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Unconventional Monetary Policy, Bank Lending, and Security Holdings: The Yield-Induced Portfolio-Rebalancing Channel

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Abstract

This article studies the impact of unconventional monetary policy on bank lending and security holdings. I exploit granular security register data and use a difference- in-differences regression setup to provide evidence for a yield-induced portfolio rebalancing: Banks experiencing large average yield declines in their securities portfolio, induced by unconventional monetary policy, increase their real-sector lending more strongly relative to other banks. The effect is stronger for banks facing many reinvestment decisions. Moreover, I find that banks with large yield declines reduce their government bond holdings and sell securities bought under the asset-purchase program of the European Central Bank (ECB).

I. Introduction

After reaching the zero lower bound on interest rates, many central banks, such as the Federal Reserve (Fed), the Bank of England (BoE), the Bank of Japan (BoJ), and the European Central Bank (ECB), embarked on a course of unconventional (nonstandard) monetary policy measures to stimulate their economies. Such measures included new communication strategies, negative interest rates, liquidity injections, and large-scale asset purchases (LSAPs), and they have indeed been sizable. Since their introduction in the eurozone, the balance sheet of

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the ECB increased from approximately EUR 1.1 trillion in Jan. 2007 to EUR 4.5 trillion in Jan. 2018; however, unlike the Fed's balance sheet, it is still growing. The question that has been at the center of the debate among policymakers, investors, and academics is whether these measures have been effective in stimulating economic activity and through what channels the transmission mechanism works. For instance, as Ben Bernanke, chairman of the Federal Reserve, put it: "The problem with quantitative easing is it works in practice, but it doesn't work in theory" (Bernanke (2014)).

I contribute to this debate by documenting how quantitative easing (QE) can affect economic activity via the banking sector. I empirically test whether banks react to a yield compression of their security holdings by i) reducing their bond holdings and ii) investing in alternative assets with a higher expected return, such as loans to the real sector. For the empirical analysis, I consider Germany, which is the largest eurozone economy. The eurozone has a bank-dominated financial system, and banks are key for the transmission of monetary policy.[1]

Economic theory yields different predictions of how QE can work. In their seminal work, Eggertsson and Woodford (2003) develop the famous irrelevance result of QE, which posits that in a standard New Keynesian model, open market operations that result in an increase in central bank reserves are ineffective at the zero lower bound. Market prices are left unchanged because they depend on the future path of consumption rather than on their relative supply. Thus, unconventional monetary policy measures like asset purchases or the change in the composition of the central bank balance sheet are not expected to have direct real effects. In this model, it is only a commitment regarding the future path of interest rates that is a powerful way to stimulate the economy. Bhattarai, Eggertsson, and Gafarov (2015) show that Large-Scale Asset Purchase (LSAP) can act as a commitment device by generating a credible signal about the future path of interest rates. Also, in finance theory, signaling is one channel through which QE can influence asset prices. LSAP can cause a change in the expectations of the future path of short-term interest rates, thus affecting the risk-neutral component of bond yields (see, e.g., Bauer and Rudebusch (2014)).

The introduction of market imperfections can lead to deviations from Eggertsson and Woodford's (2003) irrelevance result. Under the assumption of imperfect substitutability between central bank money and financial assets, investors facing lower yields on securities purchased by the central bank may turn to higher-yielding alternatives. This idea of a portfolio-rebalancing channel was developed in early articles, such as those by Tobin (1969) and Modigliani and Sutch (1966). More recently, Vayanos and Vila (2009) provided a formalization of the imperfect-substitutability assumption: LSAP can affect the term premium of long-term securities if investors have maturity-specific bond demands (see also Krishnamurthy and Vissing-Jorgensen (2011)). There exists a vast empirical

[1]ECB Chief Economist Peter Praet (2016) argues that "[t]his crucial role of the banking system explains why many of our monetary policy interventions during the crisis were aimed at repairing the bank-lending channel."

literature that analyzes the impact of QE on prices and finds that, by and large, asset purchases positively affect asset prices and decrease bond yields.[2]

In my study, I take the result that QE affects bond yields negatively as given and ask whether there are second-round effects that result in a portfolio reallocation by banks. Banks might be faced with different incentives to rebalance their portfolio composition. First, such incentives might stem from the emergence of additional liquidity on banks' balance sheets (i.e., an increase in central bank reserves). When the banks' depositors sell securities to the central bank, the resulting reserve increase might induce banks to increase loans to restore their optimal balance-sheet composition (Christensen and Krogstrup (2016)).

Second, the impact that the numerous unconventional monetary policy measures exert on the *yields* (or prices) of securities might lead to a rebalancing motive. On the one hand, the increase in the value of securities held by banks can raise their net worth and cause a rebalancing due to a "stealth recapitalization" (Brunnermeier and Sannikov (2014)). On the other hand, the change in the relative price between assets affected to varying degrees by QE can induce banks to adjust their portfolio composition. A rebalancing can result either between short-term and long-term assets (Gertler and Karadi (2013), Chen, Cúrdia, and Ferrero (2012)) or between differently affected asset classes (Dai, Dufourt, and Zhang (2013), Jouvanceau (2016)).

There is a growing body of empirical literature that examines banks' liquidity-driven rebalancing motive (see, e.g., Christensen and Krogstrup (2019), Kandrac and Schlusche (2016), and Butt, Churm, McMahon, Morotz, and Schanz (2014)) or the net-worth channel of QE (see, e.g., Rodnyansky and Darmouni (2017), Koetter, Podlich, and Wedow (2017), and Chakraborty, Goldstein, and MacKinlay (2019)).[3] However, little work has been done on a rebalancing that is driven by a relative price change between different asset classes (i.e., loans and bonds.[4] My goal is to contribute to this strand of literature by analyzing both banks' credit and security-holdings behavior.

My article is motivated by the following descriptive findings in Germany (see Figure 1). Throughout 2014 and 2015, there was a huge decline in the yields of all types of fixed-income securities in the eurozone, which coincided with the expectation, announcement, and implementation of various unconventional monetary policy measures (Graph A of Figure 1). This yield decline led to a compression of bond yields that was stronger than the decline in interest rates on newly issued loans. Consequently, there was an increase in the spread between the average interest rate that German banks charged on loans to the nonfinancial sector and the average yield of banks' securities portfolios (Graph B). At the same time, the

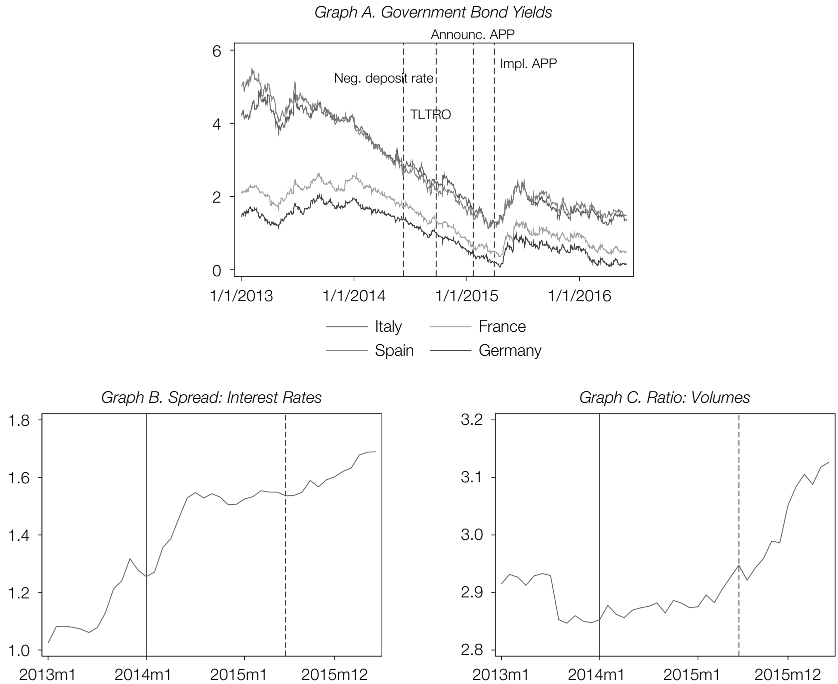
[2]See, for example, Altavilla, Carboni, and Motto (2015) for the ECB's Asset Purchase Program, Krishnamurthy, Nagel, and Vissing-Jorgensen (2017) on the ECB's Outright Monetary Transactions and the Security Markets Program, Krishnamurthy and Vissing-Jorgensen (2013) for the Fed's QE, and Joyce and Tong (2012) for the BoE's asset-purchase program.

[3]In addition to the net-worth channel, Chakraborty et al. (2019) also analyze an origination channel.

[4]Exceptions include Albertazzi, Becker, and Boucinha (2018), who mainly focus on the rebalancing of various economic sectors (i.e., nonfinancial corporations, insurance companies, investment firms, households, banks, etc.) and not primarily on banks, and Tischer (2018), who mainly focuses on credit and not on security holdings.

FIGURE 1
Descriptive Evidence

Graph A of Figure 1 shows the evolution of the 10-year government bond yields of Italy, France, Spain, and Germany (%). Graph B shows the evolution of the spread between the volume-weighted interest rates charged by German banks on loans supplied to the nonfinancial private sector and the volume-weighted yields from their securities portfolios (moving averages). Graph C depicts the time series of the ratio of the volume of credit supplied by German banks to the nonfinancial private sector over the nominal value of the securities held by German banks.



volume of credit supplied by German banks increased in relation to the nominal value of securities held (Graph C). These stylized facts raise the question of whether the larger credit quantity was driven by the change in the relative price between book credit and bonds. In other words, did the expectation and announcement of unconventional monetary policy measures that increased the relative return of book credit in terms of bond yields lead to a rebalancing from security holdings into credit?

Motivated by these stylized facts, I develop the following hypotheses to test for the presence of a yield-induced portfolio-rebalancing channel:

Hypothesis 1. Banks facing a sizeable compression of yields in their securities portfolios increase their book credit more strongly because they target a specific yield level.

Hypothesis 2. Banks with a larger average yield decline of their securities portfolios reduce their securities holdings more intensely, especially selling those securities bought by national central banks of the Eurosystem in the asset purchase program.

Thus, I analyze whether, against the background of a change in relative price between book credit and bonds, there is a rebalancing between the securities portfolio and the credit portfolio of banks that are more affected by the yield decline induced by monetary policy.

In order to test these hypotheses empirically, the German security register proves particularly useful. First, the granular information about the security-level holdings of German banks allows me to exploit the impact that the expectation and announcement of various unconventional monetary-policy measures, most importantly, the Expanded Asset Purchase Program (APP) of the ECB, had on the yield of each security. More specifically, following Albertazzi et al. (2018), I use the cross-sectional heterogeneity in the composition of each bank's securities portfolio by calculating a bank-specific "yield-decline" variable. For each security that a bank held in Jan. 2014, 1 year before the APP was announced by the ECB in Jan. 2015 and well before investors started to expect and price in this measure, I calculate by how much the specific yield changed between Jan. 2014 and June 2015. In other words, in order to rule out endogeneity stemming from reverse causality, I hold the composition of securities fixed at its Jan. 2014 level and take the impact of monetary policy on prices as given. Aggregating this information at the bank level, this yield-decline variable is characterized by substantial cross-sectional variation.

Second, the securities register includes information about the maturity date of the securities held by banks. This provides another source of heterogeneity that I exploit for identification of Hypothesis 1: From the Jan. 2014 perspective, the amount of securities maturing between Jan. 2014 and June 2015 is predetermined.[5] This allows me to test whether the rebalancing arising from a large decline in yields is stronger for banks with many reinvestment decisions. Faced with compressed yields and the freed-up liquidity resulting from the maturing securities, these banks might step up their granting of credit more strongly in order to restore the targeted yield of their portfolios.

Third, when analyzing banks' securities holdings (i.e., Hypothesis 2), I exploit the exhaustive detail of the security register for identification. I analyze the data at the security–bank–month level. The inclusion of security $\times$ time fixed effects in my baseline regressions allows me to compare the level of holdings in the same security and the same month across banks affected, to varying degrees, by unconventional monetary-policy measures. Thus, I can account for any observable or unobservable time-varying heterogeneity across securities, such as liquidity, credit risk, and the level of issuance (credit demand by the securities' issuers). Moreover, the inclusion of security $\times$ bank fixed effects allows me to control for any unobserved matching between characteristics of banks and securities, including preferences of banks for some securities over others (e.g., for regulatory reasons).

Armed with the two sources of heterogeneity (i.e., yield decline and maturing assets), I use a difference-in-differences estimation technique and find

[5]Among others, the maturity structure has been exploited for identification by Almeida, Campello, Laranjeira, and Weisbenner (2012) to study the real effects of the 2007 crisis and by Tischer (2018), who exploits banks' maturity structure to identify the effect of QE on lending using a similar data set.

significant and sizable effects on credit supply for banks with a larger decline in yields when compared with their counterparts. On average, banks with a decline in yield of 1 standard deviation increased the quantity of newly issued loans to the real sector by 4.8% between 2013 and 2015 (i.e., over a 2-year period surrounding the monetary-policy–induced yield decline) and reduced their government bond holdings by 2.7%. I find that the effect of credit supply is particularly pronounced for banks with many maturing assets (i.e., banks facing many reinvestment decisions). Moreover, I find that banks with a larger decline in yields reduce their holdings of securities that were bought by the national central banks of the Eurosystem in the APP. The results suggest that banks target a specific yield level and, facing an average yield decline in their securities portfolio, actively rebalance toward higher-yielding book credit.

Instead of increasing their book loans, banks more affected by monetary policy could seek to increase their investments in higher-yielding securities. Following Albertazzi et al. (2018), I investigate this alternative potential rebalancing opportunity but do not find evidence in support of it. I follow a line of argument similar to that of Albertazzi et al. and argue that yields were already so compressed in Germany that, given a home bias, a rebalancing into securities with a relatively high yield would make it necessary to heavily restructure the composition of the portfolio. This highlights the economic plausibility of my findings: Given the relative price change between securities and book credit, banks favor a rebalancing toward lending.

I find signs of risk taking as the affected banks increase their contingency reserves to account for latent credit risk that has not yet materialized. However, banks with larger declines in the yields of their securities portfolios do not face subsequently higher actual loan losses.

I do not find robust evidence that these effects are more pronounced for weakly capitalized banks. One potential explanation for this might be that, outside times of crisis, equity does not constitute a constraint for comparatively well-capitalized German banks. This confirms the findings of Timmer (2018), who shows that, outside times of crisis, the securities trading behavior of banks does not depend on their equity ratio.

There are three potential concerns for identification. I address these in the following way: First, the treatment intensity created by the monetary-policy–induced decline in yields could potentially be correlated with other events that simultaneously affect a bank's loan issuance through other channels. Between Sept. 2014 and Mar. 2017, Targeted Longer-Term Refinancing Operations (TLTROs) were implemented in the eurozone, with the aim of fostering credit supply. They offer central bank refinancing at favorable terms and conditions, which are tied to a bank's net credit supply. Using detailed proprietary data on the bank-specific TLTRO uptakes, I show that there is no difference between banks more and less affected by the treatment in terms of drawing on this specific credit facility. Thus, the bank-specific yield decline is not simply proxying for the TLTRO uptakes and does not capture a liquidity-driven rather than a yield-induced rebalancing motive.[6]

Second, an important prerequisite for my estimates to be attributable to the monetary-policy–induced decline in yields is that the treatment intensity (i.e., by how much the average yield of a bank's securities portfolio declined) must be unrelated to other bank characteristics that might influence lending behavior. To address this issue, I carefully adjust the data by means of a matching approach in addition to controlling for a number of covariates. I effectively select a control group that has characteristics similar to those of the treated banks. This weighting approach takes care of the parallel-trend assumption.

The third concern is that of distinguishing between supply and demand effects, which are mostly unobserved. The portfolio-rebalancing channel analyzed in this article is a notion involving a supply-driven credit increase. Because my credit data are at the bank level, I include region × time fixed effects in the regressions to proxy for local credit demand. Moreover, I follow the literature on the bank-lending channel (see, e.g., Kashyap and Stein (1995), Kishan and Opiela (2000), and Worms (2001)) when analyzing Hypothesis 1. Accordingly, I focus on groups of banks for which, economically, the supply-driven effect should be stronger. I robustly find that the yield-induced rebalancing motive toward granting more credit is especially pronounced for banks facing multiple reinvestment decisions. This result reinforces the notion of a supply-driven credit expansion.

Various robustness checks support the existence of my findings. Most importantly, a falsification test finds no significant differences in lending behavior between 2011 and 2013 among banks with diverse declines in the yields of their securities portfolios (i.e., in a period prior to the onset of the treatment). Thus, the observed change in lending outcomes is most likely attributable to the monetary-policy–induced decline in yield, as opposed to an alternative unobservable, bank-specific force. Furthermore, I show that my results are not driven by the different accounting treatment of securities or the callability of bonds.

The rest of the article proceeds as follows: Section II describes how this article fits into the existing literature. Section III presents the data used for the analysis and the empirical design. Section IV reports the empirical results, and Section V concludes.

II. Related Literature

My article contributes to the growing literature that assesses the effectiveness of unconventional monetary policy at the bank level. Many articles in this group study liquidity-driven channels. Carpinelli and Crosignani (2017), Garcia-Posada and Marchetti (2016), and Andrade, Cahn, Fraisse, and Mésonnier (2018), for example, analyze the effect of the 3-year Longer-Term Refinancing Operations (3y-LTROs) that were implemented in the eurozone in 2011 and 2012 in the wake of the eurozone sovereign debt crisis in order to prevent a funding squeeze in the banking sector. Butt et al. (2014) focus on banks' deposits as the key pass-through

[6]Note that I am allowing the TLTROs to affect a bank's credit supply through their overall effect on yields, but I want to rule out the possibility that my treatment intensity is picking up the TLTROs' effect on banks' credit granting through liquidity channels.

variable of assets sales by the banks' depositors (e.g., institutional investors). They show that the BoE's asset purchases had no impact on bank lending through this channel. Kandrac and Schlusche (2016) test for the existence of a reserve-induced portfolio-rebalancing channel, where the sale of securities increases banks' reserves, thus disturbing the banks' optimal balance-sheet composition. The authors exploit a regulatory change in the United States that influenced the reserve distribution and find that banks increase their lending and risk-taking activity in order to restore the optimal asset and liability structure.

Other articles, like those by Koetter et al. (2017), Chakraborty et al. (2019), and Rodnyansky and Darmouni (2017), focus on a net-worth channel of QE. Koetter et al. analyze the effect that the Eurosystem's Securities Markets Program (SMP) had on competition in the banking market. The authors exploit the heterogeneity in the bank-level holdings of securities that were purchased under the SMP and find positive effects on loan and deposit market shares. Chakraborty et al. analyze mortgage-backed security (MBS) and Treasury purchases by the Fed and find a crowding out of commercial lending in favor of mortgage origination following MBS sales. In addition, they find that firms borrowing from MBS selling banks reduce their investments. They distinguish between a net-worth channel and an origination channel, according to which banks with a focus on MBS origination are more affected by the Fed's purchases. Rodnyansky and Darmouni study the effect that the three rounds of QE in the United States had on lending. They mainly focus on mortgage lending and exploit the heterogeneity in banks' MBS holdings. In contrast to these articles, I do not consider banks' holdings of a particular asset class in order to define the treatment status but, rather, exploit the heterogeneity in the impact that unconventional monetary policy had on the yields of all fixed-income securities held by banks for their own account. Furthermore, the previously mentioned articles do not study banks' security-holding behavior.[7]

Overall, my contribution consists of taking the result that asset purchases affect bond yields negatively as given and asking whether banks that face substantial yield reductions have stronger incentives to i) reduce their securities holdings and ii) increase bank lending. The two articles closest to my analysis are those by Albertazzi et al. (2018) and Tischer (2018). Albertazzi et al. also study the yield-induced rebalancing motive using the heterogeneity in the APP-induced yield decline. However, they mainly focus on different sectors (e.g., households, firms, pension funds, money market funds, banks) and analyze whether those sectors have a motive to rebalance into newly issued, riskier securities. They also give suggestive evidence in favor of a yield-induced rebalancing motive of banks from countries less affected by the sovereign debt crisis by studying the credit-granting behavior of the largest 25 European institutions. As acknowledged by the authors, "the small number of banks represents a constraint for the

[7]Further articles studying the effects of unconventional monetary policy include the following: Grosse-Rueschkamp, Steffen, and Streitz (2019), Arce, Gimeno, and Mayordomo (2017), and Abidi, Miquel Flores, and Eterovic (2018) all analyze the effects of the ECB's Corporate Bond Purchase Program. Acharya, Eisert, Eufinger, and Hirsch (2019) and Ferrando, Popov, and Udell (2018) study the announcement effects of the ECB's Outright Monetary Transaction Program. Eser and Schwaab (2016) study the transmission of the SMP on bond yields. Heider, Saidi, and Schepens (2019) analyze the transmission of negative policy rates via banks.

econometric analysis" (Albertazzi et al. (2018), p. 18). Further, they do not analyze the security-holding behavior of these banks as an outcome variable. In contrast, my study explicitly focuses on banks and tests for the hypotheses developed earlier, which are motivated by the stylized fact that the relative price between credit and securities has changed in Germany. As opposed to Albertazzi et al., I find that banks with greater yield declines reduce their security holdings (besides increasing their granting of credit). Additionally, I seek to shed more light on the underlying bank-specific mechanisms as well as the heterogeneities of the yield-induced portfolio-rebalancing channel. Furthermore, by making use of data from monetary-policy operations, in particular, bank-specific TLTRO uptakes and the securities bought by national central banks of the Eurosystem in the APP, I can control for alternative, liquidity-driven transmission channels.

Tischer (2018) also analyzes the effect of QE on the bank-lending supply in Germany. To this end, he exploits the maturity structure of banks' bond holdings and finds that more exposed banks increase their loan growth during QE relative to other banks. This result supports my main finding that banks with stronger yield compressions increase assets with a higher expected return (i.e., book credit) and reduce their securities holdings at the same time. In addition, it is consistent with the finding in this article that the rebalancing motive is stronger for banks with many maturing assets that are simultaneously experiencing a strong decline in yields in their securities portfolios. In contrast to Tischer, who primarily focuses on maturing securities for identification, my main source of heterogeneity stems from the intensity of the average decline in yields in a bank's securities portfolio. Furthermore, I analyze the banks' decisions on holding securities at the security level as an outcome variable, which allows for a rich identification. Understanding the security-holding behavior of banks affected by unconventional monetary policy is a key contribution of this article. Additionally, using bank-specific TLTRO uptakes allows me to directly control for this potentially contaminating unconventional monetary policy instrument without the need to use proxy variables for this purpose.

Another article related to my study is that by Peydró, Polo, and Sette (2017). They also analyze banks' investment behavior due to monetary policy using credit and securities register data from Italy. They find that in times of crisis, less capitalized banks prefer buying securities rather than increasing the credit supply in response to a softer monetary policy. One key difference from my article is the monetary policy indicator they examine. They mainly focus on the central bank balance sheet, which incorporates the monetary-policy measures that are actually implemented. In contrast, I use the impact that the anticipation and announcement of unconventional monetary policy had on yields. Additionally, Peydró et al. study crisis and noncrisis times, whereas I focus on a time period that spans the implementation of the APP and the TLTROs.

Another group of articles uses vector autoregression (VAR) models to study the effects of asset purchases on macroeconomic variables. Their main focus is the effects of QE on output and prices. Weale and Wieladek (2016) rely on Bayesian inference and use a combination of zero and sign restrictions to identify shocks resulting from asset-purchase announcements. They find a positive effect on output and prices for the United States and the United Kingdom. A similar approach is taken by Gambacorta, Hofmann, and Peersman (2014), who estimate a panel VAR for eight advanced economies and focus on the aggregated central bank balance sheet as the main policy variable. Lewis and Roth (2019) also estimate a Bayesian VAR and identify an asset-purchase shock by using different aggregated items from the ECB's balance sheet. The authors find a positive effect of asset purchases on output for both Germany and the eurozone as a whole. They also analyze the response of bank lending to firms following the asset-purchase shock and find no reaction of this variable in the German economy. All these articles have the advantage that the exploitation of the time-series variation enables them to study the transitional dynamics of asset purchases. However, it is hard to draw conclusions about the heterogeneous reaction of various agents to the asset-purchase shock. Furthermore, most of these articles either use aggregate central bank balance-sheet items that include the actually purchased amounts of securities or construct an asset-purchase-announcement series. Therefore, they do not fully incorporate the effects stemming from the anticipation of asset-purchase programs by investors. Especially in the case of the eurozone, there is evidence that the APP was anticipated by market participants, thus positively affecting prices well in advance of the actual implementation. I explicitly incorporate this anticipated reaction in bond prices into my analysis.

My article also relates to the literature analyzing the bank-lending (Bernanke and Blinder (1988), (1992)) and risk-taking channels (Borio and Zhu (2012), Adrian and Shin (2011)) of monetary policy during normal times. In their seminal article, Kashyap and Stein (1995) exploit bank-level data and identify the bank-lending channel by showing that small banks (i.e., banks facing greater frictions and having difficulties in saturating their funding needs) contract their lending activity stronger after a tightening of monetary policy. In a similar vein, Kishan and Opiela (2000) and Gambacorta and Mistrulli (2004) focus on weakly capitalized banks instead of the banks' size. More recent contributions analyze the bank-lending and risk-taking channels using loan-level data (Jiménez, Ongena, Peydró, and Saurina (2012), (2014)).

This article also contributes to the literature studying the securities holdings of banks and institutional investors at the securities level. Abbassi, Iyer, Peydró, and Tous (2016) also use the German securities register in conjunction with lending data. However, they do not study monetary policy but are interested in securities trading by banks with trading expertise in the crisis. Timmer (2018) studies the securities trading of institutional investors. Contrary to my results, Timmer finds that banks respond procyclically to price changes (i.e., they sell securities when prices are falling). In contrast to Timmer, I focus on banks with large credit and securities portfolios and focus on a time period characterized by a huge decline in the general yield level induced by monetary policy.[8]

[8]Timmer (2018) analyzes the period from 2005:Q4 to 2014:Q4 and focuses on all German banks.

III. Data and Empirical Setting

I focus on Germany in order to analyze the yield-induced portfolio-rebalancing channel. Germany's financial system is bank dominated and the largest in the euro area, making it an ideal candidate for studying the effects of unconventional monetary policy on bank lending and securities holdings. Further, the availability and combination of the securities register with balance-sheet information and data from monetary-policy implementation provides a comprehensive view of banks' balance sheets. In this section, I first describe the data used in this article. Then, I turn to the stylized facts about the credit and securities market in Germany during the time period of investigation (i.e., from Jan. 2013 until Dec. 2015), which provide descriptive evidence for the potential presence of a yield-induced rebalancing channel. Finally, I describe the identification strategy and the empirical setup.

A. Data

To construct the data set used for the empirical analysis, I use the German securities register (Securities Holdings Statistics Database (SHS)), the Centralised Securities Database (CSDB), the Interest Rate Statistics (ZISTA) data set, the Balance Sheet Statistics (BISTA) data set, and the Income Statement Statistics of German Banks (GuV) data set. All these data sources are compiled by the Deutsche Bundesbank (the German central bank), which is a micro- and macro-prudential supervisor of the German banking system. The data sets are linked and made available for research purposes by the Research Data and Service Center (RDSC) of the Deutsche Bundesbank. This linked data set is augmented with confidential bank-level data on the refinancing operations of German banks and data on securities bought by the national central banks of the Eurosystem in the APP. The baseline time period under consideration is Jan. 2013 until Dec. 2015.

The SHS includes data on the securities investments (including fixed-income securities, equities, and fund shares) of all German banks (full census). The data are collected with the purpose of monitoring the financial markets and financial activities within the euro area.[9] Each bank reports the nominal amount of each security it holds at the end of the month. I use the International Securities Identification Number (ISIN) to combine this data set with the CSDB to obtain additional securities-specific information, such as the yield, price, maturity date, security type, and issuer sector of all reported securities. I complement these data with monthly bank-level balance-sheet information, such as total assets, equity capital, central bank reserves, savings deposits, and yearly income-statement items such as net profits and net interest received. The data on monetary-policy refinancing operations includes the bank-specific TLTRO uptakes. The data on securities bought in the APP include a list of all ISINs bought by the respective national central banks of the eurozone.

[9]The legal basis for the data collection is laid down in Section 18 of the Bundesbank Act (Bundesbankgesetz) in combination with Regulation ECB/2012/24. For more information, please refer to Bade, Flory, Gomolka, and Schoenberg (2017).

My bank-level loan data come from ZISTA; these data are collected with the purpose of reliably analyzing monetary developments in the euro area.[10] To minimize the reporting burden involved while at the same time ensuring high-quality statistics, ZISTA is composed of a representative sample of more than 200 deposit-taking and loan-granting German credit institutions. The sample is selected using a stratified sampling procedure. In the first step, all banks in Germany are subdivided on the basis of categories of banks and regional criteria (strata). In the second step, the largest institutions from each stratum are chosen. This stratified sampling procedure ensures that approximately 70% of the total German lending business is captured by this data set.[11] Thus, the sample includes German banks with a strong focus on granting credit. The unique feature of the Monetary Financial Institution (MFI) Interest Rate Statistic is that, along with the interest rates on loans, it includes the monthly volumes of new business at the end of each month for loans to households and nonfinancial corporations.

Because I focus on newly issued loans, my final sample after merging the loan data with the previously mentioned data sets consists of 204 banks. This sample is interesting for the following reasons: First, these are the banks most active in granting credit, and therefore they are particularly important for the transmission of those unconventional monetary policy measures that target an expansion of credit. Second, as described in the following section, a difference-in-differences regression setup is used, and the treatment intensity of a bank's average drop in yields is exploited for identification. This requires ensuring that the banks from the control group are similar to the treated banks in terms of observable and unobservable characteristics. As described in the following section, I deal with the observable characteristics by means of a matching procedure. However, it is more challenging to handle unobservable characteristics. Choosing banks with a similar business model (i.e., a strong focus on granting credit) can help in this respect. Third, because I am assessing a rebalancing incentive that stems from the average decline in the yield of a bank's securities portfolio, it needs to be ensured that securities are an important component of the banks' balance sheets. As described in Section III.C, the banks in my sample are characterized by a fairly large fraction of fixed-income securities on the asset side of the balance sheet.

B. Stylized Facts

One prerequisite for the presence of the yield-induced portfolio-rebalancing channel is that of a yield decline that can be attributed to unconventional monetary policy. Graph A of Figure 1 shows the evolution of 10-year government bond yields for selected eurozone countries. Between Jan. 2014 and June 2015, the yields on government securities declined substantially. The decline in yields is not specific to government securities but can also be observed among other fixed-income securities, such as corporate or covered bonds. Along with the government bond yields, the graph shows various unconventional monetary-policy measures (indicated by vertical lines). In June 2014 the deposit facility rate was lowered by 10 basis points (bps) into negative territory (i.e., to −0.10%).

[10]The legal basis for the data collection is laid down in Regulation ECB/2001/18.
[11]For more information, please refer to Bade and Krueger (2019).

In Sept. 2014 the first tender of the first TLTRO series was implemented, in Jan. 2015 the APP was announced, and in Mar. 2015 the APP was implemented. It is challenging to quantify how much of the yield decline between Jan. 2014 and June 2015 was due to the specific unconventional measures, especially because throughout 2014, there was a huge discussion among investors about whether the ECB would announce an asset-purchase program. Appendix A in the Supplementary Material contains a compilation of newsletter articles highlighting speculation on the part of investors throughout 2014. Because I want to capture these anticipation effects, in this article, I take the impact of monetary policy on asset prices as given by calculating the drop in yields between Jan. 2014 and June 2015.

A further indication of the presence of a yield-induced rebalancing motive toward more credit supply is that granting credit becomes more attractive relative to security investments. Graph B of Figure 1 illustrates the spread between the average interest rate that German banks charge on loans to the nonfinancial sector and the average yield of banks' securities portfolios. This figure increases over time, driven primarily by a decline in securities' yields that is stronger than the fall in interest rates on loans. This spread gives rise to the presence of a potential rebalancing motive toward more lending. In other words, Graph B shows the change in the relative return on bank loans in terms of bond yields, which is a prerequisite for the existence of a rebalancing motive, whereby the compression of yields on the securities held by banks induces them to invest in assets with a higher expected return (i.e., loans).[12]

The next piece of evidence is provided by Graph C of Figure 1, which depicts the evolution of the ratio of the average credit volume extended to the nonfinancial private sector in the numerator and the average nominal value of securities held by all German banks in the denominator. Similarly, this ratio, too, increases over time.

Figure 1 provides the initial descriptive evidence in favor of a yield-induced portfolio-rebalancing channel. This needs to be formally tested at the bank level to gauge the causal effect of unconventional monetary policy on bank lending and security-holding behavior.

C. Empirical Strategy

1. Identification

The identification strategy exploits differences in banks' exposure of their securities portfolios to unconventional monetary-policy measures. To this end, I construct a bank-level variable indicating by how much the average yield of the securities portfolio declined between 2014:M1 and 2015:M6 in the following way. I consider fixed-income securities because they account for more than 95% of all securities holdings of German banks. Furthermore, debt securities are most comparable, in terms of their structure, to bank loan contracts. Therefore, a rebalancing motive into more loan supply should be most pronounced for this asset class.

[12]One potential criticism of using this spread might be that the series increases because banks take on more risk in the credit portfolio (see, e.g., Borio and Zhu (2012)). Tischer (2018) calculates a risk-adjusted spread based on loans underlying asset-backed securities in Germany over a similar time period and shows that the evolution of the risk-adjusted spread is similar to that of the unadjusted spread.

For each security, I calculate by how much its yield declined between 2014:M1 and 2015:M6. I exclude all securities that mature in this time window in order to rule out the possibility that my final variable picks up any mechanical change in yield stemming from a possible pull-to-par effect.[13] Finally, I weight each security by the nominal amount held by the particular bank. I label the resulting variable "MP," which denotes monetary policy.

By holding the composition of securities fixed at its level in Jan. 2014, well before investors started to anticipate the asset-purchase program,[14] I can rule out any endogeneity stemming from reverse causality. Additionally, calculating the drop in yield between 2014:M1 and 2015:M6 irrespective of whether the security is actually still held in 2015:M6 helps me to prevent endogeneity arising from the decision by banks to sell a security due to unconventional monetary policy. The choice of June 2015 as the end date of the window for the yield-decline calculation is driven by the following trade-off decision. First, enlarging the window, such as choosing 2015:M12 as the end date, would result in a smaller fraction of securities that are actually still held at the end date. Second, picking a smaller window (e.g., 2014:M12) as the end date would result in capturing a smaller amount of unconventional monetary-policy measures.[15] Nevertheless, in Section IV.C, I show that the results are robust to choosing 2014:M12 as the end date of the window for the yield-decline calculation.

Although yields might have declined for reasons other than unconventional monetary policy, I follow Albertazzi et al. (2018) and argue that both anecdotal evidence (see Appendix A in the Supplementary Material) and the empirical literature (e.g., Altavilla et al. (2015)) demonstrate that the announcement and anticipation of the APP by financial market participants was the most important driver of asset prices in the eurozone in the period examined in this article.[16] Furthermore, Table 1 shows coefficient estimates of a security-level regression of the decline in yield between 2014:M1 and 2015:M6 for all securities held in 2014:M1 on the securities' residual maturity, a dummy indicating whether the security is a government bond, and a dummy indicating whether the security was bought by the Eurosystem in the APP. Column 2 of Table 1 shows that government securities are characterized by an approximately 37-bps-larger decline in yield as opposed to private securities (i.e., bonds of financial and nonfinancial corporations). Securities bought as part of the APP are characterized by a 48-bps-larger decline in yield compared with bonds that were not bought in the asset-purchase program. This result supports the view that unconventional monetary policy, and especially the APP, was an important driver of asset prices in the analyzed period.

[13]"Pull-to-par" describes the situation in which the bond's price will gradually converge to par as maturity approaches.

[14]To my knowledge, the first newsletter article that mentions speculation about an asset-purchase program was published in Mar. 2014 (see Appendix A in the Supplementary Material).

[15]The APP was implemented in Mar. 2015. I choose June 2015 to also capture some of the effects of the actual implementation of the APP on yields.

[16]The anticipation effect on the yields of securities makes it challenging to quantify how much of the overall yield decline was due to monetary policy. Considering only securities that were eligible under the APP would introduce an endogeneity concern because the eligible assets were determined on the announcement date of the APP, which was in Jan. 2015 (i.e., 1 year after Jan. 2014).

TABLE 1
Security-Level Yield Decline

Table 1 shows the coefficient estimates of security-level regressions of the decline in yield between Jan. 2014 and June 2015 (YIELD_DECLINE) on the securities' residual maturity (RESIDUAL_MATURITY); the indicator GOVERNMENT, which takes the value of 1 for government bonds, and 0 otherwise; and the indicator APP, which takes the value of 1 for securities that were bought as part of the Expanded Asset Purchase Program (APP), and 0 otherwise. Robust standard errors are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	Dependent Variable: YIELD_DECLINE
Variable	1
APP	0.481***
	(0.057)
GOVERNMENT	0.373***
	(0.049)
RESIDUAL_MATURITY	0.030***
	(0.004)
No. of obs.	13,522
R^2	0.012

2. Summary Statistics

Table 2 shows the summary statistics of all variables used in the empirical analysis. Most importantly, the MP variable is characterized by substantial cross-sectional variation. Whereas the securities portfolio of the lower-quartile bank faced a decline of 0.47 percentage points, the average decline in yields of the upper-quartile bank was 0.79 percentage points. The ratio of maturing securities to total assets (MATURING_ASSETS_RATIO) also displays considerable cross-sectional variation: For the lower-quartile bank, securities that mature between 2014:M1 and 2015:M6 account for 1.5% of the total balance sheet, whereas this figure amounts to 4.7% for the upper-quartile bank. Interestingly, the median bank holds approximately 16% of its total assets in fixed-income securities (TOTAL_SECURITIES_RATIO), and for the lower-quartile bank, the figure is at approximately 9%. This illustrates that the banks in my sample are characterized by a fairly large fraction of fixed-income securities on the asset side of their balance sheets.

Table 3 displays additional descriptive statistics. Given the total securities holdings in 2014:M1, the table shows that 62% of these securities were still held in 2015:M6, whereas 22.5% were maturing and 15.5% were sold in between. It is crucial to emphasize that banks would not have a rebalancing motive if they held all assets until maturity because, in this case, their eventual yield would be determined at the moment of the security's purchase. However, as Table 3 shows, banks are selling a substantial fraction of their overall securities. Additionally, they face reinvestment decisions whenever a security matures. Thus, it is an empirical question whether they continually target a specific yield level and whether the change in relative price between book credit and securities drives their granting of credit and security-holding decisions. Section C of the Appendix in the Supplementary Material contains an additional descriptive statistics table (Table A4) that splits the sample into two groups based on the median of the MP variable.

TABLE 2
Summary Statistics

Table 2 shows the summary statistics of the variables used in the empirical analysis. In the sample of model 1 of the credit analysis, all level variables are measured in Dec. 2013 (i.e., prior to the monetary-policy–induced decline in yields). Changes in log loans indicate the difference between the average for the pre-event period (Jan. 2013–Dec. 2013) and the average for the post-event period (Jan. 2015–Dec. 2015). The sample of model 2 of the credit analysis includes monthly observations for the time period analyzed in the regressions (i.e., Jan. 2013–Dec. 2015). The sample of the security analysis includes monthly observations for the period Jan. 2013–Dec. 2015. Variables with the suffix "_RATIO" are reported as a decimal fraction of total assets. An exception is Δ_LOAN_LOSSES_RATIO*, which is the first difference of loan losses between 2013 and the average of 2015 and 2016 scaled by the credit stock in 2013 (year-end). Variables denoted with * are winsorized at the 1% and 99% levels.

Variable	Mean	Std. Dev.	P25	P50	P75	No. of Obs.
MP	0.627	0.410	0.468	0.615	0.791	204
MP_BANKING_BOOK	0.617	0.402	0.452	0.608	0.787	204
MP_WITHOUT_CALL	0.634	0.399	0.473	0.616	0.799	204
MP_GOVERNMENT	0.233	0.278	0.070	0.181	0.334	204
MP_FINANCIALS	0.373	0.336	0.261	0.395	0.513	204
MP_CORPORATES	0.021	0.067	0.000	0.000	0.011	204
TOTAL_SECURITIES_RATIO	0.175	0.107	0.089	0.161	0.231	204
CORPORATES_RATIO	0.003	0.007	0.000	0.000	0.003	204
FINANCIALS_RATIO	0.121	0.084	0.066	0.112	0.162	204
GOVERNMENT_RATIO	0.051	0.054	0.018	0.037	0.073	204
MATURING_ASSETS_RATIO	0.038	0.036	0.015	0.029	0.047	204
Credit: Model 1						
LOG_ASSETS (in € thousands)	16.003	1.279	15.117	15.621	16.604	204
EQUITY_RATIO	0.066	0.026	0.047	0.065	0.079	204
RESERVES_RATIO	0.012	0.018	0.004	0.008	0.011	204
INTERBANK_RATIO	−0.038	0.160	−0.114	−0.039	0.035	204
DEPOSITS_RATIO	0.651	0.215	0.589	0.728	0.794	204
RETURN_ON_ASSETS	0.004	0.007	0.001	0.004	0.006	204
NET_INTEREST_MARGIN	0.018	0.009	0.013	0.019	0.022	204
Δ_LOG_INTEREST_INCOME$_{13/15}$*	−0.139	0.099	−0.187	−0.140	−0.091	204
Δ_LOG_INTEREST_INCOME$_{13/14}$*	−0.077	0.067	−0.106	−0.081	−0.049	204
Δ_LOAN_LOSSES_RATIO*	−0.001	0.004	−0.002	−0.000	0.000	204
Δ_LOG_CONTINGENCY_RESERVES$_{13/15}$*	−0.072	0.617	−0.190	0.000	0.147	162
Δ_LOG_LOANS (new business)*	0.109	0.345	−0.015	0.122	0.252	204
Δ_LOG_LOANS_STOCK (credit stock)*	0.043	0.232	−0.038	0.028	0.105	204
Credit: Model 2						
LOG_ASSETS (in € thousands)	16.007	1.294	15.117	15.625	16.597	7,173
EQUITY_RATIO	0.068	0.025	0.051	0.068	0.082	7,173
RESERVES_RATIO	0.010	0.015	0.002	0.007	0.010	7,173
INTERBANK_RATIO	−0.042	0.149	−0.111	−0.039	0.032	7,173
DEPOSITS_RATIO	0.656	0.213	0.611	0.731	0.794	7,173
RETURN_ON_ASSETS	0.005	0.005	0.002	0.004	0.006	7,173
NET_INTEREST_MARGIN	0.018	0.009	0.013	0.019	0.022	7,173
TLTRO_RATIO (%)	0.151	0.669	0.000	0.000	0.000	7,173
LOG_LOANS (new business; in € thousands)*	11.552	1.328	10.678	11.388	12.278	7,173
Securities						
LOG_SECURITY_HOLDINGS (in €)	14.78	2.69	13.18	15.43	16.81	1,463,750
APP	0.15	0.36	0.00	0.00	0.00	1,463,750
POST	0.35	0.48	0.00	0.00	1.00	1,463,750

TABLE 3
Securities Held in Jan. 2014

Given the securities held in Jan. 2014, Table 3 shows the fraction of securities that are still held in June 2015 and the fraction of securities that are sold between Jan. 2014 and June 2015.

	Still Held in June 2015	Maturing Before June 2015	Sold
Nominal amount	62.0%	22.5%	15.5%

3. Credit Analysis

To assess the yield-induced impact of unconventional monetary policy on bank lending (i.e., Hypothesis 1), I employ a difference-in-differences (DID) approach and run the following bank-level regression (baseline model 1):

$$(1)\quad \Delta\_\text{LOG\_LOANS}_i = \beta_0 + \beta_1 \times \text{MP}_i + X_i^{'}\beta_2 + \text{BANK\_TYPE\_FE} + u_i,$$

where i denotes a bank. The dependent variable $\Delta\_$ LOG_LOANS$_i$ is the change in the natural logarithm of newly issued loans around the yield decline. To avoid problems of serial correlation, I follow Bertrand, Duflo, and Mullainathan (2004) and collapse the monthly observations into pre-event (2013:M1–2013:M12) and post-event (Jan. 2015–Dec. 2015) averages. Thus, I have one observation for each bank. The alternative to collapsing the data is 2-way clustering of the standard errors (see following discussion). The key variable of interest is MP$_i$. Control variables are denoted by X_i. Following the bank-lending literature (Kashyap and Stein (2000)), X_i includes the natural logarithm of total assets, the equity-to-assets ratio, and the return on assets. I include the ratio of central bank reserves to assets to control for any potential sales of securities by the bank to the central bank in the context of the APP and to control for a possible reserve-induced transmission channel (Kandrac and Schlusche (2016)). The deposit-to-assets ratio controls for another liquidity-driven transmission channel operating through deposits (Butt et al. (2014)). I further include the ratio of interbank lending to assets to control for the funding situation of the bank, and I include the net interest margin to control for the profitability and the importance of credit business. Additionally, bank-type fixed effects (i.e., savings banks, cooperative banks, Landesbanks, big commercial banks, regional banks) are included in the regressions. In this collapsed regression model 1, all control variables are measured before the yield decline in Dec. 2013. Finally, u_i is an error term. The coefficient β_1 measures the treatment effect of the monetary-policy–induced yield decline.

As an alternative specification to model 1, I estimate the following panel equation (model 2):

$$(2)\quad \text{LOG\_LOANS}_{i,t} = \alpha_i + \alpha_t + \alpha_1 \quad (\text{MP}_i \times \text{POST}_t) + X_{i,t}^{'}\alpha_2 + u_{i,t},$$

where α_i are bank fixed effects and control for bank-specific, time-invariant unobserved characteristics. α_t denotes time fixed effects and controls for different economy-wide developments that change over time.[17] Note that a country-wide change in loan demand is absorbed by the time fixed effects. The dependent variable LOG_LOANS$_{i,t}$ is the natural logarithm of newly issued loans, and POST$_t$ is a dummy variable that takes the value of 1 after 2015:M1, and 0 otherwise. The model is estimated with monthly data for the period 2013:M1 until 2015:M12. Time-varying control variables are denoted by $X_{i,t}$ and include the same variables as previously described. I follow Bertrand et al. (2004) and avoid problems of serial correlation of the error term by implementing 2-way clustering of the standard errors at the bank and time levels (Petersen (2009)) instead of collapsing the data

[17]Among others, the time fixed effects control for conventional monetary policy (i.e., the main refinancing (MRO) rate of the Eurosystem) as well as economy-wide shocks.

as in model 1. The key variable of interest is the interaction term $\text{MP}_i \times \text{POST}_t$ because I am interested in the differential effect of banks with a large decline in yields versus banks with a low decline in yields when comparing the pre-MP period (Jan. 2013–Dec. 2013) relative to the period after the MP-induced decline in yields (Jan. 2015–Dec. 2015). In other words, the coefficient α_1 measures the treatment effect of the monetary-policy–induced decline in yields.

4. Securities Analysis

To analyze whether banks reduce their security holdings due to the monetary-policy–induced yield decline (i.e., Hypothesis 2), I estimate the following econometric model at the *security–bank–month* level:

$$\text{(3)} \quad \text{LOG\_SECURITY\_HOLDINGS}_{j,i,t} = \gamma_1 (\text{MP}_i \times \text{POST}_t) + \gamma_2 (\text{MP}_i \times \text{POST}_t \times \text{SECURITY\_CHARACTERISTIC}_j) + X'_{i,t}\gamma_5 + \gamma_{j,t} + \gamma_{i,t} + \gamma_{j,i} + u_{j,i,t},$$

where the dependent variable is the natural logarithm of nominal holdings of security j by bank i at month t. $X_{i,t}$ includes the bank-specific, time-varying control variables described previously. POST_t is a dummy variable that takes the value of 1 after 2015:M1, and 0 otherwise. $\text{SECURITY\_CHARACTERISTIC}_j$ is a variable that captures security-specific information. The model is estimated for the period 2013:M1 until 2015:M12.

For identification, in the strongest specification, I include security × time fixed effects to control for any security-specific time-varying observable or unobservable characteristics (e.g., liquidity, risk, issuance amount), bank × time fixed effects to control for any bank-specific time-varying observable or unobservable characteristics, and security × bank fixed effects to control for any unobserved matching between characteristics of banks and securities (i.e., a bank's preference for a particular security). In some regressions, I am interested in the interaction between MP_i and POST_t. I include security × time fixed effects along with security × bank fixed effects and time-varying, bank-specific control variables in the regression in this case; otherwise, the interaction term would be absorbed by the bank × time fixed effects. I cluster standard errors at the bank, security, and time levels.[18] The estimated coefficient γ_1 then measures the securities holdings of more affected banks versus less affected banks before versus after the monetary-policy–induced yield decline. The estimated coefficient γ_2 measures the differential securities holdings of securities with a specific characteristic (securities bought in the APP) by banks more affected versus banks less affected by monetary policy before and after the unconventional monetary-policy–driven decline in yields.

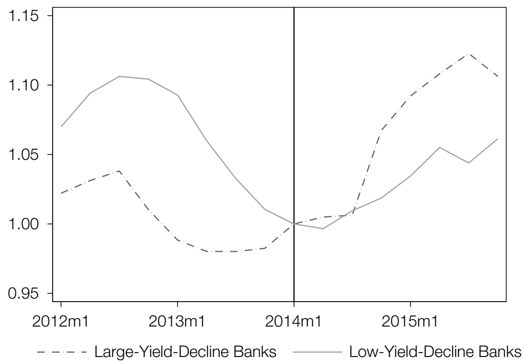
5. Parallel-Trend Assumption

The key identifying assumption is that treatment intensity is unrelated to other bank characteristics that might influence a bank's lending behavior. In other words, the trends related to granting loans need to be the same among the more and less treated banks before the treatment happens. Figure 2 provides an initial

[18]The results also hold when clustering at the security and bank levels.

FIGURE 2
Evolution of Loan Granting

Figure 2 shows the evolution of newly issued loans over the period Jan. 2012–Dec. 2015 (normalized to Dec. 2014). The solid line refers to banks in the lower 50th percentile of the MP variable, whereas the dashed line refers to banks in the upper 50th percentile of this variable. The bold vertical line denotes Jan. 2014, the month when the securities portfolios of the banks are selected for the construction of the MP variable. The graph depicts 4-month moving averages.



test of this assumption. The sample is divided into banks experiencing a large and small drop in yield according to the median of the MP variable. Before Jan. 2014, the evolution of new loans looks comparable. In line with the hypothesis of the article, starting in the middle of 2014, banks more affected by the monetary-policy–induced decline in yields increase their new loans much more strongly than less affected banks. This development continues throughout 2015.

In the next step, I assess whether the MP variable can be predicted by various (pre-shock) bank-level characteristics. Column 1 of Table 4 shows the results of a probit regression of the MP dummy on these characteristics. No variable has explanatory power for the treatment status, and also the p-value of the χ^2 test of overall model fit shows that the null hypothesis that all coefficient estimates are 0 cannot be rejected. Nevertheless, because the p-value is close to the 10% significance level, and given the pre-shock evolution of newly issued loans shown in Figure 2, in a careful attempt to ensure that my results are not biased by the potentially endogenous determination of securities holdings (with a large yield drop), I perform a nearest-neighbor propensity-score–weighting approach. In the first step, I divide my sample according to the median of the MP variable and regress the resulting treatment status on the pre-shock bank-level characteristics. The propensity scores (predicted values) of this probit regression are used in a nearest-neighbor propensity-score–matching approach with replacement. For each bank in the group with a large yield drop, a control unit is selected out of the "low-yield-drop" group that gives the best match according to the propensity score. In the second step, I use the resulting weights that are calculated based on the frequency of a match in my regressions. This way, I discard the observations that are very dissimilar to the "treated" banks by giving them a low weight. Column 2 of Table 4 displays the results of the probit regression with the matched sample. Compared with column 1, the p-value of the χ^2 test of overall model fit increases to 0.726, which indicates the satisfactory performance of the weighting

TABLE 4
Propensity-Score Weighting

Column 1 of Table 4 displays the results of a probit regression of the variable MP_DUMMY, which takes the value of 1 for banks that have an MP value above the 50th percentile, and 0 otherwise, on various bank-level characteristics. Column 2 reports the same regression results for the weighted sample. Weighting is done according to the nearest-neighbor propensity-score–matching approach with replacement. The *p*-value refers to the χ^2 test of the joint significance of all variables. Robust standard errors are reported in parentheses. *, **, and *** indicate significance at the 1%, 5%, and 1% levels, respectively.

	Probit: MP_DUMMY (50th Percentile)	
	Pre-Matching	Post-Matching
Variable	1	2
LOG_ASSETS	0.101	0.122
	(0.105)	(0.112)
EQUITY_RATIO	−3.490	6.373
	(4.073)	(4.871)
RESERVES_RATIO	−4.157	−1.015
	(5.918)	(5.796)
DEPOSITS_RATIO	0.030	0.952
	(0.699)	(0.839)
INTERBANK_RATIO	−0.969	−0.655
	(0.671)	(0.809)
RETURN_ON_ASSETS	15.936	24.198
	(14.594)	(18.420)
NET_INTEREST_MARGIN	−12.985	−19.483
	(13.605)	(25.226)
No. of obs.	204	204
p-value	0.129	0.726

exercise. Columns 2 and 4 of Table 5 report the results based on this matched sample. Section B of the Appendix in the Supplementary Material contains additional robustness checks (based on further bank-level characteristics and additional propensity-matching exercises) that all confirm the robustness of the main findings.

IV. Results

A. Credit Analysis

1. Main Results

Table 5 reports the main estimation results for the credit regressions to test Hypothesis 1. Columns 1 and 2 show the results of the collapsed baseline model 1, where the dependent variable is the change of the natural logarithm of newly issued loans of bank *i* between the pre-event average (Jan. 2013–Dec. 2013) and the post-event average (Jan. 2015–Dec. 2015). Bank-type fixed effects are included. The coefficient estimate of the MP variable is statistically significant at the 1% significance level. The positive sign is in line with the presence of a yield-induced rebalancing motive: Banks experiencing a larger average yield decline of their securities portfolios induced by expansionary unconventional monetary policy increase their lending to the real economy more strongly in response. To illustrate the economic impact of the effect, consider the coefficient of the MP variable in column 1, which shows the results in a sample without propensity-score weighting. A bank with a 1-standard-deviation decrease in the average yield (0.41) of its

TABLE 5
Baseline Regressions

Columns 1 and 2 of Table 5 show the coefficient estimates of the baseline regression (equation (1)) pre-matching (column 1) and post-matching (column 2). The dependent variable denotes the change in the natural logarithm of the pre-event (Jan. 2013–Dec. 2013) average and the post-event (Jan. 2015–Dec. 2015) average of newly issued loans. All control variables are measured in Dec. 2013 and include the natural logarithm of total assets, the equity-to-assets ratio, the reserves-to-asset ratio, the deposit-to-assets ratio, the interbank-to-assets ratio, the return on assets, the net interest margin, and bank-type fixed effects (FE; e.g., Landesbanks, cooperative banks, savings banks, regional banks, big commercial banks, mortgage banks). Robust standard errors are reported in parentheses. Columns 3 and 4 show the coefficient estimates of regression model 2. The dependent variable denotes the natural logarithm of newly issued loans for the time period of Jan. 2013–Dec. 2015. POST is a dummy variable taking the value of 1 after Jan. 2015, and 0 otherwise. All control variables are measured monthly. Bank and month fixed effects are included. Standard errors (SEs) are 2-way clustered at the bank and time levels and reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	Model 1: Δ_LOG_LOANS		Model 2: LOG_LOANS	
Variable	1	2	3	4
MP	0.216***	0.177***		
	(0.057)	(0.043)		
MP × POST			0.116***	0.130***
			(0.042)	(0.040)
LOG_ASSETS	−0.004	−0.035	0.787***	0.818***
	(0.040)	(0.039)	(0.273)	(0.263)
EQUITY_RATIO	−0.905	1.287	3.775**	1.488
	(1.581)	(1.910)	(1.661)	(2.057)
RESERVES_RATIO	−2.967**	−4.953***	−1.109*	−1.873**
	(1.292)	(1.517)	(0.575)	(0.794)
DEPOSITS_RATIO	0.085	−0.197	0.248	0.629
	(0.243)	(0.285)	(0.530)	(0.592)
INTERBANK_RATIO	0.013	0.290	−0.393	−0.753
	(0.185)	(0.199)	(0.358)	(0.476)
RETURN_ON_ASSETS	10.435**	3.247	−0.511	0.026
	(4.149)	(3.457)	(1.956)	(2.425)
NET_INTEREST_MARGIN	1.185	−2.090	6.772	0.340
	(2.481)	(6.487)	(6.884)	(8.472)
Matching	Pre-	Post-	Pre-	Post-
Bank-type FE	Yes	Yes	No	No
Bank FE	No	No	Yes	Yes
Month FE	No	No	Yes	Yes
2-way clustered SEs	No	No	Yes	Yes
No. of obs.	204	204	7,173	7,173
R^2	0.180	0.184	0.930	0.930

securities portfolio increases its average new lending by 8.8% between 2013 and 2015 compared to a bank without such a decrease in yields.

In column 2 of Table 5, I report the results with the weighted sample based on the propensity-score–matching procedure described earlier. The coefficient in column 2 is only slightly smaller compared with the unmatched sample. This indicates that it is unlikely that my results in the unmatched sample in column 1 are biased by the potentially endogenous determination of security holdings (with a large yield drop).

Next, in columns 3 and 4 of Table 5, I present results for model 2, where instead of taking pre- and post-event averages, the regression is performed using monthly observations with standard errors clustered at the bank and time levels. Because the dependent variable is the natural logarithm of newly issued loans, the coefficient estimate in column 3 suggests that banks with a decrease of 1 standard deviation (0.41) in the average yield in their securities portfolios on average increase their newly issued loans by 4.8% between 2013 and 2015 compared to banks without such a decrease in yields. Compared with model 1, the estimate in model 2 is smaller in magnitude. This is partly driven by the bank-type fixed effects included in model 1 and partly by the control variables. Whereas in model 1 the bank-specific control variables are measured before the monetary-policy–induced yield decline (Dec. 2013), model 2 includes the time-varying values. As I show in Section IV.C, the inclusion of bank-type × time fixed effects in model 2 decreases the difference in magnitudes of the two models. As before, the coefficient estimate is only slightly changed when using the weighted sample (see column 4). Therefore, for the ease of exposition, in all subsequent regressions, I report the results with the unweighted sample.

2. Heterogeneities: Maturing Assets

The main hypothesis analyzed in this article is that banks facing a stronger compression of yields rebalance their portfolios toward alternative assets with a higher expected return. This effect should be particularly strong for banks that hold many maturing securities. Once a security matures and additional liquidity is released, the bank has to make a reinvestment decision. Hence, the yield-induced portfolio-rebalancing effect toward loans to nonfinancial companies and households should be particularly strong for banks with many maturing assets that simultaneously undergo a sharp decline in yields in their securities portfolios. These banks might accelerate their lending growth in order to restore the targeted yield of their securities portfolios.

In Table 6, I test for this incentive by exploiting the heterogeneity given by the amount of securities that mature between 2014:M1 and 2015:M6 for identification.[19] In column 1, I incorporate the MATURING_ASSETS_RATIO along with an interaction term between MP and the MATURING_ASSETS_RATIO in the regression model 1. As expected, the interaction term is positive and statistically significant. This means that the treatment effect is larger for banks with a larger ratio of maturing assets to total assets. The coefficient estimate of the MP variable remains positive and significant. The marginal effect of the MP variable depending on MATURING_ASSETS_RATIO is depicted in Figure A1 in the Supplementary Material.

To better understand the magnitude of the interaction of MP and the MATURING_ASSETS_RATIO, consider the following example. The marginal effect of MP on bank lending for a bank with a MATURING_ASSETS_RATIO of 1.5% (25th percentile) is 0.174 (0.110 + 0.015 × 4.308), whereas the marginal effect for a bank with a MATURING_ASSETS_RATIO of 2.9% (50th percentile) is 0.235 (0.110 + 0.029 × 4.308). These results suggest that for a bank in the 25th percentile, a 1-standard-deviation decline in the average yield (0.41) of the security portfolio results in an increase of newly issued loans by 7.1% (0.41 × 0.174), whereas the bank in the 50th percentile increases its newly issued loans by 9.6% (0.41 × 0.235).

Thus, the results seem to confirm the previous conjecture that banks facing reinvestment decisions due to many maturing securities increase their

[19]The maturing-assets ratio is calculated based on the securities portfolio in 2014:M1.

TABLE 6
Additional Results

Columns 1–4 of Table 6 show the coefficient estimates of model 1. The dependent variable denotes the change in the natural logarithm of the pre-event (Jan. 2013–Dec. 2013) average and the post-event (Jan. 2015–Dec. 2015) average of newly issued loans. Column 5 shows the coefficient estimates of a regression with the first difference of the natural logarithm between 2013 (year-end) and 2015 (year-end) of the overall interest income from the profit and loss accounts as the dependent variable. All control variables are measured in Dec. 2013 and include the natural logarithm of total assets, the equity-to-assets ratio, the reserves-to-assets ratio, the deposit-to-assets ratio, the interbank-to-assets ratio, the return on assets, the net interest margin, and bank-type fixed effects (FE; e.g., Landesbanks, cooperative banks, savings banks, regional banks, big commercial banks, mortgage banks). In column 6, the dependent variable is the first difference of the natural logarithm between 2013 (year-end) and 2014 (year-end). In column 7, the dependent variable is the first difference of the natural logarithm of contingency reserves between 2013 (average of Jan 2013–Dec. 2013) and 2015 (average of Jan. 2015–Dec. 2015). In column 8, the dependent variable is the first difference of loan losses between 2013 (average of Jan. 2013–Dec. 2013) and the average of 2015 and 2016 (Jan. 2015–Dec. 2016) scaled by the credit stock in 2013 (year-end). All control variables are measured in Dec. 2013 and include the maturing-assets-to-total-assets ratio (when interaction estimated), the natural logarithm of total assets, the equity-to-assets ratio, the reserves-to-assets ratio, the deposit-to-assets ratio, the interbank-to-assets ratio, the return on assets, the net interest margin, and bank-type fixed effects (e.g., Landesbanks, cooperative banks, savings banks, regional banks, big commercial banks, mortgage banks). Robust standard errors are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	MATURING_ ASSETS_ RATIO	EQUITY_ RATIO	Sectors: Corporations	Sectors: Households	Δ_LOG_ INTEREST_ $INCOME_{13/15}$	Δ_LOG_ INTEREST_ $INCOME_{13/14}$	Δ_LOG_ CONTINGENCY_ $RESERVES_{13/15}$	Δ_LOAN_ LOSSES_ $RATIO_{13/16}$
Variable	1	2	3	4	5	6	7	8
MP	0.110* (0.064)	0.323** (0.142)	0.252* (0.149)	0.197* (0.100)	0.004 (0.016)	−0.018 (0.013)	0.270* (0.143)	−0.001 (0.001)
MP × VARIABLE	4.308** (1.902)	−1.938 (2.358)						
VARIABLE	−1.725 (1.146)	0.158 (1.457)						
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank-type FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	204	204	204	204	204	204	162	204
R^2	0.202	0.183	0.275	0.136	0.136	0.184	0.116	0.106

(higher-yielding) credit granting when they are more severely affected by the monetary-policy–induced decline in yields. These findings seem to be in line with banks targeting a specific yield level for their total assets. Furthermore, these findings are consistent with the results of Tischer (2018).

3. Heterogeneities: Equity

Now, I turn my attention to analyzing whether the effect of unconventional monetary policy is stronger for weakly capitalized banks. In the presence of funding constraints, the monetary-policy–induced valuation gains on securities held by banks can potentially improve the banks' capital position and, consequently, their lending capacity. Column 2 of Table 6 tests for this mechanism. The regression setup remains unchanged from the previous description, with the exception that an interaction term between the MP variable and the equity ratio (EQUITY_RATIO) is included in the regression. Intuitively, because they face more frictions, worse-capitalized banks should profit more by the valuation gains as opposed to well-capitalized banks: They are more likely to be constrained by their capital position, and they have more problems in attracting funds. Hence, if this form of equity mechanism is at work, one would expect a stronger effect of the MP variable on bank-lending behavior for banks with a lower ratio of equity to assets. The coefficient estimates of the interaction term between MP and EQUITY_RATIO are not statistically different from 0 in either model. Thus, I do not find evidence for the conjecture.[20]

4. Heterogeneities: Sectors

So far, I have focused on total lending to the private nonfinancial sector. An interesting question is which sectors receive the additionally issued loans. Columns 3 and 4 of Table 6 contain the results of regressions with the dependent variable split into loans to nonfinancial corporations and loans to households. The results do not show any difference in granting loans to either of the two sectors. Accordingly, both the nonfinancial corporation and household sectors increase their borrowing.

5. Contaminating Events

One potential concern regarding the identification strategy implemented in this article is that one of the unconventional monetary-policy measures potentially affecting banks through other non-yield-induced channels might be both correlated with the MP variable and linked to banks' lending behavior. One such measure is the TLTROs, which were implemented between Dec. 2014 and Mar. 2017 (i.e., during most of the time period analyzed in this article). The main aim of the TLTROs was to provide banks with liquidity under favorable conditions in order to foster the supply of credit. These refinancing operations have a maturity of up to 4 years. The amount that a bank is allowed to draw in the numerous tender operations and the interest rate it has to pay for the central bank money are linked to the bank's newly issued loans.

In an initial attempt to determine whether the potential contamination of the TLTROs might bias my results, in Graph A of Figure 3, I use data on bank-specific TLTRO uptakes to show the average TLTRO uptake as a fraction of total assets of the two groups of banks divided according to the median of the MP variable. The evolution of the TLTRO ratio is mostly parallel for the two groups, which is an initial indication that banks whose yields decline significantly do not use the TLTROs more extensively than banks with a lower decline in yields. Next, in Table A1 in the Supplementary Material, I run regressions in which I explicitly control for the bank-specific TLTRO uptakes (TLTRO_RATIO).[21] All previous results hold. Thus, the results suggest that the monetary-policy–induced yield decline is not simply proxying for TLTRO uptakes. This indicates that my results do not seem to be driven by alternative liquidity-driven transmission channels but instead capture yield-induced rebalancing motives.

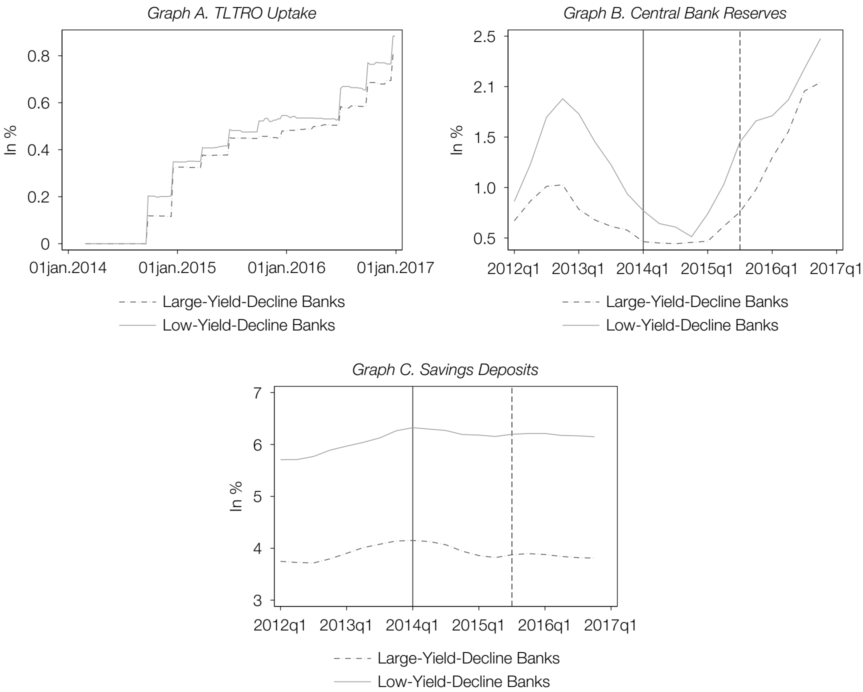
Apart from the TLTROs, further potentially contaminating events are the actual purchases of securities by the central banks of the Eurosystem in the context of the APP. When a bank sells eligible securities on behalf of its

[20] An investigation of bank size as an additional measure of financing constraints did not detect heterogeneous effects.

[21] I use the empirical specification of model 2 in this case because model 1 includes control variables measured in Dec. 2013, and the TLTROs were initiated in late 2014. An alternative to reporting the results with the additional control variable separately would be to directly include it in the main specification. However, in this case, the TLTRO_RATIO could only enter model 2. To ensure comparability of estimates stemming from the model choice and not from different control variables, I chose to report results separately in Table A1 of the Supplementary Material.

FIGURE 3
Contaminating Events

Graph A of Figure 3 shows the evolution of the ratio of the Targeted Longer-Term Refinancing Operations (TLTRO) uptake to total assets. Graph B depicts the ratio of reserves held at central banks to total assets, and Graph C shows the saving-deposits-to-assets ratio. The solid line refers to banks in the lower 50th percentile of the MP variable, whereas the dashed line refers to banks in the upper 50th percentile of this variable.



depositors, the bank's total central bank reserves on its asset side and its savings deposits on its liability side might increase. This increase might disturb the bank's optimal balance-sheet composition. In order to restore the original composition, banks might seek to increase their loan supply. This argument has been made by Friedman and Schwartz (1963) and has recently been empirically tested by Kandrac and Schlusche (2016). In addition to controlling for the deposit-to-assets ratio and the reserves-to-asset ratio in all regressions, Graphs B and C of Figure 3 show the evolution of those variables for the two groups of banks. Although the central bank reserves ratio increases sharply starting at the beginning of 2015, banks whose yields drop significantly do not face a major increase compared with banks with a small drop in yields. Similarly, there is no differential pattern for the evolution of the deposit-to-assets ratio. Thus, the MP variable does not proxy for this reserve-induced portfolio-rebalancing effect.

6. Additional Evidence for Hypothesis 1

According to Hypothesis 1, banks facing larger compressions of yields in their securities portfolios increase their book credit *because they target a specific yield level*. So far, the results in Table 5 show a positive relationship between the increase in bank lending and the average yield decline in a bank's securities portfolio. To provide additional evidence that the rationale behind banks increasing their lending is that they are *targeting a specific yield level*, columns 5 and 6 of Table 6 show the coefficient estimates of bank-level regressions with the change in the natural logarithm of overall interest income (Δ_LOG_INTEREST_INCOME) as the dependent variable. Overall interest income is a profit and loss account variable and is available at a yearly frequency. Because the yield decline happens mostly throughout the years 2014 and 2015 (see Graph A of Figure 1), I calculate both the growth rate between 2013 (end of the year) and 2015 (column 5 of Table 6) and the growth rate between 2013 (end of year) and 2014 (column 6 of Table 6). In both cases, the magnitude of the coefficient estimates of the MP variable is small. Furthermore, both coefficients are not statistically significant at conventional significance levels. Thus, the banks' overall interest income does not change in response to variations in MP. This result suggests that banks are able to offset declines in the yield on their securities portfolios with extra interest from their book credit, which supports the view that the rationale behind banks increasing lending is that they are indeed *targeting a specific yield level*.

7. Risk Taking

Next, I investigate whether the increase in newly issued lending of banks more affected by the monetary-policy–induced yield decline results in higher risk taking. To maintain the same targeted yield level, a bank might potentially lend to riskier borrowers when increasing its lending. To test for this potential risk-taking incentive, I construct two different variables. First, I generate the first difference of the natural logarithm of contingency reserves (also called general value adjustments) between 2013 and 2015 (Δ_LOG_CONTINGENCY_RESERVES$_{13\backslash 15}$). Under German commercial law (Handelsgesetzbuch (HGB)), banks can account for latent credit risk that has not yet materialized by forming contingency reserves.[22] Second, to measure ex post credit risk, I construct the growth rate of loan losses (Δ_LOAN_LOSSES_RATIO$_{13\backslash 16}$).[23]

Column 7 of Table 6 shows the coefficient estimate of a bank-level regression with Δ_LOG_CONTINGENCY_RESERVES$_{13\backslash 15}$ as the dependent variable. All previously described control variables are included. The coefficient estimate is significant both statistically and economically. Banks with a 1-standard-deviation (0.41) decrease of the average yield in their security portfolios on average increase their contingency reserves by 11.1% between 2013 and 2015 as compared to banks without such a decrease in yields.

In column 8 of Table 6, I test whether credit risk has actually materialized for more affected banks. For this purpose, I regress Δ_LOAN_LOSSES_RATIO$_{13\backslash 16}$ on the MP variable and the control variables. The coefficient is not statistically or

[22]Out of the 204 banks, 42 do not have contingency reserves. Therefore, the regression in column 7 of Table 6 is based on 162 banks.

[23]The loan losses variable captures the value adjustments and write-downs/write-ups of nonperforming loans. Because some banks have net write-ups (resulting in a negative value), the growth rate instead of the first difference of the natural logarithm of the loan losses is calculated.

economically significant.[24] One potential explanation for this finding might be that loan losses resulting from the additional lending might materialize at a later point in time and in a staggered manner, which might make measurement challenging.

All in all, I conclude that there are signs of risk taking as banks more affected by unconventional monetary policy increase their contingency reserves. However, more affected banks do not face higher actual loan losses.

8. Additional Results: Decomposition of MP

So far, I have focused on the average monetary-policy–induced yield decline of banks' overall security holdings. An interesting question is which (security) sector drives the effect of MP on growth in banks' newly issued loans. Table 7 shows coefficient estimates of the credit regressions with the MP variable decomposed according to the yield decline of the three classes of securities. To construct MP_GOVERNMENT, I consider the nominal government bond holdings of a bank and weight each government security by the nominal amount held by the particular bank over the bank's total nominal bond holdings. I proceed equivalently with financial and corporate bonds.

Columns 1–3 of Table 7 show the coefficient estimates of regressions with the decomposed MP shocks included on their own, whereas column 4 shows the results with all three MP variables included jointly in the regression. The results show that it is the decline in the yield of government and financial securities that drives the effect of MP on new lending. The coefficient estimates of (nonfinancial) corporate securities are not statistically different from 0. This result is reasonable because the mean fraction of corporate-sector bonds to total assets amounts to

TABLE 7
Decomposition of MP

Table 7 shows coefficient estimates of model 1 with different shock variables. The dependent variable denotes the change in the natural logarithm of the pre-event (Jan. 2013–Dec. 2013) average and the post-event (Jan. 2015–Dec. 2015) average of newly issued loans. MP_GOVERNMENT, MP_FINANCIALS, and MP_CORPORATES are decompositions of the MP variable. All control variables are measured in Dec. 2013 and include the natural logarithm of total assets, the equity-to-assets ratio, the reserves-to-asset ratio, the deposit-to-assets ratio, the interbank-to-assets ratio, the return on assets, the net interest margin, and bank-type fixed effects (FE; e.g., Landesbanks, cooperative banks, savings banks, regional banks, big commercial banks, mortgage banks). Robust standard errors are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Variables	1	2	3	4
MP_GOVERNMENT	0.193*			0.221**
	(0.108)			(0.102)
MP_FINANCIALS		0.214***		0.231***
		(0.075)		(0.074)
MP_CORPORATES			0.150	–0.032
			(0.297)	(0.274)
Controls	Yes	Yes	Yes	Yes
Bank-type FE	Yes	Yes	Yes	Yes
No. of obs.	204	204	204	204
R^2	0.137	0.156	0.119	0.181

[24]The growth rate between 2013 and 2016 is calculated instead of the growth rate between 2013 and 2015 because it takes more time for loan losses to materialize. Different growth-rate calculations did not yield substantially different results.

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0.3% (see Table 2), and only 89 out of 204 banks hold corporate-sector bonds for their own account. Thus, it is the decline in government and financial bonds that drives the effect of MP on banks' loan granting.

B. Securities Analysis

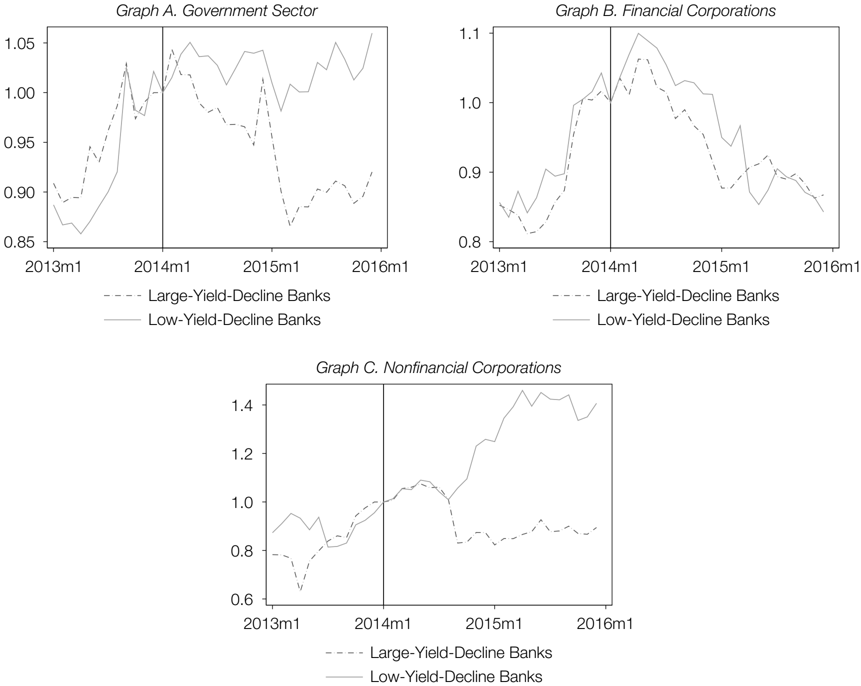
1. Main Results

This section investigates whether banks more affected by unconventional monetary policy reduce their securities holdings (Hypothesis 2). Figure 4 presents an overview and shows the evolution of the securities-to-total-assets ratio of different issuer sectors of banks more and less affected by monetary policy. Banks that are more affected reduce their nominal holdings of government bonds, whereas banks not affected by monetary policy do not (Graph A). There are no differences in the pattern with respect to securities issued by financial corporations (Graph B). Banks with a larger average yield decline reduce their corporate-sector holdings, whereas less affected banks do not (Graph C).[25]

FIGURE 4

Security Holdings by Issuer Sector

Figure 4 shows the evolution of the security holdings of the government (Graph A), financial corporations (Graph B), and nonfinancial corporations (Graph C) issuer sectors in nominal amounts to total assets over the period Jan. 2012–Dec. 2015 (normalized to Jan. 2014). The solid line refers to banks in the lower 50th percentile of the MP variable, whereas the dashed line refers to banks in the upper 50th percentile of that variable. The bold vertical line denotes Jan. 2014.



[25]Note, however, that the ratio of nonfinancial corporate-sector bonds to total assets is very small as compared to government securities or financial-sector bonds, as shown in Table 2. Additionally,

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A more formal analysis (i.e., the results of estimating different specifications of equation (3)) is presented in Tables 8 and 9. Column 1 of Table 8 shows that banks more affected by unconventional monetary policy reduce their total nominal securities holdings after the shock. In column 2, I add security × time fixed effects and find similar results in terms of significance and magnitude. When including security × bank fixed effects in column 3, the effect vanishes. Next, in columns 4–6, I restrict the sample to government bonds. I saturate the regression with security × time and security × bank fixed effects in column 6 and find that banks more affected by unconventional monetary policy reduce their nominal government bond holdings after the shock. Economically, banks with a 1-standard-deviation drop in the average yield of their securities portfolios reduce their government bond holdings by approximately 2.7% (0.41 × (−0.065)). This result does not seem to hold for financial-sector or non-financial-sector corporate bonds in the specification including bank × security and security × time fixed effects (columns 9 and 12).

It is reasonable that banks more affected by the monetary-policy–induced yield decline reduce their government bond holdings. As shown in Table 1, government bonds are characterized by larger declines in yield compared with private securities (i.e., of financial and nonfinancial issuers). Additionally, government bonds were the main focus of the APP. A question that arises is whether there is a difference regarding the holdings of securities that were bought by the national central banks of the Eurosystem in the APP. I now turn to this investigation.

2. Additional Security Results

Figure 5 shows that banks more affected by the monetary-policy–induced decline in yields decrease their holdings of securities that were bought by the national central banks of the Eurosystem in the APP. Banks with a lower average decline in yields do not reduce their holdings of these securities.

In Table 9, I add the triple-interaction term between MP_i, $\text{POST}_{2015:\text{M3}}$, and APP_j, along with all other double-interaction terms between those three variables. The variable APP_j takes the value of 1 if the security was bought by the national central banks of the Eurosystem in the APP, and 0 otherwise. The variable $\text{POST}_{2015:M3}$ takes the value of 1 after the start of the APP in Mar. 2015, and 0 otherwise. I add security × time, bank × time, and security × bank fixed effects into the regression, which allows for a particularly strong identification. In column 1, I find that banks more affected by monetary policy (i.e., with a 1-standard-deviation decline) reduce their holdings of securities that were bought in the APP by 6.2% (0.41 × −0.150) after the start of asset purchases. This finding highlights the fact that not only did the APP give banks an incentive to rebalance their portfolios due to the effect it had on the yields of banks' security holdings, but also more affected banks actively sold these securities bought by the national central banks of the Eurosystem.

A concern could arise due to the accounting treatment of securities held by banks. Because trading book assets are marked to market, security price gains

only a small number of banks hold corporate-sector bonds. Therefore, this ratio is much more prone to the idiosyncratic changes of single banks.

TABLE 8

Securities

In Table 8, the dependent variable is the natural logarithm of nominal securities holdings (LOG_SECURITY_HOLDINGS) by each bank *i* of security *j* during month *t* in the period of Jan. 2013–Dec. 2015. POST is a dummy variable taking the value of 1 after Jan. 2015, and 0 otherwise. Fixed effects (FE) are either included ("Yes"), not included ("No"), or spanned by other fixed effects ("—"). A constant is included, but its coefficient is left unreported. Standard errors are clustered at the bank, security, and time levels and are reported in parentheses. **, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	Dependent Variable: LOG_SECURITY_HOLDINGS											
	All			Government			Financials			Corporates		
Variables	1	2	3	4	5	6	7	8	9	10	11	12
MP × POST	−0.133**	−0.124**	−0.001	−0.107*	−0.143*	−0.065**	−0.094**	−0.061*	0.031	−0.264**	−0.315**	−0.012
	(0.049)	(0.048)	(0.039)	(0.054)	(0.084)	(0.026)	(0.041)	(0.035)	(0.050)	(0.117)	(0.116)	(0.161)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Security FE	Yes	–	–	Yes	–	–	Yes	–	–	Yes	–	–
Bank FE	Yes	Yes	–	Yes	Yes	–	Yes	Yes	–	Yes	Yes	–
Time FE	Yes	–	–	Yes	–	–	Yes	–	–	Yes	–	–
Security × time FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Security × bank FE	No	No	Yes	No	No	Yes	No	No	Yes	No	No	Yes
No. of obs.	1,463,750	1,003,450	996,058	325,697	286,918	285,104	1,037,614	629,500	624,760	100,384	87,009	85,946
R^2	0.754	0.519	0.890	0.491	0.471	0.889	0.821	0.533	0.891	0.532	0.564	0.833

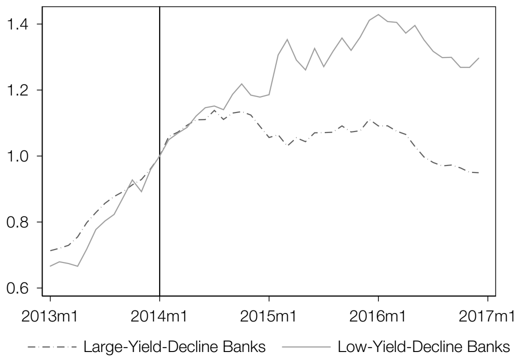
TABLE 9
Additional Security Regressions

The dependent variable in Table 9 is the natural logarithm of nominal securities holdings (LOG_SECURITY_HOLDINGS) by each bank *i* of security *j* during month *t* in the period of Jan. 2013–Dec. 2015. POST is a dummy variable taking the value of 1 after Jan. 2015, and 0 otherwise. $POST_{2015:M3}$ is a dummy variable taking the value of 1 after Mar. 2015, and 0 otherwise. APP is a dummy variable taking the value of 1 when a security was bought by the central bank, and 0 otherwise. Fixed effects (FE) are either included ("Yes"), not included ("No"), or spanned by other fixed effects ("—"). A constant is included, but its coefficient is left unreported. Standard errors are clustered at the bank, security, and time levels and are reported in parentheses. *, **, and ***, indicate significance at the 10%, 5%, and 1% levels, respectively.

	Dependent Variable: LOG_SECURITY_HOLDINGS			
	Government			
		Baseline	Banking Book	Trading Book
Variables	1	2	3	4
MP × $POST_{2015:M3}$ × APP	−0.150*			
	(0.087)			
MP × POST		−0.065**	−0.061*	0.010
		(0.026)	(0.034)	(0.376)
Controls	–	Yes	Yes	Yes
Bank × time FE	Yes	No	No	No
Security × time FE	Yes	Yes	Yes	Yes
Security × bank FE	Yes	Yes	Yes	Yes
No. of obs.	285,104	285,104	228,791	43,611
R^2	0.893	0.889	0.941	0.837

FIGURE 5
Evolution of APP Securities

Figure 5 shows the evolution of the ratio of nominal security holdings of Expanded Asset Purchase Program (APP) securities to total assets over the period Jan. 2012–Dec. 2016 (normalized to Jan. 2014). The solid line refers to banks in the lower 50th percentile of the MP variable, whereas the dashed line refers to banks in the upper 50th percentile of this variable. The bold vertical line denotes Jan. 2014, the month when the securities portfolios of the banks are selected for the construction of the MP variable.



would effectively serve to recapitalize banks with a higher MP. Thus, banks would not need to sell securities in order to expand their book credit. I can directly test whether this channel is operative because the security-holding statistics allow the identification of bonds held in the banking book versus those held in the trading book. Out of the 204 banks in my sample, 36 have a trading book. Trading-book assets account for approximately 11.5% of the total securities held in 2014:M1. In columns 3 and 4 of Table 9, I report separate coefficient estimates of equation (3) for banking-book and trading-book government bonds. The coefficient estimate of the interaction between MP and POST for the banking-book assets (column 3) is quantitatively very similar to the coefficient estimate of the baseline model (column 2). However, there is no evidence that banks with sizeable yield declines reduce their trading-book government bond holdings because the coefficient estimate in column 4 is not statistically different from 0. Thus, I conclude that banks that are more affected by the monetary-policy–induced yield decline reduce their government bond holdings in their banking books.

In unreported regressions, I investigate whether there is a difference in heterogeneity in the securities holdings with respect to the equity ratio. I do not find evidence in favor of the hypothesis that banks with a low equity ratio reduce their securities holdings more strongly. One potential explanation might be that, outside times of crisis, equity does not constitute a constraint for comparatively well-capitalized German banks.

Following Albertazzi et al. (2018), I analyze whether banks more affected by monetary policy rebalance toward securities with a higher yield.[26] I do not find evidence for such rebalancing into higher-yielding securities. Like Albertazzi et al., I argue that one possible explanation for this might be that yields were already so compressed in Germany that, given a home bias, investing in securities with a relatively high yield would make it necessary to extensively restructure the composition of the portfolio. This highlights the economic plausibility of my findings: Given the relative price change between securities and book credit, banks favor a rebalancing toward lending.

C. Robustness

So far, I have found the monetary-policy–induced decline in yields to have significant effects on banks' lending and security-holding behavior. In this section, I test the robustness of these results. Most importantly, to test whether the MP variable picks up any other observable or unobservable traits that might be linked to banks' lending behavior, I run placebo regressions with a different timing of the dependent variable. I regress the change in the natural logarithm of newly issued loans between 2011 and 2013 (i.e., in a period where the difference in yield decline should have no effect on bank lending) on all control variables noted previously. Column 1 of Table 10 shows the results of this falsification exercise. As expected, the MP variable is not statistically significant and has the wrong sign. This points toward the exogeneity of the MP variable. Hence, the change in lending outcomes observable in the period under investigation is most likely attributable to the fall in yields as opposed to an alternative observable or unobservable force.

Second, I present results for a group of banks excluding large commercial banks (in terms of total assets) and Landesbanken. Large commercial banks might hedge their exposure to interest rate risk.[27] The results in column 2 of Table 10 remain qualitatively unchanged, which means that the effects are not driven by the behavior of this particular banking group.

[26]This can be tested by the inclusion of an interaction term between MP_i, POST_t, and the time-varying yield of the security $\text{YIELD}_{j,t}$ in the security-level regression equation (3)).

[27]Hoffmann, Langfield, Pierobon, and Vuillemey (2019) show that large European banks use derivatives to reduce their risk exposure by one-quarter on average.

TABLE 10
Robustness Checks

Table 10 shows the coefficient estimates of various robustness checks. Column 1 shows placebo regressions, where the dependent variable denotes the change in the natural logarithm of newly issued loans between the averages of 2011 (Jan. 2011–Dec. 2011) and 2013 (Jan. 2013–Dec. 2013). In column 2, large commercial banks and Landesbanken are omitted from the regression. In column 3, the dependent variable is credit stock. Column 4 shows results with a dummy (above 50th percentile of MP) variable instead of the continuous MP variable. In column 5, the MP variable is calculated based on banking-book assets only. In column 6, bonds with a call option are excluded when calculating the MP variable. In column 7, the MP variable is weighted with the securities-to-assets ratio. Column 8 shows results after winsorizing the MP variable at the 1% and 99% levels. In column 9, the dependent variable is not winsorized. Columns 10 and 11 show results with a sample split according to the median of the maturing-assets-to-total-assets ratio, along with the *p*-value of group difference. Column 12 shows the results with a different timing of the MP variable. All control variables are measured in Dec. 2013 and include the natural logarithm of total assets, the equity-to-assets ratio, the reserves-to-asset ratio, the deposit-to-assets ratio, the interbank-to-assets ratio, the return on assets, the net interest margin, and bank-type fixed effects (FE; e.g., Landesbanks, cooperative banks, savings banks, regional banks, big commercial banks, mortgage banks). Robust standard errors are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Variables	Placebo Regression	Large Banks Omitted	Alternative Dependent Variable: Credit Stock	Alternative MP: Dummy P50	Alternative MP: MP_BANKING_BOOK	Alternative MP: MP_WITHOUT_CALL
	1	2	3	4	5	6
MP	−0.034	0.213***	0.075**	0.112**	0.206***	0.213***
	(0.129)	(0.060)	(0.036)	(0.051)	(0.058)	(0.057)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Bank-type FE	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	204	189	204	204	204	204
R^2	0.232	0.175	0.196	0.140	0.172	0.175

Variables	Alternative MP: Weighted	Alternative MP: Winsorized	No Winsorization of Credit	Low Maturing-Asset Ratio	High Maturing-Asset Ratio	Different Timing of MP: Jan. 2014–Dec. 2014
	7	8	9	10	11	12
MP	1.015***	0.257***	0.247***	0.116**	0.365***	0.187***
	(0.315)	(0.079)	(0.076)	(0.057)	(0.104)	(0.069)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Bank-type FE	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	204	204	204	102	102	204
R^2	0.176	0.353	0.360	0.140	0.341	0.156
p-value (group difference)				0.039		

Third, I show the results for an alternative dependent variable. Instead of newly issued credit, in column 3 of Table 10, I use the outstanding stock of credit as an outcome variable (Δ_LOG_LOANS_STOCK). The previous results hold. As expected, the magnitude of the effect is reduced in this case because the credit stock includes maturing assets, which might lead to a smaller increase in this variable as opposed to the amount of truly newly issued loans. Looking at the coefficient of the MP variable in column 3 of Table 10, banks with a 1-standard-deviation decrease in the average yield (0.41) of their portfolios increased their outstanding stock of credit by approximately 3% between 2013 and 2015.

Column 4 of Table 10 shows the results with a dummy variable instead of the continuous MP variable. The dummy takes the value of 1 for banks with a yield drop above the median of the MP variable distribution. The baseline result remains qualitatively unchanged.

As already discussed in Section IV.B.2, one concern with the MP measure might be that it is calculated based on both banking-book and trading-book assets, which are marked to market. Under mark-to-market accounting, security price gains affect equity directly such that banks would not need to sell securities in order to expand their book credit. As shown in column 5 of Table 10, the results remain unchanged if I calculate the MP variable based on banking book assets only (MP_BANKING_BOOK).

A further concern with the MP measure might be that it includes bonds that have a call option. In a falling-interest-rate environment, banks might have an incentive to call previously issued bonds, refinance at lower interest rates, and lend out some of the proceeds as book credit. Based on the security-holdings statistics, it is possible to identify securities that have an embedded call option. Out of the 55,225 different securities in the analyzed sample, banks hold 3,543 bonds that have a call option. In terms of nominal amounts, 3.1% is accounted for by securities with a call option. To make sure that my results in Table 5 are not driven by banks' decisions to call a bond in the falling-interest environment, as a further robustness check, I calculate an alternative MP variable (MP_WITHOUT_CALL) that is restricted to securities without a call option. Column 6 in Table 10 shows the main credit results with this alternative MP measure. The coefficient estimate remains virtually unaffected. Table A2 in the Supplementary Material shows the main security regressions in a sample that excludes the 3,543 bonds with a call option. Again, coefficients are virtually unaffected in this new sample. Thus, I conclude that the results of the article are robust to the potential effect that callable bonds might have on banks' credit supply and security-holding decisions.

Next, to further highlight the economic plausibility of my results, in column 7 of Table 10, I weight the MP variable with the securities-to-assets ratio. The rebalancing motive should be larger for banks that hold a larger fraction of yield-decreasing securities relative to the total balance sheet. As expected, this robustness check indicates that the size of the securities portfolio plays a role in the strength of the rebalancing motive.

To rule out the possibility that the results are driven by potential outliers or the level of winsorization applied to the outcome variable in all preceding regressions, I present the results of two additional specifications. In column 8 of Table 10, I winsorize the MP variable at the 1% and 99% levels of the distribution, with little impact on the coefficient estimates. I report results without winsorizing the dependent variable in column 9. The findings are confirmed.

Next, instead of estimating an interaction term between the maturing-asset ratio and the MP variable, I split the sample according to the median of the ratio of maturing assets to total assets in columns 10 and 11 of Table 10. As expected, the statistical and economic significance is larger for banks with a higher maturing-assets-to-total-assets ratio. For banks with below-median maturing assets, the coefficient estimate is still significant and positive. Additionally, the difference between the two coefficients of the two groups of banks (with a high or low maturing-asset ratio) is also significant for both models.[28]

In a further step, I change the timing of the construction of the MP variable. Instead of calculating the decline in yields between Jan. 2014 and June 2015, I

[28]The p-value of the 2-sided t-test of the difference between the two coefficients (with 87 degrees of freedom, i.e., 102 observations, 15 controls, and fixed effects) is 3.9%. In both cases the t-statistic reads as follows: $(\hat{\beta}_1 - \hat{\beta}_2)/\left(\sqrt{\text{se}(\hat{\beta}_1)^2 + \text{se}(\hat{\beta}_2)^2}\right)$.

choose a smaller time window (i.e., Jan. 2014 until Dec. 2014). The results are robust to this alternative timing and are displayed in column 12 of Table 10. The coefficient estimate of the MP variable is somewhat smaller in this case. This makes sense economically because yields declined further after Dec. 2014.

Next, I add bank-specific lagged loan growth (Δ_LOG_LOANS$_{t-1}$) as an additional control variable to rule out the possibility of my results being driven by a potential mean reversion of lending of banks more affected by monetary policy. The results are presented in Table A3 in the Supplementary Material. The coefficient estimate of Δ_LOG_LOANS$_{t-1}$ in column 1 of Table A3 is negative and significant, which supports the visual evidence presented in Figure 2. Banks with lower loan growth between 2012 and 2013 tend to increase their real-sector lending subsequently. The coefficient estimate of the MP variable is somewhat smaller in this case (0.190 vs. 0.216 in the baseline model) and remains statistically significant at the 1% level. Furthermore, the inclusion of lagged loan growth helps to address potential demand shocks at the bank level.

To further rule out variation in banks' loan growth because of differences in credit demand, I include fixed effects at the region level[29] in model 1 as a proxy for local credit demand (see column 2 of Table A3 in the Supplementary Material). Column 4 shows the equivalent coefficient estimates of model 2 with region × time fixed effects included in the regression. The coefficient estimates from the regressions with these additional demand proxies confirm the main findings.

As discussed in Section IV.A.1, in Table 5, the coefficient estimate of MP in model 2 is smaller in magnitude than that in model 1. One difference between the models is that model 1 includes bank-type fixed effects. Therefore, in a first attempt to get to the bottom of what drives the difference in the coefficient estimates, I include bank-type × time fixed effects in model 2 (see column 5 of Table A3 in the Supplementary Material). The coefficient estimate of the MP variable increases to 0.125 in this case. In a second step, I include bank-type × region fixed effects in both models and region fixed effects in model 1, along with region × time fixed effects in model 2 (columns 3 and 6 of Table A3). Both coefficient estimates further converge in this case (i.e., the estimate of model 1 decreases to 0.188, and the coefficient estimate of model 2 further increases to 0.126). The remaining difference is most likely driven by the control variables, which are constant in model 1 and time varying in model 2.

V. Conclusion

In this article, I analyze how unconventional monetary policy affects bank lending and security holdings. I show evidence for a yield-induced portfolio-rebalancing channel: Banks experiencing larger drops in yields in their securities portfolios, induced by unconventional monetary policy, seek to restore their targeted yield level by increasing their higher-yielding credit extension. This effect is particularly pronounced for banks with many maturing assets that have to make reinvestment decisions. I find signs of risk taking as more affected banks increase

[29]It is only feasible to use the first 2 digits of the 5-digit ZIP code in order to have enough banks in one region.

their contingency reserves. At the same time, these banks reduce their government bond holdings and sell securities bought by the national central banks of the Eurosystem under the APP.

My findings highlight the fact that not only did the APP give banks an incentive to rebalance their portfolios due to the effect of the APP on the yields of banks' security holdings, but also more affected banks actively sell these securities bought by the national central banks of the Eurosystem.

My results are informative for the current debate on the effectiveness of unconventional monetary policy because they shed additional light on how the transmission of unconventional monetary policy works at the bank level. My article highlights the importance of keeping hold of the impact of these measures on financial markets because changes in relative prices between bonds and book credit have implications for bank lending to the real sector.

Supplementary Material

Supplementary Material for this article is available at https://doi.org/10.1017/S0022109019001054.

References

Abbassi, P.; R. Iyer; J.-L. Peydró; and F. R. Tous. "Securities Trading by Banks and Credit Supply: Micro-Evidence from the Crisis." *Journal of Financial Economics*, 121 (2016), 569–594.

Abidi, N., and I. Miquel Flores. N. A. Eterovic. "Who Benefits from the ECB's Corporate Sector Purchase Programme? A Difference-in-Discontinuities Approach." Working Paper No. 2145, European Central Bank (2018).

Acharya, V. V.; T. Eisert; C. Eufinger; and C. W. Hirsch. "Whatever It Takes: The Real Effects of Unconventional Monetary Policy." *Review of Financial Studies*, 32 (2019), 3366–3411.

Adrian, T., and H. Shin. "Financial Intermediaries and Monetary Economics." In *Handbook of Monetary Economics*, B. M. Friedman and M. Woodford, eds. Amsterdam: Elsevier (2011), 601–650.

Albertazzi, U.; B. Becker; and M. Boucinha. "Portfolio Rebalancing and the Transmission of Large-Scale Asset Programs: Evidence from the Euro Area." Working Paper No. 2125, European Central Bank (2018).

Almeida, H.; M. Campello; B. Laranjeira; and S. Weisbenner. "Corporate Debt Maturity and the Real Effects of the 2007 Credit Crisis." *Critical Finance Review*, 1 (2012), 3–58.

Altavilla, C.; G. Carboni; and R. Motto. "Asset Purchase Programmes and Financial Markets: Lessons from the Euro Area." Working Paper No. 1864, European Central Bank (2015).

Andrade, P.; C. Cahn; H. Fraisse; and J.-S. Mésonnier. "Can the Provision of Long-Term Liquidity Help to Avoid a Credit Crunch? Evidence from the Eurosystem's LTROs." *Journal of the European Economic Association*, 17 (2018), 1070–1106.

Arce, O.; R. Gimeno; and S. Mayordomo. "Making Room for the Needy: The Effects of the Corporate Sector Purchase Programme on Firms Credit." Working Paper No. 1746, Banco de Espana (2017).

Bade, M.; J. Flory; M. Gomolka; and T. Schoenberg. "SHS-Base Plus, Data Report 2017-08, Metadata Version 1-1." Deutsche Bundesbank Research Data and Service Centre (RDSC) (2017).

Bade, M., and M. Krueger. "MFI Interest Rate Statistics, Data Report 2019-05, Metadata Version 3." Deutsche Bundesbank Research Data and Service Centre (RDSC) (2019).

Bauer, M. D., and G. D. Rudebusch. "The Signaling Channel for Federal Reserve Bond Purchases." *International Journal of Central Banking*, 10 (2014), 233–289.

Bernanke, B. "A Conversation: The Fed Yesterday, Today and Tomorrow." The Brookings Institution, Jan. 16, 2014.

Bernanke, B., and A. Blinder. "Credit, Money, and Aggregate Demand." *American Economic Review*, 78 (1988), 435–439.

Bernanke, B., and A. Blinder. "The Federal Funds Rate and the Channels of Monetary Transmission." *American Economic Review*, 82 (1992), 901–921.

Bertrand, M.; E. Duflo; and S. Mullainathan. "How Much Should We Trust Differences-in-Differences Estimates?" *Quarterly Journal of Economics*, 119 (2004), 249–275.

Bhattarai, S.; G. B. Eggertsson; and B. Gafarov. "Time Consistency and the Duration of Government Debt: A Signalling Theory of Quantitative Easing." Working Paper, National Bureau of Economic Research (2015).

Borio, C., and H. Zhu. "Capital Regulation, Risk-Taking and Monetary Policy: A Missing Link in the Transmission Mechanism?" *Journal of Financial Stability*, 8 (2012), 236–251.

Brunnermeier, M. K., and Y. Sannikov. "A Macroeconomic Model with a Financial Sector." *American Economic Review*, 104 (2014), 379–421.

Butt, N.; R. Churm; M. F. McMahon; A. Morotz; and J. F. Schanz. "QE and the Bank Lending Channel in the United Kingdom." Working Paper No. 511, Bank of England (2014).

Carpinelli, L., and M. Crosignani. "The Design and Transmission of Central Bank Liquidity Provisions." Unpublished Paper, available at matteocrosignani.com (2017).

Chakraborty, I.; I. Goldstein; and A. MacKinlay. "Monetary Stimulus and Bank Lending." *Journal of Financial Economics*, 136 (2020), 189–218.

Chen, H.; V. Cúrdia; and A. Ferrero. "The Macroeconomic Effects of Large-Scale Asset Purchase Programmes." *Economic Journal*, 122 (2012), 289–315.

Christensen, J. H., and S. Krogstrup. "A Portfolio Model of Quantitative Easing." Working Paper 2016-12, Federal Reserve Bank of San Francisco (2016).

Christensen, J. H., and S. Krogstrup. "Transmission of Quantitative Easing: The Role of Central Bank Reserves." *Economic Journal*, 129 (2019), 249–272.

Dai, M.; F. Dufourt; and Q. Zhang. "Large Scale Asset Purchases with Segmented Mortgage and Corporate Loan Markets." Working Paper 1336, Aix-Marseille School of Economics (2013).

Eggertsson, G., and M. Woodford. "The Zero Bound on Interest Rates and Optimal Monetary Policy." *Brookings Papers on Economic Activity*, (2003), 139–233.

Eser, F., and B. Schwaab. "Evaluating the Impact of Unconventional Monetary Policy Measures: Empirical Evidence from the ECBs Securities Markets Programme." *Journal of Financial Economics*, 119 (2016), 147–167.

Ferrando, A.; A. Popov; and G. F. Udell. "Do SMEs Benefit from Unconventional Monetary Policy and How? Micro-Evidence from the Eurozone." *Journal of Money, Credit, and Banking*, 51 (2018), 895–928.

Friedman, M., and A. J. Schwartz. "Money and Business Cycles." *Review of Economics and Statistics*, 45 (1963), 32–64.

Gambacorta, L.; B. Hofmann; and G. Peersman. "The Effectiveness of Unconventional Monetary Policy at the Zero Lower Bound: A Cross-Country Analysis." *Journal of Money, Credit and Banking*, 46 (2014), 615–642.

Gambacorta, L., and P. E. Mistrulli. "Does Bank Capital Affect Lending Behavior?" *Journal of Financial Intermediation*, 13 (2004), 436–457.

Garcia-Posada, M., and M. Marchetti. "The Bank Lending Channel of Unconventional Monetary Policy: The Impact of the VLTROs on Credit Supply in Spain." *Economic Modelling*, 58 (2016), 427–441.

Gertler, M., and P. Karadi. "QE 1 vs. 2 vs. 3...: A Framework for Analyzing Large-Scale Asset Purchases as a Monetary Policy Tool." *International Journal of Central Banking*, 9 (2013), 5–53.

Grosse-Rueschkamp, B.; S. Steffen; and D. Streitz. "A Capital Structure Channel of Monetary Policy." *Journal of Financial Economics*, 133 (2019), 357–378.

Heider, F.; F. Saidi; and G. Schepens. "Life Below Zero: Bank Lending under Negative Policy Rates." *Review of Financial Studies*, 32 (2019), 3728–3761.

Hoffmann, P.; S. Langfield; F. Pierobon; and G. Vuillemey. "Who Bears Interest Rate Risk?" *Review of Financial Studies*, 32 (2019), 2921–2954.

Jiménez, G.; S. Ongena; J.-L. Peydró; and J. Saurina. "Credit Supply and Monetary Policy: Identifying the Bank Balance-Sheet Channel with Loan Applications." *American Economic Review*, 102 (2012), 2301–2326.

Jiménez, G.; S. Ongena; J.-L. Peydró; and J. Saurina. "Hazardous Times for Monetary Policy: What Do Twenty-Three Million Bank Loans Say about the Effects of Monetary Policy on Credit Risk-Taking?" *Econometrica*, 82 (2014), 463–505.

Jouvanceau, V. "The Portfolio Rebalancing Channel of Quantitative Easing." Working Paper 1625, GATE (2016).

Joyce, M. A., and M. Tong. "QE and the Gilt Market: A Disaggregated Analysis." *Economic Journal*, 122 (2012), 348–384.

Kandrac, J., and B. Schlusche. "Quantitative Easing and Bank Risk Taking: Evidence from Lending." Finance and Economics Discussion Series 2017-125, Board of Governors of the Federal Reserve System (2016).

Kashyap, A. K., and J. C. Stein. "The Impact of Monetary Policy on Bank Balance Sheets." *Carnegie-Rochester Conference Series on Public Policy*, 42 (1995), 151–195.
Kashyap, A. K., and J. C. Stein. "What Do a Million Observations on Banks Say about the Transmission of Monetary Policy?" *American Economic Review*, 90 (2000), 407–428.
Kishan, R. P., and T. P. Opiela. "Bank Size, Bank Capital, and the Bank Lending Channel." *Journal of Money, Credit and Banking*, 32 (2000), 121–141.
Koetter, M.; N. Podlich; and M. Wedow. "Inside Asset Purchase Programs: The Effects of Unconventional Policy on Banking Competition." Working Paper No. 2017, European Central Bank (2017).
Krishnamurthy, A.; S. Nagel; and A. Vissing-Jorgensen. "ECB Policies Involving Government Bond Purchases: Impact and Channels." *Review of Finance*, 22 (2017), 1–44.
Krishnamurthy, A., and A. Vissing-Jorgensen. "The Effects of Quantitative Easing on Interest Rates: Channels and Implications for Policy." *Brookings Papers on Economic Activity*, 2 (2011), 215–287.
Krishnamurthy, A., and A. Vissing-Jorgensen. "The Ins and Outs of LSAPs." In *Federal Reserve Bank of Kansas City Economic Policy Symposium*, Kansas City, MO: Kansas City Federal Reserve (2013).
Lewis, V., and M. Roth. "The Financial Market Effects of the ECB's Asset Purchase Programs." *Journal of Financial Stability*, 43 (2019), 40–52.
Modigliani, F., and R. Sutch. "Innovations in Interest Rate Policy." *American Economic Review*, 56 (1966), 178–197.
Petersen, M. A. "Estimating Standard Errors in Finance Panel Data Sets: Comparing Approaches." *Review of Financial Studies*, 22 (2009), 435–480.
Peydró, J.-L.; A. Polo; and E. Sette. "Monetary Policy at Work: Security and Credit Application Registers Evidence." Working Paper 964, Barcelona GSE (2017).
Praet, P. "Monetary Policy and the Euro Area Banking System." Speech by Peter Praet, Member of Executive Board of the European Central Bank, Madrid, Oct. 4, 2016.
Rodnyansky, A., and O. Darmouni. "The Effects of Quantitative Easing on Bank Lending Behavior." *Review of Financial Studies*, 30 (2017), 3858–3887.
Timmer, Y. "Cyclical Investment Behavior across Financial Institutions." *Journal of Financial Economics*, 129 (2018), 268–286.
Tischer, J. "Quantitative Easing, Portfolio Rebalancing and Credit Growth: Evidence from Germany." Discussion Paper 20/2018, Deutsche Bundesbank (2018).
Tobin, J. "A General Equilibrium Approach to Monetary Theory." *Journal of Money, Credit and Banking*, 1 (1969), 15–29.
Vayanos, D., and J.-L. Vila. "A Preferred-Habitat Model of the Term Structure of Interest Rates." Working Paper, National Bureau of Economic Research (2009).
Weale, M., and T. Wieladek. "What Are the Macroeconomic Effects of Asset Purchases?" *Journal of Monetary Economics*, 79 (2016), 81–93.
Worms, A. "Monetary Policy Effects on Bank Loans in Germany: A Panel-Econometric Analysis." Discussion Paper No 17/2001, Deutsche Bundesbank (2001).