity related to shocks in term premia (i.e., expectations about future excess returns on Treasury bonds, $\tilde{x}_{xg,t+1}$) plus a quantity related to shocks in credit premia (i.e., expectations about future returns on corporate bonds in excess of Treasury bonds, $\tilde{x}_{xc,t+1}$). A priori, it should be important to assess which of these two parts of total bond premia news is relatively more important in explaining the policy effect on bond returns. In other words, is the risk premium response to policy shocks, documented in the previous section, due to effects on future excess returns of default-free bonds or due to effects on the excess risk premia associated with bonds having credit risk?

By incorporating the residual return term in the present-value relation above, we have an exact equality:

$$\tilde{x}_{n,t+1} = -\tilde{x}_{xc,t+1} - \tilde{x}_{xg,t+1} - \tilde{x}_{y,t+1} + \tilde{x}_{q,t+1} + \tilde{x}_{r,t+1}. \tag{34}$$

In order to implement empirically the augmented return decomposition, we include the excess Treasury return on the VAR state vector, $\mathbf{z}_t = \left[def_t, term_t, inf_t, \Delta q_t, y_t, x^g_{n+1,t}, x_{n+1,t}\right]'$. In the VAR associated with long-term and intermediate bond indices, we employ the excess return associated with $Tr20y$ and $Tr5y$, respectively, as the empirical proxy for $x^g_{n+1,t}$. In the case of the

AAA bond indices, the VAR state vector is given by $\mathbf{z}_t = \left[def_t, term_t, inf_t, y_t, x^g_{n+1,t}, x_{n+1,t}\right]'$.

The estimation results for the excess corporate return forecasting equation in the augmented VAR are displayed in Table 9. The estimates are quite similar to those in the benchmark VAR of Section 4. The reason hinges on the fact the slope estimates associated with $x^g_{n+1,t}$ are insignificant in the majority of the cases. The main exceptions occur for the lowest rating bonds (B^L and B^I), in which cases the excess Treasury return helps to forecast a significant (1% level) rise in $x_{n,t+1}$. In the cases of BB^L and BB^I, the corresponding slope estimates are also positive, but the statistical significance is marginal (10% level). Hence, for low-rating bonds there is some degree of positive feedback from lagged Treasury returns, apart from the own positive time-series return momentum already documented in the last section.

The results for the forecasting regressions associated with the Treasury bonds, reported in Table 10, produce results that are consistent with the results discussed in the last part of the previous section. It turns out that the term spread predicts a significant (1% level) increase in bond risk premia in all 12 cases. We also observe that there is positive momentum in the returns of intermediate Treasury bonds, as the slope estimates associated with $x^g_{n+1,t}$ tend to be significantly positive among those bonds. On the other hand, the excess corporate bond returns predict a significant decline in $x^g_{n,t+1}$ in the cases of intermediate low-rating bonds (BBB^I, BB^I, and B^I). We also observe that the forecasting power of term risk premia tends to be larger among lower-rating bonds, as indicated by the higher R^2 estimates. The results for the forecasting regressions associated with y_{t+1} and Δq_{t+1}, which are presented in the internet appendix, are very similar to those associated with the benchmark VAR from Section 4. Among the most salient features, in the forecasting regression for the short-interest rate, we observe that the Treasury returns forecast a decline in y_{t+1} for intermediate high-rating bonds.

The terms in the present-value relation are identified as follows,

$$\tilde{x}_{n,t+1} = \mathbf{s}'_{xc}\mathbf{w}_{t+1}, \tag{35}$$

$$\tilde{x}_{xc,t+1} = (\mathbf{s}_{xc} - \mathbf{s}_{xg})'(\rho\mathbf{A} - \rho^n\mathbf{A}^n)(\mathbf{I} - \rho\mathbf{A})^{-1}\mathbf{w}_{t+1}, \tag{36}$$

$$\tilde{x}_{xg,t+1} = \mathbf{s}'_{xg}(\rho\mathbf{A} - \rho^n\mathbf{A}^n)(\mathbf{I} - \rho\mathbf{A})^{-1}\mathbf{w}_{t+1}, \tag{37}$$

$$\tilde{x}_{y,t+1} = \mathbf{s}'_{y}(\rho\mathbf{A} - \rho^n\mathbf{A}^n)(\mathbf{I} - \rho\mathbf{A})^{-1}\mathbf{w}_{t+1}, \tag{38}$$

$$\tilde{x}_{q,t+1} = \mathbf{s}'_{q}(\mathbf{I} - \rho^n\mathbf{A}^n)(\mathbf{I} - \rho\mathbf{A})^{-1}\mathbf{w}_{t+1}, \tag{39}$$

$$\tilde{x}_{r,t+1} = \tilde{x}_{n,t+1} + \tilde{x}_{xc,t+1} + \tilde{x}_{xg,t+1} + \tilde{x}_{y,t+1} - \tilde{x}_{q,t+1}, \tag{40}$$

where $\mathbf{s}'_{xc} = [0,0,0,0,0,0,1]$, $\mathbf{s}'_{xg} = [0,0,0,0,0,1,0]$, $\mathbf{s}'_{y} = [0,0,0,0,1,0,0]$, and $\mathbf{s}'_{q} = [0,0,0,1,0,0,0]$

denote the indicator vectors in this setup.[34]

In the case of the AAA bond indices, the unobserved components are computed as follows

$$
\begin{aligned}
\tilde{x}_{n,t+1} &= \mathbf{s}'_{xc}\mathbf{w}_{t+1}, \\
\tilde{x}_{xc,t+1} &= (\mathbf{s}_{xc} - \mathbf{s}_{xg})'(\rho\mathbf{A} - \rho^n\mathbf{A}^n)(\mathbf{I} - \rho\mathbf{A})^{-1}\mathbf{w}_{t+1}, \\
\tilde{x}_{xg,t+1} &= \mathbf{s}'_{xg}(\rho\mathbf{A} - \rho^n\mathbf{A}^n)(\mathbf{I} - \rho\mathbf{A})^{-1}\mathbf{w}_{t+1}, \\
\tilde{x}_{y,t+1} &= \mathbf{s}'_{y}(\rho\mathbf{A} - \rho^n\mathbf{A}^n)(\mathbf{I} - \rho\mathbf{A})^{-1}\mathbf{w}_{t+1}, \\
\tilde{x}_{r,t+1} &= \tilde{x}_{n,t+1} + \tilde{x}_{xc,t+1} + \tilde{x}_{xg,t+1} + \tilde{x}_{y,t+1},
\end{aligned}
$$

with $\mathbf{s}'_{xc} = [0, 0, 0, 0, 0, 1]$, and similarly for the other indicator vectors.

This identification implies that the variance of unexpected excess bond returns associated with the augmented return decomposition becomes:

$$
\begin{aligned}
Var\left(\tilde{x}_{n,t+1}\right) = \; & Var\left(\tilde{x}_{xc,t+1}\right) + 2Cov\left(\tilde{x}_{xc,t+1}, \tilde{x}_{xg,t+1}\right) + 2Cov\left(\tilde{x}_{xc,t+1}, \tilde{x}_{y,t+1}\right) - 2Cov\left(\tilde{x}_{xc,t+1}, \tilde{x}_{q,t+1}\right) \\
& -2Cov\left(\tilde{x}_{xc,t+1}, \tilde{x}_{r,t+1}\right) \\
& +Var\left(\tilde{x}_{xg,t+1}\right) + 2Cov\left(\tilde{x}_{xg,t+1}, \tilde{x}_{y,t+1}\right) - 2Cov\left(\tilde{x}_{xg,t+1}, \tilde{x}_{q,t+1}\right) - 2Cov\left(\tilde{x}_{xg,t+1}, \tilde{x}_{r,t+1}\right) \\
& +Var\left(\tilde{x}_{y,t+1}\right) - 2Cov\left(\tilde{x}_{y,t+1}, \tilde{x}_{q,t+1}\right) - 2Cov\left(\tilde{x}_{y,t+1}, \tilde{x}_{r,t+1}\right) \\
& +Var\left(\tilde{x}_{q,t+1}\right) + 2Cov\left(\tilde{x}_{q,t+1}, \tilde{x}_{r,t+1}\right) + Var\left(\tilde{x}_{r,t+1}\right). \qquad (41)
\end{aligned}
$$

In the case of AAA bonds, this variance decomposition specializes to

$$
\begin{aligned}
Var\left(\tilde{x}_{n,t+1}\right) = \; & Var\left(\tilde{x}_{xc,t+1}\right) + 2Cov\left(\tilde{x}_{xc,t+1}, \tilde{x}_{xg,t+1}\right) + 2Cov\left(\tilde{x}_{xc,t+1}, \tilde{x}_{y,t+1}\right) - 2Cov\left(\tilde{x}_{xc,t+1}, \tilde{x}_{r,t+1}\right) \\
& +Var\left(\tilde{x}_{xg,t+1}\right) + 2Cov\left(\tilde{x}_{xg,t+1}, \tilde{x}_{y,t+1}\right) - 2Cov\left(\tilde{x}_{xg,t+1}, \tilde{x}_{r,t+1}\right) \\
& +Var\left(\tilde{x}_{y,t+1}\right) - 2Cov\left(\tilde{x}_{y,t+1}, \tilde{x}_{r,t+1}\right) + Var\left(\tilde{x}_{r,t+1}\right).
\end{aligned}
$$

The results for the augmented variance decomposition are displayed in Table 11. We can see that the shares associated with term premia news ($Var\left(\tilde{x}_{xg,t+1}\right)$) are statistically significant for all 12 bond indices. In comparison, the weights corresponding to credit premia news ($Var\left(\tilde{x}_{xc,t+1}\right)$) tend to be significant only among high-credit risk bonds (BBB, BB, and B). This implies that the credit premia channel tends to represent the major force driving the excess re-

[34]Note that in the identification of $\tilde{x}_{xc,t+1}$, the risk-free rate cancels out by subtracting the two excess returns, $x_{n,t+1} - x^g_{n,t+1}$. An equivalent identification method would be to include the excess corporate-Treasury bond return $(x_{n+1,t} - x^g_{n+1,t})$ in the VAR, $\mathbf{z}_t = \left[def_t, term_t, inf_t, \Delta q_t, y_t, x^g_{n+1,t}, x_{n+1,t} - x^g_{n+1,t}\right]'$, and then compute credit premia news as $\tilde{x}_{xc,t+1} = \mathbf{s}'_{xc}(\rho\mathbf{A} - \rho^n\mathbf{A}^n)(\mathbf{I} - \rho\mathbf{A})^{-1}\mathbf{w}_{t+1}$, while the unexpected bond return would be given by $\tilde{x}_{n,t+1} = (\mathbf{s}_{xc} + \mathbf{s}_{xg})'\mathbf{w}_{t+1}$.

turns of low-rating bonds, whereas the term premia channel is dominant among the high-rating bond categories, with shares often close to or above 50%. The shares associated with interest rate news ($Var\left(\tilde{x}_{y,t+1}\right)$) are significant in all 12 cases, in line with the results obtained for the benchmark VAR analysis. However, generally, these weights are smaller in magnitude than those corresponding to either credit premia news or term premia news. The exceptions occur for intermediate high-quality bonds (AAA^I, AA^I, and A^I), in which cases the interest rate channel dominates, with shares above 50%. Further, the association between credit premia news and interest rate news assumes a significant weight for several bond indices, with such effect being stronger among low-grading bonds. Similar to the benchmark variance decomposition in Section 4, the weights associated with both $Cov\left(\tilde{x}_{xc,t+1}, \tilde{x}_{r,t+1}\right)$ and $Cov\left(\tilde{x}_{y,t+1}, \tilde{x}_{r,t+1}\right)$ are both economically and statistically significant for several bond indices.

Turning to the focus of our analysis in this section, the policy responses are given by the following formulas:

$$\tilde{x}_{n,t+1}^{MP} \equiv \frac{\partial \tilde{x}_{n,t+1}}{\partial MP_{t+1}} = \mathbf{s}_{xc}' \boldsymbol{\phi}, \tag{42}$$

$$\tilde{x}_{xc,t+1}^{MP} \equiv \frac{\partial \tilde{x}_{xc,t+1}}{\partial MP_{t+1}} = (\mathbf{s}_{xc} - \mathbf{s}_{xg})'(\rho \mathbf{A} - \rho^n \mathbf{A}^n)(\mathbf{I} - \rho \mathbf{A})^{-1} \boldsymbol{\phi}, \tag{43}$$

$$\tilde{x}_{xg,t+1}^{MP} \equiv \frac{\partial \tilde{x}_{xg,t+1}}{\partial MP_{t+1}} = \mathbf{s}_{xg}'(\rho \mathbf{A} - \rho^n \mathbf{A}^n)(\mathbf{I} - \rho \mathbf{A})^{-1} \boldsymbol{\phi}, \tag{44}$$

$$\tilde{x}_{y,t+1}^{MP} \equiv \frac{\partial \tilde{x}_{y,t+1}}{\partial MP_{t+1}} = \mathbf{s}_{y}'(\rho \mathbf{A} - \rho^n \mathbf{A}^n)(\mathbf{I} - \rho \mathbf{A})^{-1} \boldsymbol{\phi}, \tag{45}$$

$$\tilde{x}_{q,t+1}^{MP} \equiv \frac{\partial \tilde{x}_{q,t+1}}{\partial MP_{t+1}} = \mathbf{s}_{q}'(\mathbf{I} - \rho^n \mathbf{A}^n)(\mathbf{I} - \rho \mathbf{A})^{-1} \boldsymbol{\phi}, \tag{46}$$

$$\tilde{x}_{r,t+1}^{MP} \equiv \frac{\partial \tilde{x}_{r,t+1}}{\partial MP_{t+1}} = \tilde{x}_{n,t+1}^{MP} + \tilde{x}_{xc,t+1}^{MP} + \tilde{x}_{xg,t+1}^{MP} + \tilde{x}_{y,t+1}^{MP} - \tilde{x}_{q,t+1}^{MP}. \tag{47}$$

In the case of the AAA indices, we have:

$$\begin{aligned}
\tilde{x}_{n,t+1}^{MP} &\equiv \frac{\partial \tilde{x}_{n,t+1}}{\partial MP_{t+1}} = \mathbf{s}_{xc}' \boldsymbol{\phi}, \\
\tilde{x}_{xc,t+1}^{MP} &\equiv \frac{\partial \tilde{x}_{xc,t+1}}{\partial MP_{t+1}} = (\mathbf{s}_{xc} - \mathbf{s}_{xg})'(\rho \mathbf{A} - \rho^n \mathbf{A}^n)(\mathbf{I} - \rho \mathbf{A})^{-1} \boldsymbol{\phi}, \\
\tilde{x}_{xg,t+1}^{MP} &\equiv \frac{\partial \tilde{x}_{xg,t+1}}{\partial MP_{t+1}} = \mathbf{s}_{xg}'(\rho \mathbf{A} - \rho^n \mathbf{A}^n)(\mathbf{I} - \rho \mathbf{A})^{-1} \boldsymbol{\phi}, \\
\tilde{x}_{y,t+1}^{MP} &\equiv \frac{\partial \tilde{x}_{y,t+1}}{\partial MP_{t+1}} = \mathbf{s}_{y}'(\rho \mathbf{A} - \rho^n \mathbf{A}^n)(\mathbf{I} - \rho \mathbf{A})^{-1} \boldsymbol{\phi}, \\
\tilde{x}_{r,t+1}^{MP} &\equiv \frac{\partial \tilde{x}_{r,t+1}}{\partial MP_{t+1}} = \tilde{x}_{n,t+1}^{MP} + \tilde{x}_{xc,t+1}^{MP} + \tilde{x}_{xg,t+1}^{MP} + \tilde{x}_{y,t+1}^{MP}.
\end{aligned}$$

Table 12 displays the VAR-based responses to monetary shocks under the augmented VAR.

As in the baseline VAR analysis of the last section 4, the interest rate channel is more important among long-term high-quality bonds, that is, AAA^L when the policy proxy is $MP1$ and both AAA^L and AA^L when the proxy is $MP2$. For all other cases, the risk premia channel is quantitatively more important. Disentangling between the components of total corporate bond risk premia, it turns out that the estimates of $\tilde{x}^{MP}_{xc,t+1}$ tend to show larger magnitudes, and with strong statistical significance, among low-rating bonds (BBB, BB, and B). This mechanism is especially clear when the policy proxy is $MP1$. On the other hand, the term premia channel tends to dominate the credit premia channel for high-quality bonds, especially among intermediate bonds, where the corresponding estimates are strongly significant (5%) in most cases. Still, for the long-maturity highest quality bonds (AAA and AA), the interest rate channel represents the main driver, consistent with the findings obtained for Treasury bonds in Section 4. As in the baseline VAR, we also see that the residual component is quantitatively the most important channel (with significance at the 5% level) in terms of explaining policy effects on the return of B^I when $MP2$ is the monetary proxy.

These results concerning the policy effect mix among the components of bond risk premia are not totally surprising. Bonds with higher credit risk should be more sensitive to shocks in credit premia (that is, expected returns in excess to premia associated with default-free bonds), and hence that channel should play a more important role in explaining the reaction to monetary policy shocks. On the other hand, bonds with lower credit risk act more like Treasury bonds, and thus, both the corresponding returns and the policy effects on those returns, should be more sensitive to shocks in the expected excess returns of Treasury bonds (term premia news).[35].

6 Conclusion

There is a vast amount of literature on the monetary policy implications for asset prices. Generally, stock and government bond markets have been the focus of the attention while there is significantly less empirical work carried out with respect to corporate bonds. The aim of this paper is to examine whether U.S. monetary policy has any implications for corporate bond returns and their components. Our analysis is timely since the Fed has in the process of normalising monetary conditions following a prolonged period of ultra-loose monetary policy. Moreover, we shed some light on the impact of the recent financial crisis on the empirical relationship between corporate bond market movements and monetary policy actions. To start, we simply regress monthly excess bond returns on a monetary policy indicator to provide an estimation

[35]This finding is also consistent with the evidence provided in Huang and Huang (2012)

of the respective contemporaneous correlation. Next, we adapt the log-linear return decomposition framework of Campbell and Ammer (1993), together with a first-order VAR model, to decompose the monetary policy effects on unexpected excess bond returns in terms of their three components: risk premium news, interest rate news, and cash-flow news.

By conducting simple regressions over the 1989.06–2015.12 period, we obtain a negative and significant response of excess returns on corporate bonds to monetary policy shocks. This conclusion remains valid across both medium and longer maturities as well as across different credit ratings. However, lower rating bonds are significantly more responsive to monetary shocks. Similar results are obtained when we examine monetary policy effects on unexpected excess bond returns, which are obtained from a first-order VAR.

The central part of the paper is in explaining what drives those bond return responses to monetary policy shocks. We provide evidence that bond premia news constitute the key driving force that explains the response of bond returns to monetary shocks. In other words, the largest share of the contemporaneous negative response of corporate bond returns to monetary policy tightening can be attributed to higher future expected excess bond returns (higher bond risk premia). The effects of monetary policy shocks on the expectations of future short-term interest rates (interest rate news) assume smaller magnitudes, albeit significant in many cases, when it comes to explaining the negative effect of policy tightening on current excess bond returns. Therefore, the risk premia channel represents an important mechanism through which monetary policy affects corporate bonds. Critically, the policy effect on bond premia news tends to be quantitatively more important for low-grade bonds and is also more statistically significant among intermediate bonds. On the other hand, the interest rate channel is more important for high-grade bonds, especially among the long-term categories. Further, the effect of policy shocks on future coupon payments (cash-flow news) tends to be quite small and insignificant in nearly all cases. In comparison, the impact of monetary shocks on the residual component of bond returns assumes a large magnitude and significance in the case of the intermediate B index.

We also compute VAR-based responses to policy shocks for intermediate and long-maturity Treasury bonds. The results suggest that Treasury bonds behave in a similar way to corporate bonds with low credit risk when assessing the impact of monetary policy shocks, that is, interest rate news represents the main channel of affecting bond returns. Hence, the effects of policy shocks on Treasuries are quite different from those observed for low-rating corporate bonds.

In the last part of the paper, we compute an alternative bond return decomposition, which disentangles bond premia news into one component related to term premia news (which is related to the slope of the Treasury yield curve) and another component related with credit premia news. The results indicate that credit premia news is the most important channel (in explaining the return responses to policy shocks) among low-rating bonds. On the other hand, the term premia channel tends to dominate for high-quality categories, especially among intermediate bonds.

In sum, our findings provide relevant new evidence on the effects of monetary policy on corporate bond returns and on the monetary transmission mechanism. The results overall support the predictions of theories of imperfect financial markets, whereas borrowers with lower credit rating are more sensitive to monetary policy shifts, relative to those with high rating.

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Figure 1: Barclays corporate bond indices

This figure plots the monthly time-series for long-term (L) and intermediate (I) maturity Barclays corporate bond indices with AAA, AA, A, BBB, BB and B ratings. Shaded areas denote US recessions as classified by NBER business cycle dates. The series have been normalised so that they are equal to 100 at the start of the sample period. The sample period is 1989.06–2015.12.

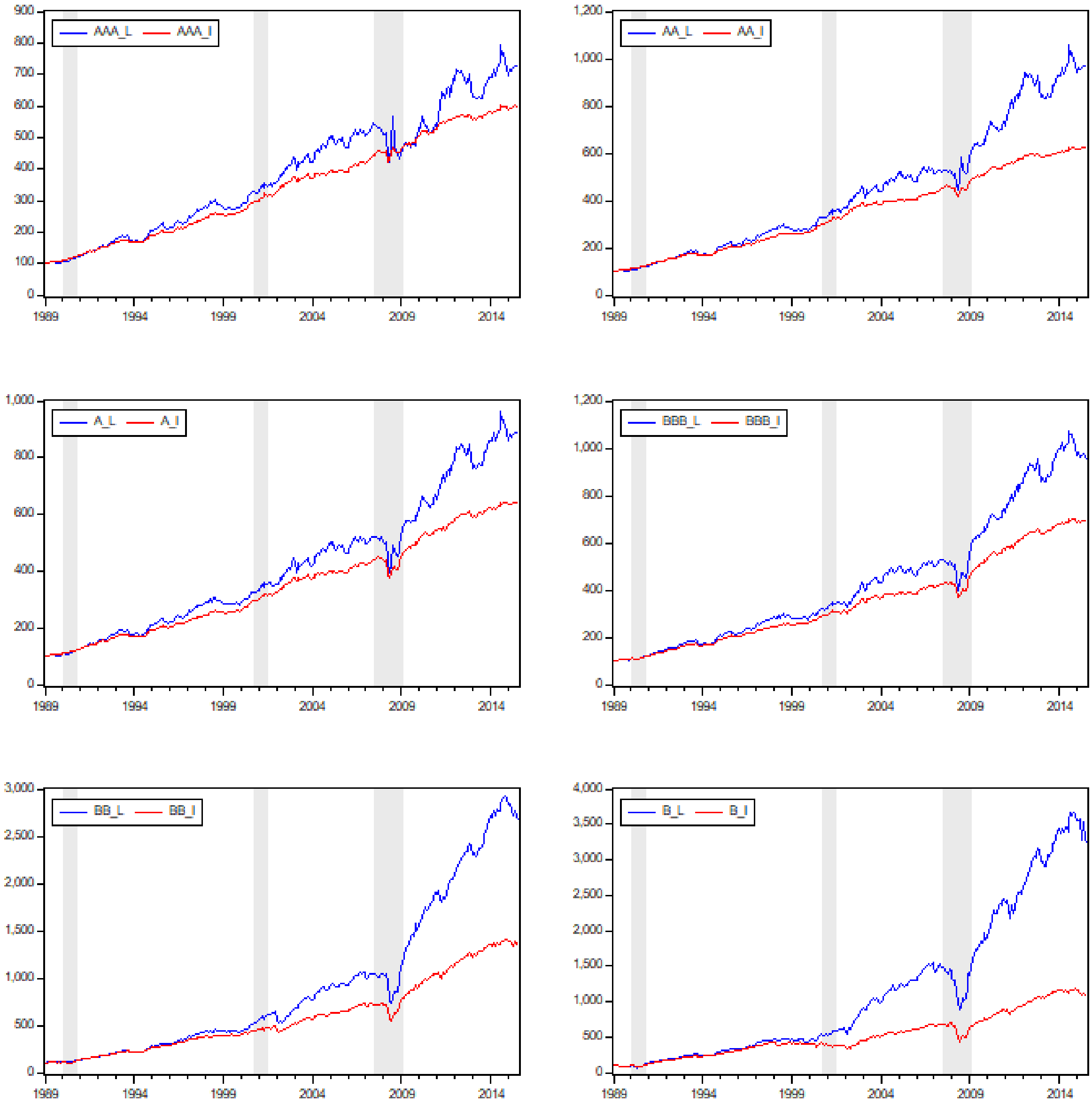

Figure 2: Monetary policy shocks

This figure plots the monthly time-series for monetary policy shocks (MP), proxied by surprises derived from the eight-quarter ahead Eurodollar futures ($MP1$) and the three-month ahead Fed funds futures ($MP2$). See Section 2 for more details. Shaded areas denote US recessions as classified by NBER business cycle dates. The sample period is 1989.06–2015.12.

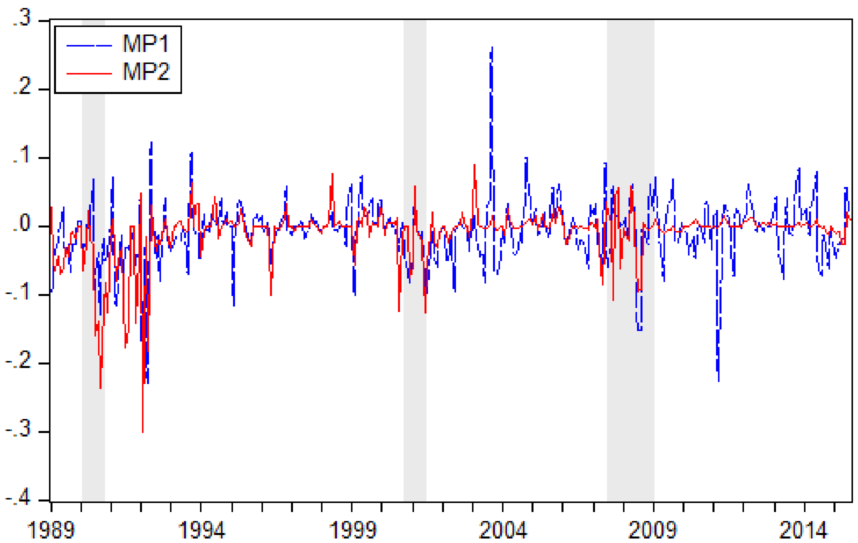

Table 1: Descriptive statistics for monetary policy shocks and other variables

This table presents descriptive statistics for the monetary policy shocks, proxied by surprises derived from the eight-quarter ahead Eurodollar futures ($MP1$) and the three-month ahead Fed funds futures ($MP2$), and the other variables used in the empirical analysis. These include the excess returns on Barclays corporate bond indices, representing portfolios of long-term (L) and intermediate (I) maturity corporate bonds with AAA, AA, A, BBB, BB and B ratings; the index-specific default spread (def); the term spread for long-term ($term^L$) and intermediate maturity ($term^I$) bonds; the inflation rate (π); the short-term rate (y); the log growth in coupon payments (Δq); and the excess returns on five-year ($Tr20y$) and twenty-year (Tr20y) Treasuries. The sample period is 1989.06–2015.12.

	Mean(%)	Stdev.(%)	Min.(%)	Max.(%)	Mean(%)	Stdev.(%)	Min.(%)	Max.
		Returns				def		
AAA^L	0.39	3.07	-19.26	16.78	0.67	0.55	-0.50	3.66
AA^L	0.47	2.72	-9.90	16.44	0.88	0.59	-0.28	3.35
A^L	0.45	2.75	-12.76	15.65	1.15	0.64	0.02	4.48
BBB^L	0.47	2.64	-16.48	11.02	1.70	0.76	0.33	5.68
BB^L	0.79	2.87	-21.11	11.69	3.20	1.47	1.21	11.67
B^L	0.85	4.39	-19.38	27.35	4.37	1.77	0.93	10.56
AAA^I	0.32	1.27	-7.92	5.07	0.62	0.53	0.11	4.05
AA^I	0.33	1.25	-6.80	5.56	0.77	0.68	-0.12	5.03
A^I	0.34	1.42	-11.62	5.46	1.14	0.90	0.37	6.46
BBB^I	0.36	1.46	-10.93	4.78	1.80	1.13	0.67	8.12
BB^I	0.57	2.39	-16.03	8.48	3.87	1.80	1.45	13.74
B^I	0.50	3.42	-18.37	16.09	5.77	2.41	2.46	19.01
$Tr5y$	0.25	1.23	-3.46	4.49				
$Tr20y$	0.46	2.88	-10.59	14.42				
$term^L$	2.58	1.52	-0.78	5.18				
$term^I$	1.31	0.97	-1.63	3.47				
$MP1$	-0.01	0.05	-0.23	0.26				
$MP2$	-0.01	0.04	-0.30	0.09				
π	0.21	0.27	-1.79	1.37				
y	0.25	0.20	0.00	0.74				
Δq^{AA}	0.00	0.01	-0.10	0.10				
Δq^{A}	0.00	0.01	-0.04	0.04				
Δq^{BBB}	0.00	0.01	-0.06	0.09				
Δq^{BB}	0.00	0.03	-0.26	0.16				
Δq^{B}	0.00	0.11	-0.65	0.98				

Table 2: Correlation matrix of excess corporate bond returns

This table presents the correlation coefficients for excess returns on Barclays corporate bond indices. The Barclays indices represent portfolios of long-term (L) and intermediate (I) maturity corporate bonds with AAA, AA, A, BBB, BB and B ratings. The sample period is 1989.06–2015.12.

	AAA^L	AA^L	A^L	BBB^L	BB^L	B^L	AAA^I	AA^I	A^I	BBB^I	BB^I	B^I
AAA^L	1.00											
AA^L	0.92	1.00										
A^L	0.88	0.97	1.00									
BBB^L	0.75	0.89	0.95	1.00								
BB^L	0.32	0.48	0.60	0.74	1.00							
B^L	0.14	0.29	0.39	0.51	0.71	1.00						
AAA^I	0.86	0.83	0.82	0.72	0.34	0.22	1.00					
AA^I	0.78	0.85	0.87	0.80	0.50	0.36	0.94	1.00				
A^I	0.76	0.82	0.88	0.84	0.60	0.45	0.90	0.96	1.00			
BBB^I	0.56	0.73	0.83	0.91	0.77	0.59	0.71	0.83	0.87	1.00		
BB^I	0.22	0.38	0.50	0.64	0.87	0.84	0.27	0.42	0.52	0.71	1.00	
B^I	0.13	0.27	0.39	0.51	0.75	0.87	0.15	0.29	0.40	0.56	0.90	1.00

Table 3: Responses of excess bond returns to monetary policy shocks

This table presents the estimated response of excess corporate and Treasury bond returns to monetary policy shocks, proxied by surprises derived from the eight-quarter ahead Eurodollar futures ($MP1$) and the three-month ahead Fed funds futures ($MP2$), as described in Section 3. Corporate bond returns are calculated using the Barclays corporate bond indices, which represent portfolios of long-term (L) and intermediate (I) maturity corporate bonds with AAA, AA, A, BBB, BB and B ratings. Treasury returns correspond to five-year ($Tr5y$) and twenty-year ($Tr20y$) bonds. The sample period is 1989.06–2015.12. $\overline{R}^2$ is the adjusted R^2. t-statistics using heteroskedasticity-consistent standard errors are reported in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

	AAA^L	AA^L	A^L	BBB^L	BB^L	B^L	AAA^I	AA^I	A^I	BBB^I	BB^I	B^I	$Tr5y$	$Tr20y$
Panel A: $MP1$														
Intercept	0.003**	0.004***	0.004**	0.004**	0.01***	0.01***	0.003***	0.003***	0.003***	0.003***	0.01***	0.004*	0.002***	0.004***
	(2.00)	(2.75)	(2.33)	(2.51)	(4.07)	(2.97)	(3.90)	(4.11)	(3.50)	(3.54)	(3.44)	(1.96)	(3.40)	(2.67)
MP	-6.58	-6.76	-8.61*	-8.13**	-10.19**	-15.67**	-3.57*	-3.97**	-4.39**	-5.24**	-10.30***	-13.71***	-1.94	-4.95
	(-1.10)	(-1.45)	(-1.94)	(-2.13)	(-2.42)	(-2.21)	(-1.93)	(-2.13)	(-2.07)	(-2.44)	(-2.77)	(-2.71)	(-1.17)	(-1.07)
$\overline{R}^2$	0.010	0.014	0.022	0.021	0.028	0.028	0.017	0.022	0.021	0.029	0.041	0.035	0.005	0.007
Panel B: $MP2$														
Intercept	0.004	0.002**	0.001*	0.004**	0.01***	0.01**	0.002***	0.003***	0.003***	0.003***	0.004***	0.004	0.003***	0.002**
	(1.59)	(2.35)	(1.87)	(2.10)	(3.72)	(2.48)	(3.25)	(3.50)	(2.84)	(3.04)	(2.91)	(1.46)	(3.00)	(2.47)
MP	-10.54*	-10.73**	-13.47***	-12.51***	-12.66***	-25.24**	-6.96***	-7.37***	-8.51***	-8.42***	-16.19***	-21.15***	-3.95**	-5.70
	(-1.88)	(-2.35)	(-2.95)	(-3.22)	(-3.02)	(-2.28)	(-3.34)	(-3.66)	(-3.71)	(-4.04)	(-4.19)	(-2.96)	(-2.22)	(-1.26)
$\overline{R}^2$	0.020	0.026	0.040	0.038	0.032	0.055	0.050	0.058	0.060	0.056	0.077	0.064	0.017	0.007

Table 4: Responses of excess bond returns to monetary policy shocks: controlling for business conditions

This table presents the estimated response of excess corporate bond returns to monetary policy shocks, proxied by surprises derived from the eight-quarter ahead Eurodollar futures ($MP1$) and the three-month ahead Fed funds futures ($MP2$), controlling for business conditions, as described in Section 3. Bond returns are calculated using the Barclays corporate bond indices, which represent portfolios of long-term (L) and intermediate (I) maturity corporate bonds with AAA, AA, A, BBB, BB and B ratings. The business conditions controls include the index-specific default spread (def); the term spread ($term$); and the inflation rate (inf). The sample period is 1989.06–2015.12. $\overline{R}^2$ is the adjusted R^2. t-statistics using heteroskedasticity-consistent standard errors are reported in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

	AAA^L	AA^L	A^L	BBB^L	BB^L	B^L	AAA^I	AA^I	A^I	BBB^I	BB^I	B^I
Panel A: $MP1$												
$Intercept$	0.03***	0.02***	0.02**	0.01	0.002	0.01	0.01***	0.01***	0.01**	0.004	0.01	0.02**
	(3.13)	(3.01)	(2.43)	(1.62)	(0.27)	(1.28)	(3.45)	(3.58)	(2.58)	(1.37)	(1.27)	(2.21)
MP	-6.27	-6.49	-8.51**	-8.14**	-10.02**	-15.86**	-3.61**	-4.02**	-4.45**	-5.21**	-10.84***	-16.19***
	(-1.15)	(-1.50)	(-2.01)	(-2.09)	(-2.28)	(-2.18)	(-1.98)	(-2.18)	(-2.03)	(-2.18)	(-2.68)	(-2.94)
def	-1.24	-0.33	-0.46	-0.26	0.01	-0.27	-0.20	-0.11	-0.12	0.01	-0.10	-0.32**
	(-1.55)	(-0.84)	(-0.95)	(-0.68)	(0.06)	(-1.17)	(-0.56)	(-0.52)	(-0.49)	(0.08)	(-0.61)	(-2.06)
$term$	-0.25*	-0.09	-0.08	0.03	0.15	0.27*	-0.19**	-0.16**	-0.12	-0.05	0.16	0.43**
	(-1.86)	(-0.83)	(-0.71)	(0.28)	(1.58)	(1.86)	(-2.55)	(-2.06)	(-1.48)	(-0.57)	(1.38)	(2.20)
inf	-3.71***	-2.87***	-2.35***	-1.45*	0.56	-0.85	-0.98***	-0.78***	-0.85**	-0.11	-0.07	-0.17
	(-3.55)	(-3.42)	(-2.75)	(-1.68)	(0.51)	(-0.55)	(-2.71)	(-2.65)	(-2.31)	(-0.23)	(-0.08)	(-0.13)
Panel B: $MP2$												
$Intercept$	0.02***	0.01***	0.01**	0.01	0.002	0.02	0.01***	0.01***	0.01**	0.003	0.01	0.02**
	(2.97)	(2.87)	(2.31)	(1.50)	(0.18)	(1.53)	(3.50)	(3.59)	(2.55)	(1.33)	(1.58)	(2.49)
MP	-9.68*	-10.90**	-13.60***	-12.69***	-12.54***	-27.97**	-7.35***	-7.70***	-8.78***	-8.47***	-17.61***	-25.49***
	(-1.79)	(-2.45)	(-3.00)	(-3.18)	(-2.88)	(-2.39)	(-3.59)	(-3.85)	(-3.79)	(-3.75)	(-3.84)	(-3.19)
def	-1.19	-0.31	-0.44	-0.25	0.01	-0.36	-0.21	-0.12	-0.12	0.01	-0.15	-0.37**
	(-1.48)	(-0.82)	(-0.93)	(-0.65)	(0.06)	(-1.55)	(-0.62)	(-0.60)	(-0.50)	(0.06)	(-0.91)	(-2.32)
$term$	-0.24*	-0.08	-0.07	0.04	0.16*	0.27*	-0.21***	-0.18**	-0.13*	-0.06	0.14	0.38**
	(-1.75)	(-0.78)	(-0.64)	(0.38)	(1.71)	(1.85)	(-2.73)	(-2.24)	(-1.67)	(-0.74)	(1.22)	(2.12)
inf	-3.73***	-2.90***	-2.39***	-1.49*	0.51	-1.00	-1.02***	-0.82***	-0.88**	-0.15	-0.21	-0.37
	(-3.66)	(-3.53)	(-2.86)	(-1.77)	(0.45)	(-0.63)	(-2.92)	(-2.87)	(-2.53)	(-0.32)	(-0.23)	(-0.28)

Table 5: Benchmark VAR estimates: equation for $x_{n,t+1}$

This table presents the estimated coefficients for the excess corporate bond return ($x_{n,t+1}$) equation in the benchmark VAR(1). The VAR state vector is given by $[def_t, term_t, inf_t, \Delta q_t, y_t, x_{n+1,t}]'$, where x_{n+1} denotes the excess return (relative to the risk-free rate) on the Barclays corporate bond index with average maturity $n+1$; def denotes the default spread; $term$ is the term spread; y denotes the continuously compounded one-month Treasury bill rate; Δq is the log growth in the recovery coupon rate; and inf represents the inflation rate. The Barclays indices represent portfolios of long-term (L) and intermediate (I) maturity corporate bonds with AAA, AA, A, BBB, BB, and B ratings. In the case of AAA bonds, there is no cash-flow news component and the VAR state vector is given by $[def_t, term_t, inf_t, y_t, x_{n+1,t}]'$. The sample period is 1989.07–2015.12. $\overline{R}^2$ is the adjusted R^2. Newey–West t-ratios (with one lag) are reported in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

	def_t	$term_t$	inf_t	Δq_t	y_t	$x_{n+1,t}$	$\overline{R}^2$
AAA^L	0.194	0.487*	−1.126		2.960	0.034	0.02
	(0.22)	(1.81)	(−0.91)		(1.60)	(0.36)	
AA^L	0.870*	0.669***	−1.561	−14.806	3.718***	0.009	0.06
	(1.86)	(3.58)	(−1.36)	(−0.78)	(2.73)	(0.11)	
A^L	0.525	0.561***	−1.356	3.174	3.180**	0.089	0.05
	(1.01)	(3.10)	(−1.33)	(0.14)	(2.41)	(1.11)	
BBB^L	0.566*	0.548***	−1.006	4.366	3.060***	0.105	0.06
	(1.65)	(3.93)	(−1.35)	(0.49)	(2.92)	(1.34)	
BB^L	0.433***	0.366***	−1.264**	−0.551	2.680***	0.339***	0.17
	(2.76)	(3.06)	(−2.41)	(−0.14)	(3.30)	(3.37)	
B^L	0.520**	0.315*	−1.389	−0.253	0.438	0.289***	0.12
	(2.36)	(1.66)	(−1.30)	(−0.09)	(0.24)	(2.79)	
AAA^I	0.200	0.255***	−0.398		0.744**	0.114**	0.04
	(0.76)	(3.21)	(−1.17)		(2.24)	(2.26)	
AA^I	0.211	0.266***	−0.483	−10.408	0.730**	0.163***	0.06
	(1.19)	(3.19)	(−1.48)	(−1.50)	(2.16)	(2.95)	
A^I	0.195	0.270***	−0.486	−0.495	0.723*	0.198***	0.07
	(1.06)	(3.24)	(−1.37)	(−0.04)	(1.89)	(3.52)	
BBB^I	0.223*	0.291***	−0.450*	0.968	0.628*	0.214***	0.09
	(1.86)	(3.62)	(−1.79)	(0.14)	(1.73)	(2.68)	
BB^I	0.260**	0.155	−1.069*	5.929	0.624	0.333***	0.16
	(2.43)	(1.35)	(−1.95)	(1.18)	(0.88)	(3.17)	
B^I	0.191	0.228	−1.139	−0.208	−0.041	0.348***	0.13
	(1.54)	(1.27)	(−1.23)	(−0.10)	(−0.04)	(3.40)	

Table 6: Variance decomposition for unexpected excess corporate bond returns

This table presents the decomposition of the variance of unexpected excess corporate bond returns into the variance of bond premia news ($\tilde{x}_{x,t+1}$); the variance of interest rate news ($\tilde{x}_{y,t+1}$); the variance of cash-flow news ($\tilde{x}_{q,t+1}$); the variance of the residual component ($\tilde{x}_{r,t+1}$); and the corresponding covariance terms. The news components are extracted from a VAR(1). The VAR state vector is given by $[def_t, term_t, inf_t, \Delta q_t, y_t, x_{n+1,t}]'$, where x_{n+1} denotes the excess return (relative to the risk-free rate) on the Barclays corporate bond index with average maturity $n+1$; def denotes the default spread; $term$ is the term spread; y denotes the continuously compounded one-month Treasury bill rate; Δq is the log growth in the coupon recovery rate; and inf represents the inflation rate. The Barclays indices represent portfolios of long-term (L) and intermediate (I) maturity corporate bonds with AAA, AA, A, BBB, BB, and B ratings. In the case of AAA bonds, there is no cash-flow news component and the VAR state vector is given by $[def_t, term_t, inf_t, y_t, x_{n+1,t}]'$. The sample period is 1989.07–2015.12. The numbers in parentheses represent empirical p-values obtained from a bootstrap simulation. *, **, and *** denotes statistical significance at the 10%, 5%, and 1% level, respectively.

	AAA^L	AA^L	A^L	BBB^L	BB^L	B^L	AAA^I	AA^I	A^I	BBB^I	BB^I	B^I
$Var\,(\tilde{x}_x)$	0.80***	0.81***	0.69**	1.11***	1.49***	1.38***	0.54**	0.55**	0.60**	1.27***	1.09***	0.49**
	(0.00)	(0.00)	(0.02)	(0.00)	(0.00)	(0.00)	(0.01)	(0.03)	(0.02)	(0.00)	(0.00)	(0.02)
$Cov\,(\tilde{x}_x, \tilde{x}_y)$	0.43***	0.01***	0.02***	−0.36***	−0.51***	−0.35***	0.27***	0.11***	−0.25***	−0.72***	−0.51***	−0.29***
	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
$Cov\,(\tilde{x}_x, \tilde{x}_q)$		−0.00**	0.00	−0.00***	−0.00	0.01		−0.01**	0.00	−0.00**	−0.00	0.00
		(0.04)	(0.48)	(0.01)	(0.59)	(0.33)		(0.02)	(0.71)	(0.04)	(0.43)	(0.81)
$Cov\,(\tilde{x}_x, \tilde{x}_r)$	−0.72*	−0.35	0.12	−0.08	−1.25**	−1.24**	−0.23	0.06	0.37	−0.04	0.06	0.39
	(0.10)	(0.25)	(0.68)	(0.82)	(0.04)	(0.04)	(0.38)	(0.82)	(0.28)	(0.92)	(0.90)	(0.29)
$Var\,(\tilde{x}_y)$	0.26***	0.34***	0.34***	0.36***	0.26***	0.10***	0.67***	0.68***	0.51***	0.47***	0.17***	0.08***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
$Cov\,(\tilde{x}_y, \tilde{x}_q)$		0.00***	0.00***	0.00***	0.00***	0.00***		0.00***	0.00***	0.00*	0.00***	0.00***
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)		(0.00)	(0.00)	(0.07)	(0.00)	(0.00)
$Cov\,(\tilde{x}_y, \tilde{x}_r)$	−0.45***	−0.12***	−0.36***	−0.11***	−0.13***	0.07***	−0.68***	−0.74***	−0.48***	−0.05***	−0.15***	−0.14***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)
$Var\,(\tilde{x}_q)$		0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00
		(0.39)	(0.56)	(0.46)	(0.48)	(0.18)		(0.26)	(0.59)	(0.54)	(0.54)	(0.35)
$Cov\,(\tilde{x}_q, \tilde{x}_r)$		0.00	0.00	0.00	0.00	0.01		−0.00	0.00	0.00	0.00	0.01
		(0.82)	(0.81)	(0.69)	(0.94)	(0.23)		(0.28)	(0.91)	(0.82)	(0.83)	(0.67)
$Var\,(\tilde{x}_r)$	0.67	0.30	0.18	0.09	1.13	1.03	0.43	0.35	0.24	0.07	0.34	0.45
	(1.00)	(1.00)	(1.00)	(1.00)	(0.37)	(0.48)	(1.00)	(1.00)	(1.00)	(1.00)	(0.99)	(0.94)

Table 7: VAR-based responses of excess corporate bond returns to monetary policy shocks

This table presents the estimated response of unexpected excess corporate bond returns ($\tilde{x}_n^{MP}$) and the four news components—bond premia news ($\tilde{x}_x^{MP}$); interest rate news ($\tilde{x}_y^{MP}$); cash-flow news ($\tilde{x}_q^{MP}$); and the residual component ($\tilde{x}_r^{MP}$)—to monetary policy shocks ($MP1, MP2$). $MP1$ represents policy surprises derived from the eight-quarter ahead Eurodollar futures contract, while $MP2$ represents policy surprises derived from the three-month ahead Fed funds futures contract. The news components are extracted from a VAR(1). The VAR state vector is given by $[def_t, term_t, inf_t, \Delta q_t, y_t, x_{n+1,t}]'$, where x_{n+1} denotes the excess return (relative to the risk-free rate) on the Barclays corporate bond index with average maturity $n+1$; def denotes the default spread; $term$ is the term spread; y denotes the continuously compounded one-month Treasury bill rate; Δq is the log growth in the coupon recovery rate; and inf represents the inflation rate. The Barclays indices represent portfolios of long-term (L) and intermediate (I) maturity corporate bonds with AAA, AA, A, BBB, BB, and B ratings. In the case of AAA bonds, there is no cash-flow news component and the VAR state vector is given by $[def_t, term_t, inf_t, y_t, x_{n+1,t}]'$. The sample period is 1989.07–2015.12. The numbers in parentheses represent empirical p-values obtained from a bootstrap simulation. *, **, and *** denotes statistical significance at the 10%, 5%, and 1% level, respectively.

	AAA^L	AA^L	A^L	BBB^L	BB^L	B^L	AAA^I	AA^I	A^I	BBB^I	BB^I	B^I
						Panel A: $MP1$						
$\tilde{x}_n^{MP}$	−3.50	−3.35	−4.72*	−4.41*	−5.96**	−10.94**	−1.92*	−2.14*	−2.22*	−3.25**	−6.08**	−9.13***
	(0.16)	(0.14)	(0.07)	(0.07)	(0.03)	(0.01)	(0.09)	(0.07)	(0.08)	(0.02)	(0.01)	(0.01)
$\tilde{x}_x^{MP}$	0.12	3.24***	4.22***	4.71***	4.49***	7.31***	0.92**	1.12**	1.79***	3.22***	5.31***	5.19***
	(0.44)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.04)	(0.03)	(0.01)	(0.00)	(0.00)	(0.00)
$\tilde{x}_y^{MP}$	1.28***	0.85***	−0.24	0.40***	0.61***	0.67***	−0.44	−0.09	−0.28	−0.38	−0.50	−0.47
	(0.00)	(0.00)	(1.00)	(0.00)	(0.00)	(0.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)
$\tilde{x}_q^{MP}$		−0.01	0.00	0.01	−0.01	0.01		0.00	0.00	0.01	0.00	0.05
		(0.22)	(0.67)	(0.78)	(0.35)	(0.52)		(0.49)	(0.52)	(0.78)	(0.51)	(0.66)
$\tilde{x}_r^{MP}$	−2.10	0.74	−0.75	0.69	−0.86	−2.98	−1.44	−1.11	−0.71	−0.41	−1.27	−4.47
	(0.55)	(0.80)	(0.81)	(0.82)	(0.78)	(0.55)	(0.35)	(0.46)	(0.65)	(0.80)	(0.60)	(0.23)
						Panel B: $MP2$						
$\tilde{x}_n^{MP}$	−7.43**	−6.65**	−9.23***	−8.49***	−6.88**	−14.63***	−5.05***	−4.78***	−5.96***	−6.19***	−8.80***	−14.09***
	(0.03)	(0.03)	(0.01)	(0.01)	(0.02)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
$\tilde{x}_x^{MP}$	−0.04	1.67*	6.81***	8.09***	7.70***	8.26***	1.89***	2.50***	3.82***	5.49***	6.00***	2.50**
	(0.52)	(0.08)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.05)
$\tilde{x}_y^{MP}$	3.76***	3.31***	1.58***	1.95***	3.13***	3.12***	0.73***	0.65***	0.42***	0.61***	1.14***	1.26***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
$\tilde{x}_q^{MP}$		−0.01*	0.00	0.01	−0.08**	−0.09		0.01	−0.01	0.01	−0.06*	0.00
		(0.07)	(0.20)	(0.73)	(0.02)	(0.24)		(0.90)	(0.11)	(0.71)	(0.06)	(0.48)
$\tilde{x}_r^{MP}$	−3.71	−1.66	−0.84	1.54	4.02	−3.16	−2.43	−1.64	−1.70	−0.10	−1.60	−10.33**
	(0.37)	(0.64)	(0.83)	(0.65)	(0.27)	(0.57)	(0.17)	(0.34)	(0.34)	(0.96)	(0.55)	(0.04)

Table 8: VAR-based responses of excess Treasury bond returns to monetary policy shocks

This table presents the estimated response of unexpected excess Treasury bond returns ($\tilde{x}_n^{MP}$) and the three news components—Treasury risk premium news ($\tilde{x}_{xg}^{MP}$); interest rate news ($\tilde{x}_y^{MP}$); and the residual component ($\tilde{x}_r^{MP}$)—to monetary policy shocks ($MP1, MP2$). $MP1$ represents policy surprises derived from the eight-quarter ahead Eurodollar futures contract, while $MP2$ represents policy surprises derived from the three-month ahead Fed funds futures contract. The news components are extracted from a VAR(1). The VAR state vector is given by $\left[term_t, inf_t, y_t, x_{n+1,t}^g\right]'$, where x_{n+1}^g denotes the excess return (relative to the risk-free rate) on the Treasury bond with average maturity $n+1$; $term$ is the term spread; y denotes the continuously compounded one-month Treasury bill rate; and inf represents the inflation rate. The bonds are the 20-year ($Tr20y$) and 5-year ($Tr5y$) maturity Treasury bonds. The sample period is 1989.07–2015.12. The numbers in parentheses represent empirical p-values obtained from a bootstrap simulation. *, **, and *** denotes statistical significance at the 10%, 5%, and 1% level, respectively.

	$MP1$		$MP2$	
	$Tr20y$	$Tr5y$	$Tr20y$	$Tr5y$
$\tilde{x}_n^{MP}$	−2.60	−0.57	−4.09	−2.71**
	(0.22)	(0.35)	(0.15)	(0.05)
$\tilde{x}_{xg}^{MP}$	−0.18	−0.23	−1.06	−0.74
	(0.63)	(0.84)	(0.89)	(0.98)
$\tilde{x}_y^{MP}$	1.53***	0.60***	4.61***	3.11***
	(0.00)	(0.00)	(0.00)	(0.00)
$\tilde{x}_r^{MP}$	−1.25	−0.19	−0.55	−0.35
	(0.71)	(0.90)	(0.89)	(0.83)

Table 9: Augmented VAR estimates: equation for $x_{n,t+1}$

This table presents the estimated coefficients for the excess corporate bond return ($x_{n,t+1}$) equation in the augmented VAR(1). The VAR state vector is given by $\left[def_t, term_t, inf_t, \Delta q_t, y_t, x^g_{n+1,t}, x_{n+1,t}\right]'$, where x_{n+1} denotes the excess return (relative to the risk-free rate) on the Barclays corporate bond index with average maturity $n+1$; x^g_{n+1} represents the excess return of a Treasury bond with average maturity $n+1$; def denotes the default spread; $term$ is the term spread; y denotes the continuously compounded one-month Treasury bill rate; Δq is the log growth in the coupon recovery rate; and inf represents the inflation rate. The Barclays indices represent portfolios of long-term (L) and intermediate (I) maturity corporate bonds with AAA, AA, A, BBB, BB, and B ratings. In the case of AAA bonds, there is no cash-flow news component and the VAR state vector is given by $\left[def_t, term_t, inf_t, y_t, x^g_{n+1,t}, x_{n+1,t}\right]'$. The sample period is 1989.07–2015.12. $\overline{R}^2$ is the adjusted R^2. Newey–West t-ratios (with one lag) are reported in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

	def_t	$term_t$	inf_t	Δq_t	y_t	$x^g_{n+1,t}$	$x_{n+1,t}$	$\overline{R}^2$
AAA^L	0.083	0.481*	−1.125		2.929	0.127	−0.069	0.02
	(0.08)	(1.74)	(−0.90)		(1.56)	(0.54)	(−0.26)	
AA^L	0.839*	0.691***	−1.479	−9.878	3.797***	0.167	−0.131	0.06
	(1.78)	(3.59)	(−1.37)	(−0.57)	(2.82)	(0.98)	(−0.66)	
A^L	0.504	0.566***	−1.302	4.101	3.173**	0.049	0.051	0.05
	(1.00)	(3.07)	(−1.37)	(0.18)	(2.45)	(0.30)	(0.27)	
BBB^L	0.568*	0.547***	−1.020	4.152	3.062***	−0.008	0.111	0.06
	(1.67)	(3.90)	(−1.43)	(0.47)	(2.92)	(−0.07)	(0.81)	
BB^L	0.419***	0.385***	−1.010**	−1.203	2.694***	0.093*	0.324***	0.18
	(2.74)	(3.22)	(−2.13)	(−0.33)	(3.37)	(1.95)	(3.20)	
B^L	0.440**	0.390**	−0.573	−1.226	0.813	0.307***	0.289***	0.16
	(1.99)	(2.16)	(−0.56)	(−0.48)	(0.47)	(3.36)	(2.89)	
AAA^I	0.155	0.265***	−0.420		0.776**	0.122	0.012	0.04
	(0.55)	(3.41)	(−1.21)		(2.30)	(0.96)	(0.10)	
AA^I	0.212	0.265***	−0.484	−10.485	0.729**	−0.004	0.166*	0.06
	(1.20)	(3.14)	(−1.50)	(−1.55)	(2.14)	(−0.04)	(1.67)	
A^I	0.211	0.260***	−0.500	−1.152	0.733*	−0.069	0.237***	0.06
	(1.14)	(3.07)	(−1.42)	(−0.09)	(1.91)	(−0.69)	(2.70)	
BBB^I	0.241**	0.271***	−0.520**	−1.070	0.668*	−0.122	0.270**	0.10
	(2.07)	(3.32)	(−2.01)	(−0.15)	(1.82)	(−1.14)	(2.35)	
BB^I	0.236**	0.195*	−0.973*	5.811	0.642	0.166*	0.328***	0.16
	(2.21)	(1.67)	(−1.86)	(1.16)	(0.91)	(1.95)	(3.13)	
B^I	0.150	0.328*	−0.932	−0.694	0.080	0.387***	0.351***	0.14
	(1.19)	(1.82)	(−1.08)	(−0.35)	(0.08)	(2.78)	(3.49)	

Table 10: Augmented VAR estimates: equation for $x^g_{n,t+1}$

This table presents the estimated coefficients for the excess Treasury bond return ($x^g_{n,t+1}$) equation in the augmented VAR(1). The VAR state vector is given by $\left[def_t, term_t, inf_t, \Delta q_t, y_t, x^g_{n+1,t}, x_{n+1,t}\right]'$, where x_{n+1} denotes the excess return (relative to the risk-free rate) on the Barclays corporate bond index with average maturity $n+1$; x^g_{n+1} represents the excess return of a Treasury bond with average maturity $n+1$; def denotes the default spread; $term$ is the term spread; y denotes the continuously compounded one-month Treasury bill rate; Δq is the log growth in the coupon recovery rate; and inf represents the inflation rate. The Barclays indices represent portfolios of long-term (L) and intermediate (I) maturity corporate bonds with AAA, AA, A, BBB, BB, and B ratings. In the case of AAA bonds, there is no cash-flow news component and the VAR state vector is given by $\left[def_t, term_t, inf_t, y_t, x^g_{n+1,t}, x_{n+1,t}\right]'$. The sample period is 1989.07–2015.12. $\overline{R}^2$ is the adjusted R^2. Newey–West t-ratios (with one lag) are reported in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

	def_t	$term_t$	inf_t	Δq_t	y_t	$x^g_{n+1,t}$	$x_{n+1,t}$	$\overline{R}^2$
AAA^L	0.757	0.554***	−0.555		2.920*	−0.037	0.068	0.02
	(1.02)	(2.58)	(−0.65)		(1.87)	(−0.17)	(0.28)	
AA^L	0.408	0.517***	−0.929	−3.784	2.599*	0.168	−0.199	0.02
	(0.86)	(2.60)	(−0.89)	(−0.40)	(1.80)	(1.17)	(−1.15)	
A^L	0.261	0.469***	−0.740	11.847	2.317	0.174	−0.219	0.03
	(0.59)	(2.60)	(−0.81)	(0.41)	(1.64)	(1.43)	(−1.38)	
BBB^L	0.135	0.437***	−0.674	8.014	2.036	0.167*	−0.247**	0.04
	(0.38)	(2.69)	(−0.78)	(0.94)	(1.48)	(1.95)	(−2.01)	
BB^L	−0.031	0.399***	−0.703	−8.995	1.494	0.061	−0.226**	0.06
	(−0.20)	(2.87)	(−0.86)	(−1.63)	(1.22)	(1.05)	(−2.50)	
B^L	0.048	0.395***	−0.916	0.921	1.696	0.005	−0.085*	0.02
	(0.40)	(2.88)	(−0.86)	(0.84)	(1.51)	(0.07)	(−1.85)	
AAA^I	0.181	0.244***	−0.207		0.534	0.183	−0.069	0.03
	(0.91)	(3.07)	(−0.83)		(1.54)	(1.55)	(−0.65)	
AA^I	0.148	0.254***	−0.205	−8.985***	0.547	0.184*	−0.089	0.03
	(1.04)	(3.09)	(−0.82)	(−3.56)	(1.58)	(1.88)	(−0.97)	
A^I	0.105	0.249***	−0.201	0.443	0.609*	0.183**	−0.082	0.03
	(0.98)	(3.09)	(−0.80)	(0.03)	(1.70)	(2.31)	(−1.28)	
BBB^I	0.064	0.243***	−0.140	1.675	0.510	0.221***	−0.145**	0.04
	(0.86)	(3.05)	(−0.60)	(0.30)	(1.44)	(3.01)	(−2.28)	
BB^I	0.036	0.239***	−0.233	−3.531	0.448	0.130**	−0.102***	0.07
	(0.96)	(3.01)	(−1.03)	(−1.32)	(1.30)	(2.21)	(−3.55)	
B^I	0.022	0.237***	−0.198	0.589	0.417	0.103*	−0.062***	0.06
	(0.71)	(2.78)	(−0.86)	(1.22)	(1.21)	(1.71)	(−2.60)	

Table 11: Augmented variance decomposition for unexpected excess corporate bond returns

This table presents the decomposition of the variance of unexpected excess corporate bond returns into the variance of credit premia news ($\tilde{x}_{xc,t+1}$); the variance of term premia news ($\tilde{x}_{xg,t+1}$); the variance of interest rate news ($\tilde{x}_{y,t+1}$); the variance of cash-flow news ($\tilde{x}_{q,t+1}$); the variance of the residual component ($\tilde{x}_{r,t+1}$); and the corresponding covariance terms. The news components are extracted from a VAR(1). The VAR state vector is given by $\left[def_t, term_t, inf_t, \Delta q_t, y_t, x^g_{n+1,t}, x_{n+1,t}\right]'$, where x_{n+1} denotes the excess return (relative to the risk-free rate) on the Barclays corporate bond index with average maturity $n+1$; x^g_{n+1} represents the excess return of a Treasury bond with average maturity $n+1$; def denotes the default spread; $term$ is the term spread; y denotes the continuously compounded one-month Treasury bill rate; Δq is the log growth in the coupon recovery rate; and inf represents the inflation rate. The Barclays indices represent portfolios of long-term (L) and intermediate (I) maturity corporate bonds with AAA, AA, A, BBB, BB, and B ratings. In the case of AAA bonds, there is no cash-flow news component and the VAR state vector is given by $\left[def_t, term_t, inf_t, y_t, x^g_{n+1,t}, x_{n+1,t}\right]'$. The sample period is 1989.07–2015.12. The numbers in parentheses represent empirical p-values obtained from a bootstrap simulation. *, **, and *** denotes statistical significance at the 10%, 5%, and 1% level, respectively.

	AAA^L	AA^L	A^L	BBB^L	BB^L	B^L	AAA^I	AA^I	A^I	BBB^I	BB^I	B^I
$Var(\tilde{x}_{xc})$	0.29^{***}	0.11	0.04	0.34^{**}	1.42^{***}	0.94^{**}	0.03	0.02	0.07	0.54^{***}	0.69^{**}	0.36^{*}
	(0.01)	(0.11)	(0.57)	(0.04)	(0.01)	(0.02)	(0.29)	(0.79)	(0.40)	(0.01)	(0.01)	(0.06)
$Cov(\tilde{x}_{xc}, \tilde{x}_{xg})$	0.07	0.17	0.11	0.14	−0.48	0.21	0.04	0.08	0.13	0.33^{*}	0.24^{*}	0.12^{*}
	(0.33)	(0.18)	(0.39)	(0.41)	(0.15)	(0.24)	(0.46)	(0.39)	(0.27)	(0.06)	(0.08)	(0.10)
$Cov(\tilde{x}_{xc}, \tilde{x}_{y})$	0.38^{***}	-0.09^{***}	-0.06^{***}	-0.38^{***}	-0.54^{***}	-0.35^{***}	0.25^{***}	0.05^{***}	-0.24^{***}	-0.70^{***}	-0.48^{***}	-0.30^{***}
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
$Cov(\tilde{x}_{xc}, \tilde{x}_{q})$		-0.00^{*}	−0.00	−0.00	−0.00	0.02^{**}		−0.00	−0.00	−0.00	−0.00	0.00
		(0.06)	(0.65)	(0.18)	(0.82)	(0.05)		(0.19)	(0.95)	(0.15)	(0.21)	(0.77)
$Cov(\tilde{x}_{xc}, \tilde{x}_{r})$	-0.69^{**}	−0.08	0.08	0.03	-1.32^{**}	−0.92	−0.21	0.01	0.21	0.04	0.02	0.19
	(0.01)	(0.58)	(0.72)	(0.92)	(0.04)	(0.11)	(0.12)	(0.95)	(0.36)	(0.87)	(0.98)	(0.70)
$Var(\tilde{x}_{xg})$	0.51^{**}	0.59^{**}	0.57^{**}	0.63^{**}	0.56^{**}	0.24^{**}	0.46^{**}	0.44^{*}	0.38^{*}	0.34^{*}	0.15^{**}	0.06^{**}
	(0.03)	(0.02)	(0.04)	(0.03)	(0.03)	(0.03)	(0.02)	(0.05)	(0.05)	(0.06)	(0.03)	(0.03)
$Cov(\tilde{x}_{xg}, \tilde{x}_{y})$	0.06^{***}	0.10^{***}	0.05^{***}	0.03^{***}	0.02^{***}	-0.00^{***}	0.02^{**}	0.06^{***}	−0.01	−0.01	-0.03^{***}	-0.01^{***}
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.13)	(0.14)	(0.00)	(0.00)
$Cov(\tilde{x}_{xg}, \tilde{x}_{q})$		−0.00	−0.00	-0.00^{**}	−0.00	-0.01^{**}		-0.00^{**}	−0.00	−0.00	0.00	−0.00
		(0.17)	(0.75)	(0.03)	(0.81)	(0.02)		(0.03)	(0.67)	(0.11)	(0.27)	(0.11)
$Cov(\tilde{x}_{xg}, \tilde{x}_{r})$	−0.08	−0.25	0.05	−0.10	0.06	−0.42	−0.02	0.02	0.14	−0.06	0.04	0.10
	(0.71)	(0.37)	(0.88)	(0.77)	(0.84)	(0.14)	(0.91)	(0.94)	(0.63)	(0.83)	(0.86)	(0.57)
$Var(\tilde{x}_{y})$	0.26^{***}	0.34^{***}	0.32^{***}	0.34^{***}	0.27^{***}	0.10^{***}	0.67^{***}	0.70^{***}	0.54^{***}	0.51^{***}	0.18^{***}	0.08^{***}
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
$Cov(\tilde{x}_{y}, \tilde{x}_{q})$		0.00^{***}	0.00^{***}	0.00^{***}	0.00^{***}	0.00^{***}		0.00^{***}	-0.00^{***}	0.00^{***}	0.00^{***}	0.00^{***}
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
$Cov(\tilde{x}_{y}, \tilde{x}_{r})$	-0.47^{***}	-0.17^{***}	-0.34^{***}	-0.11^{***}	-0.13^{***}	0.06^{***}	-0.69^{***}	-0.74^{***}	-0.48^{***}	-0.06^{***}	-0.16^{***}	-0.13^{***}
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
$Var(\tilde{x}_{q})$		0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00
		(0.39)	(0.55)	(0.44)	(0.48)	(0.18)		(0.26)	(0.58)	(0.52)	(0.54)	(0.34)
$Cov(\tilde{x}_{q}, \tilde{x}_{r})$		0.00	−0.00	0.00	0.00	0.02		−0.00	0.00	0.00	0.00	0.01
		(0.83)	(0.81)	(0.69)	(0.95)	(0.16)		(0.25)	(0.94)	(0.79)	(0.83)	(0.53)
$Var(\tilde{x}_{r})$	0.67	0.29	0.18	0.09	1.14	1.11	0.46	0.38	0.25	0.08	0.35	0.52
	(1.00)	(1.00)	(1.00)	(1.00)	(0.36)	(0.39)	(1.00)	(1.00)	(1.00)	(1.00)	(0.98)	(0.89)

Table 12: VAR-based responses of excess corporate bond returns to monetary policy shocks: augmented decomposition

This table presents the estimated response of unexpected excess corporate bond returns ($\tilde{x}_n^{MP}$) and the five news components—credit premia news ($\tilde{x}_{xc}^{MP}$); term premia news ($\tilde{x}_{xg}^{MP}$); interest rate news ($\tilde{x}_y^{MP}$); cash-flow news ($\tilde{x}_q^{MP}$); and the residual component ($\tilde{x}_r^{MP}$)—to monetary policy shocks ($MP1, MP2$). $MP1$ represents policy surprises derived from the eight-quarter ahead Eurodollar futures contract, while $MP2$ represents policy surprises derived from the three-month ahead Fed funds futures contract. The news components are extracted from a VAR(1). The VAR state vector is given by $\left[def_t, term_t, inf_t, \Delta q_t, y_t, x^g_{n+1,t}, x_{n+1,t}\right]'$, where x_{n+1} denotes the excess return (relative to the risk-free rate) on the Barclays corporate bond index with average maturity $n+1$; x^g_{n+1} represents the excess return of a Treasury bond with average maturity $n+1$; def denotes the default spread; $term$ is the term spread; y denotes the continuously compounded one-month Treasury bill rate; Δq is the log growth in the coupon recovery rate; and inf represents the inflation rate. The Barclays indices represent portfolios of long-term (L) and intermediate (I) maturity corporate bonds with AAA, AA, A, BBB, BB, and B ratings. In the case of AAA bonds, there is no cash-flow news component and the VAR state vector is given by $\left[def_t, term_t, inf_t, y_t, x^g_{n+1,t}, x_{n+1,t}\right]'$. The sample period is 1989.07–2015.12. The numbers in parentheses represent empirical p-values obtained from a bootstrap simulation. *, **, and *** denotes statistical significance at the 10%, 5%, and 1% level, respectively.

	AAA^L	AA^L	A^L	BBB^L	BB^L	B^L	AAA^I	AA^I	A^I	BBB^I	BB^I	B^I
						Panel A: $MP1$						
$\tilde{x}_n^{MP}$	-3.78	-3.28	-4.67^{*}	-4.43^{*}	-5.48^{**}	-9.37^{**}	-1.90^{*}	-2.15^{*}	-2.32^{*}	-3.54^{**}	-5.63^{**}	-7.99^{**}
	(0.14)	(0.14)	(0.07)	(0.07)	(0.04)	(0.03)	(0.09)	(0.07)	(0.07)	(0.02)	(0.02)	(0.02)
$\tilde{x}_{xc}^{MP}$	0.15	1.72^{**}	1.76^{**}	3.00^{***}	3.06^{**}	4.13^{**}	-0.17	0.27	0.87^{**}	2.61^{***}	3.52^{***}	2.94^{**}
	(0.37)	(0.02)	(0.03)	(0.01)	(0.02)	(0.03)	(0.82)	(0.16)	(0.03)	(0.00)	(0.00)	(0.03)
$\tilde{x}_{xg}^{MP}$	-0.15	1.10	2.25^{**}	1.69^{*}	1.10	1.50^{*}	0.95^{**}	0.85^{*}	1.02^{**}	1.24^{**}	1.45^{**}	1.67^{***}
	(0.57)	(0.14)	(0.04)	(0.08)	(0.14)	(0.09)	(0.03)	(0.05)	(0.03)	(0.02)	(0.01)	(0.00)
$\tilde{x}_y^{MP}$	1.38^{***}	1.08^{***}	0.04^{**}	0.45^{***}	0.59^{***}	0.66^{***}	-0.36	-0.22	-0.39	-0.81	-0.60	-0.53
	(0.00)	(0.00)	(0.02)	(0.00)	(0.00)	(0.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)
$\tilde{x}_q^{MP}$		-0.01	0.00	0.01	-0.01	0.01		0.00	0.00	0.01	0.00	0.05
		(0.22)	(0.68)	(0.79)	(0.36)	(0.52)		(0.50)	(0.52)	(0.82)	(0.52)	(0.66)
$\tilde{x}_r^{MP}$	-2.41	0.62	-0.62	0.70	-0.72	-3.09	-1.49	-1.25	-0.83	-0.51	-1.26	-3.95
	(0.50)	(0.83)	(0.85)	(0.82)	(0.82)	(0.52)	(0.33)	(0.40)	(0.60)	(0.75)	(0.60)	(0.28)
						Panel B: $MP2$						
$\tilde{x}_n^{MP}$	-7.73^{**}	-7.01^{**}	-9.29^{***}	-8.50^{***}	-6.41^{**}	-12.89^{**}	-5.09^{***}	-4.78^{***}	-6.01^{***}	-6.42^{***}	-8.31^{***}	-12.53^{***}
	(0.03)	(0.03)	(0.01)	(0.01)	(0.03)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
$\tilde{x}_{xc}^{MP}$	0.43	0.96^{*}	2.67^{**}	4.62^{***}	5.50^{***}	4.73^{**}	-0.19	0.56^{*}	1.48^{**}	3.49^{***}	3.04^{**}	-1.19
	(0.22)	(0.09)	(0.01)	(0.00)	(0.00)	(0.03)	(0.82)	(0.07)	(0.01)	(0.00)	(0.01)	(0.83)
$\tilde{x}_{xg}^{MP}$	-0.37	0.75	3.85^{**}	3.22^{**}	1.94^{*}	1.88^{*}	1.66^{***}	1.40^{**}	1.92^{***}	1.85^{**}	2.45^{***}	2.28^{***}
	(0.64)	(0.24)	(0.01)	(0.02)	(0.07)	(0.08)	(0.01)	(0.02)	(0.01)	(0.01)	(0.00)	(0.00)
$\tilde{x}_y^{MP}$	3.81^{***}	3.54^{***}	2.24^{***}	2.26^{***}	3.10^{***}	3.13^{***}	1.15^{***}	1.28^{***}	1.01^{***}	0.87^{***}	1.19^{***}	1.26^{***}
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
$\tilde{x}_q^{MP}$		-0.01^{*}	0.00	0.01	-0.08^{**}	-0.09		0.01	-0.01	0.00	-0.06^{*}	0.00
		(0.08)	(0.22)	(0.70)	(0.02)	(0.24)		(0.88)	(0.12)	(0.65)	(0.05)	(0.47)
$\tilde{x}_r^{MP}$	-3.86	-1.75	-0.52	1.60	4.21	-3.07	-2.47	-1.54	-1.59	-0.22	-1.57	-10.18^{**}
	(0.36)	(0.63)	(0.89)	(0.64)	(0.23)	(0.59)	(0.16)	(0.36)	(0.37)	(0.91)	(0.57)	(0.03)