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Jörg Schmidt

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Coordination: Bernd Hayo • Philipps-University Marburg
School of Business and Economics • Universitätsstraße 24, D-35032 Marburg
Tel: +49-6421-2823091, Fax: +49-6421-2823088, e-mail: hayo@wiwi.uni-marburg.de

Unconventional Monetary Policy and Bank Risk-Taking in the Euro Area

Jörg Schmidt*
Justus-Liebig-Universität Gießen, Germany

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Abstract

This paper studies risk-taking by European banks. After an overview about the banking landscape in the euro area, we construct a measure of risk-taking which relates changes in three month ahead expected credit standards for several non-financial private sector categories to the risk of the macroeconomic environment banks operate in. With this approach we want to tackle the question if credit standards react disproportionately strong to changes in the monetary policy stance. We use an estimated bond market based measure to assess the overall riskiness prevailing in the economy. With this approach we want to shed some light on whether banks act excessively risky and provide new evidence as well as an alternative assessment on the amplifying nature of the risk-taking channel of monetary policy. We put our measure into a VAR model in which structural innovations are identified with sign restrictions. The key outcomes of this paper are the following: expansionary monetary policy shocks decrease our measure of risk-taking. Decreases in our measure are caused by disproportionately strong reactions in credit standards compared to the overall macroeconomic risk, especially during the recent financial crisis. Disproportionately in the sense that our macroeconomic risk measure is less affected by expansionary monetary policy shocks than credit standards. The credit granting reaction depends on the category: In general, loans to non-financial corporations are less sensitive to monetary policy shocks while mortgages seem to be affected more. We conclude that expansionary monetary policy shifts the portfolio of banks to overall riskier asset holdings.

Keywords:
monetary policy, euro area, bank risk-taking, credit standards, bank lending survey
JEL classification:
E44, E52, G12

*Email: joerg.schmidt@wirtschaft.uni-giessen.de

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1 Motivation and Contribution

Risk-taking issues in financial sectors have in general gained growing attention since Rajan (2006) has introduced this topic and all the more since the recent global financial crisis with its deep turmoils in financial markets as well as in the real economy. Borio & Zhu (2012) emphasize the importance of the relatively new risk-taking channel of monetary policy for central bank policy makers. Beside the lack of a clear and precise definition of the phenomenon *risk-taking* by financial intermediaries, they line out that there are multiple forms and dimensions of *risk-taking*, linked to the behavior and incentives of financial intermediaries. Overall, risk can occur on the funding side, it can be related to securitization activities, mis-incentives based on principal agent issues and payment contracts or the inherent riskiness of financial intermediaries' portfolio of assets, especially loans. In this paper, the ex ante assessment of the riskiness of additionally acquired assets, here newly granted loans, is in the focal point. To capture this issue, the recent literature emphasize the importance of credit standard adjustments. Ciccarelli et al. (2015) assess their importance for monetary policy transmission, both for the U.S. and the euro area. They map survey based changes in credit standards compared to the previous quarter to the bank lending channel. Major results relevant for this paper are that credit standard changes are an important transmitter and amplifier of monetary policy in the euro area, especially for mortgages and corporate loans. Similar results are lined out by Paligorova & Santos (2016) who focus on *individual* data of banks' credit granting decisions. They also use a survey-based measure of risk appetite and link credit spreads to individual distance to default proxies, the monetary policy environment and the individual response to (U.S.) Senior Loan Officer Survey credit standard changes. The basic outcome of their cross-section approach is that risk tolerant banks lower risk mark-ups for riskier borrowers in periods of monetary easing. One important finding, especially for this paper, is that bond investors do not show similar increases in risk appetite during prolonged periods of low interest rates.

From these findings about the existence and operating principles of the risk-taking channel we deduct the question if the adjustment of credit standards and the overall inherent risk of banks' core business react to monetary policy shocks in an appropriate manner. Maddaloni & Peydro (2013) work out that the reaction of credit standards to changing monetary policy is quite heterogeneous across the euro area. Additionally, they find that especially in mortgage credit standards excessive risk taking occurs in a low interest rate environment. In their paper, excessiveness is captured by controlling credit standard changes for altered borrower quality and risk, bank capitalization or yield changes. They emphasize the importance of these findings for the risk assessment of the overall financial system but also line out that identifying *excessiveness in risk taking* remains a difficult issue. This is where we want to contribute. We relate the adjustments in credit standards to the macroeconomic environment banks operate in and focus on the reaction to changes in the monetary policy stance. If they do not adjust adequately, potential pitfalls for the financial system in general and bank balance-sheets in particular might stem from disproportionately strong credit standard adjustments, induced by changes in monetary policy.

We suggest an alternative way to unveil the amplifying nature of monetary policy transmission via the risk-taking channel of monetary policy due to disproportionately altered credit standards by financial intermediaries. In contrast to the existing literature, we want to evaluate credit standard changes for the non-financial private sector with a measure extracted from their financial market substitutes: corporate bonds. The advantage of using bond markets is that they explicitly reflect the broad view of markets regarding the riskiness of the respective bonds, conditional on the set of perceived current and future macroeconomic risk.

The tight relationship between business-cycle-fluctuations and various bond market spreads is a well known one. Gilchrist & Zakrajšek (2012) use a broad spectrum of U.S. corporate bond prices to construct a future economic forecasting index for

the U.S. economy. They show that bond spreads have high explanatory power for present as well as future macroeconomic risk. This holds especially for term premia and idiosyncratic risk premia which are related to expected future short term yields and to changes in the probability to default of corporations, respectively, emphasizing their appropriateness to evaluate prevailing macroeconomic risk. For the euro area, Gilchrist & Mojon (2016) introduce a similar measure by using bond market spreads for constructing risk indicators reflecting the refinancing costs for financial- as well as non-financial private sector firms via the discrepancy of their respective bond yields to German Bund, the assumed risk-free rate. Adrian, Moench & Shin (2010) construct a macro-risk-premium based on bond market information to connect the in principle unobservable tension of Value-at-Risk constrained bank balances and their propensity to grant credit. They interpret the resulting series as a proxy for the marginal propensity to grant additional credit and elucidate that this proxy is a market-based view of the ease of banks' credit standards. We will pick up all these outlined ideas later in this paper.

Linking credit standard survey responses to macroeconomic and other financial variables is not a new approach but is done e.g. in Bassett et al. (2014). They introduce a credit supply indicator for commercial and industrial loans that corrects the individual responses of (U.S.) Senior Loan Officer Opinion Survey credit standard changes for bank-specific and macroeconomic factors. Next, they include this indicator into a VAR model consisting of real GDP, inflation, lending capacity and the bond spread index by Gilchrist & Zakrajšek (2012). Major outcome is that negative[1] shocks to their credit supply indicator induces a negative GDP and borrowing capacity reaction as well as increased bond premia and a monetary easing. Likewise, Altavilla et al. (2015) proceed for the euro area. They construct a propensity-score-based loan supply indicator that relates the individual Bank Lending Survey (BLS, hereinafter) responses to a probability function which describes the tightening decision

[1] In the sense of supply-dampening.

conditional on a set of macro variables as well as additional BLS based information. They show that tightening in credit standards leads non-financial corporations to evade bank loans and increase funding via issuing additional bonds. This emphasizes the complementary nature and interchangeability of both kinds of debt capital. We combine different aspects and ideas of the presented literature to tackle the issue of evaluating ex-ante risk-taking by euro area banks in the context of monetary policy shocks.

This paper proceeds as follows: we present some facts about European banks' operational business and about the nexus between credit standards and bank profitability. We then estimate a measure for the macroeconomic risk perceived by financial markets. For this purpose, we construct a measure that reflects the degree of riskiness of the macroeconomic environment by using information extracted from European bond markets. We then relate credit standard changes to this macro risk premium (MRP hereinafter). With this approach we try to elaborate in how far e.g. monetary policy shocks drive numerator and denominator of this ratio in the same manner or if they show differences. If they show differences this can be an indicator for risk-taking. We also account for the various non-financial sector credit categories queried in the BLS of the ECB and explicitly distinguish between credit standards for non-financial private corporations, loans for house purchases[2], and consumer credits. We also calculate an overall non-financial private sector credit standard. This results in four different relative risk-taking measures. We then include each of these measures in a VAR model that consists of GDP-growth, inflation, a monetary policy variable and credit growth of the respective category. For identification we use sign restrictions. The subsequent structural analysis with impulse response functions to a monetary policy shock is a proper way to figure out in how far the included variables and especially our ratio as well as credit growth react to unex-

[2]We will use the phrases "mortgages" and "loans for house purchases" interchangeably within this paper. Rubio (2014) provides a deeper look at the housing market heterogeneity in the euro area and differences in contract and loan rate structure, but in most countries mortgage contracts dominate housing finance.

pected changes in the monetary policy stance. We use two samples to account for possible differences related to unconventional monetary usage. The key outcome is that changes in credit standards indeed react disproportionately strong to monetary policy shocks in general and most intense in the sample characterized by unconventional monetary policy. This can be observed for three out of the four categories we deal with in this paper. One additional point worth to mention is that monetary policy does not affect credit growth in a notable manner, except for loans for house purchases in the financial crisis sample. Third, these outcomes are tested for robustness with an alternative identification scheme, we exploit recursive ordering of the variables. Major outcomes and implications remain untouched. The paper closes with a conclusion and an outlook for further issues and research.

2 Banking in the Euro Area

2.1 Euro Area Banks' Lending Activities

The three most relevant non-financial private sector categories, and the ones queried in the BLS when credit standards are of interest, are loans to non-financial corporations, loans for housing, and consumer credit. Fig. (1) depicts their respective share on the outstanding amount of loans of these categories, calculated via the outstanding stock of loans depicted in Fig. (10), appendix.

As we can see, loans for non-financial corporations and loans for housing are by far the most relevant business areas, while consumer credit plays a minor role in the European banking landscape. One interesting thing worth to point out is that since the peak of the recent *Great Recession* the share of loans for housing slowly but continuously increases, mirror-imaging the decreasing share of loans to firms.

Beside shifts in the share of business activities, financial as well as sovereign debt crises, financial market turmoils and unconventional monetary policy measures to an extend never seen before, European banks have been able to keep the profitability

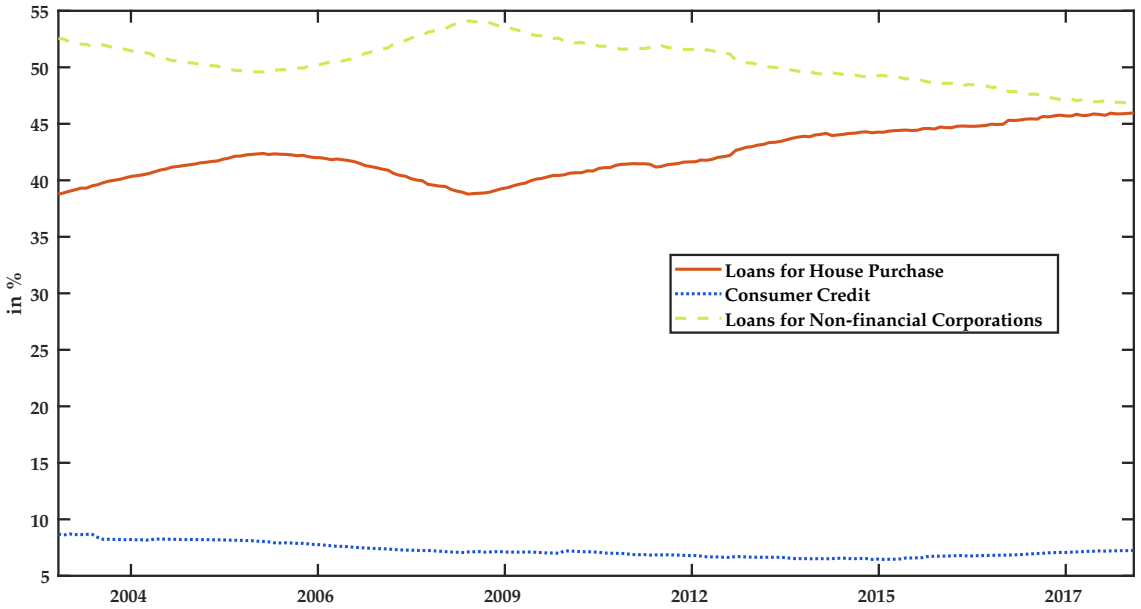

Figure 1: Shares of the three non-financial private sector credit categories queried in the BLS, on the overall outstanding amount of non-financial private sector loans.
Notes: Non-financial corporation loans (dashed yellow line), Mortgages (solid red line), and Consumer Credits (dashed blue line).
Source: ECB, authors' calculations.

of their core business, credit granting, relatively stable. Fig. (2) depicts the average net margins of European banks, a proxy for profitability, both for outstanding and newly granted loans. The net margin for new loans fluctuates tightly around 1.5% and the gap between margins of outstanding and new loans[3] vanishes since the financial crisis.

The ability to keep their margins constant might root in fluctuations in risk-taking by European banks. As outlined in the introduction, this risk-taking-channel of monetary policy primarily works via adjusting credit standards. One key characteristic of banks' credit granting decisions, in contrast to e.g. bond investors, is the banks' propensity to adjust their leverage to work at a minimum Value-at-Risk-constraint set by their supervisors. Adrian & Shin (2010) elaborate that banks strife to employ all additional scope of leverage when their equity faces e.g. a positive valuation shock after expansionary monetary policy. In their set-up, this leads to extending the credit supply to less credit-worthy borrowers via lowering their credit standards.

[3]This gap can be a relic from pre-euro times with the old credit contracts expiring.

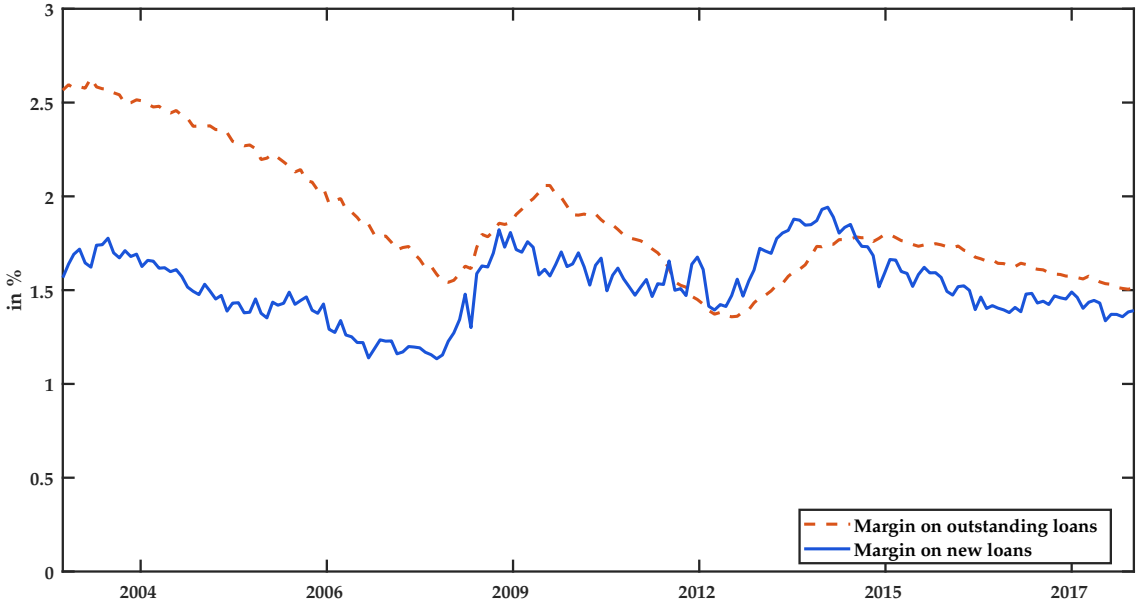

Figure 2: Average euro area net bank margins for outstanding and newly granted loans.
Notes: For simplicity, the average margins depicted here are calculated by multiplying national bank margins with their respective share on the weighting of the HICP.
Source: ECB, authors' calculations.

This is an additional amplifier beside the bank-lending channel and amends the financial acceleration of monetary policy via the financial system. In the following section, we will take a closer look at credit standard adjustments in the euro area to get a better understanding of what is meant by credit standards within this paper.

2.2 Credit Standards in the Euro Area

Since 2003, the ECB quarterly conducts among the largest banks in the EA the BLS. It contains questions about *expected changes* in the applied credit standards for the next three months. The survey distinguishes between three different non-financial private sector categories outlined before. Questions 8 and 21 of the survey, see Fig. (**??**), are the focal point of interest in this paper. Unfortunately, the complete survey results for all 140 survey participants are not available due to the confidential nature of the questionnaire. Also the *level* of credit standards is, in contrast to e.g. the (U.S.) Senior Loan Officer Survey, not available, only net-percentage changes are

published.[4] We also construct an overall non-financial private sector credit standard net-percentage change (CS_{NFPS}) by using the weightings (w_i) depicted in Fig. (1):

$$CS_{NFPS,t} = \sum_{i=1}^{3} w_{i,t}\ CS_{i,t}, \tag{1}$$

with $i = \in$ [non-financial corporations, mortgages, and consumer credit].

Fig. (3) depicts the raw data of the net-percentage changes in the relevant questions of the ECB BLS, complemented by our overall non-financial private sector credit standard changes[5].

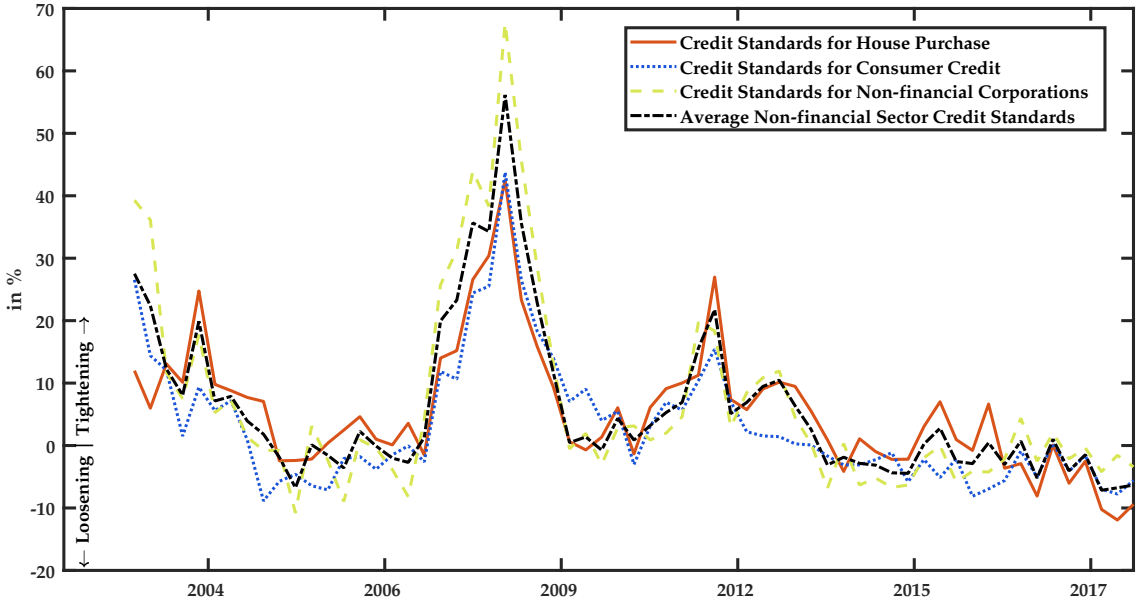

Figure 3: Net-percentage credit standard changes in the euro area.
Notes: Average non-financial Sector credit standards (black narrow-dashed line), Non-financial corporation credit standards (dashed yellow line), Mortgage standards (solid red line), Consumer credit standards (dotted blue line).
Source: ECB, authors' calculations.

Per construction, the range of possible outcomes of the net-percentage changes is bounded to $[-100; 100]$.[6] The course of the European economy with its outstanding

[4] In the context of credit standards, the net-percentage change is defined as the difference between the sum of the percentages of banks responding "tightened considerably" and "tightened somewhat", and the sum of the percentages of banks responding "eased considerably" and "eased somewhat".

[5] We do not want to conceal that there might be a systematic bias in the answers of survey participants. The survey conductor, the ECB, is since November, 2014 also the participants' supervisory authority (Single Supervisory Mechanism (SSM)) and thus banks might have an incentive to understate their intended alignment of credit standard policies. This could bear the caveat of an upward bias when answering the survey. We leave this possible issue for further research.

[6] 100 = all banks tighten their standards (considerably), -100 = all banks ease their standards

events is quite well mirror-imaged by the series: the echo of the busted new economy bubble, the Financial Crisis and the European Sovereign Debt Crisis are peaks in credit-standard-tightening-stages while before the Financial Crisis and after the ECB announcement of Outright Monetary Transactions credit standards show the tendency to loose. In the next subsection, we want to take a closer look at the nexus between quite volatile credit standard changes and banks' relatively stable profitability.

2.3 Credit Standards and Bank Profitability: Who drives Whom?

When taking a first glance on a possible empirical relationship between credit standards and banks' margins we can not disentangle a clear causal direction. Both variables are might be related endogenously:

I. Changes in credit standards can impact banks' margins **or**

II. Efforts to stabilize margins can impact credit standards

As depicted in Equ. (2), we mitigates this issue for the first case by involving granger-causality considerations. Thus, credit standards enter lagged. Additionally, we control for the term premium, a main driver for banks' ability to transform maturities, and include a dummy variable in a second set-up to account for possible effects of unconventional monetary policy:

$$margin_t = \alpha_1 c + \alpha_2 cs_{t-1} + \alpha_3 tp_{t-1} (+\alpha_4 UMP_{t-1}) + \varepsilon_t$$
$$\text{with } UMP_t = \begin{cases} 1, & \text{if t} \geq \text{ June, 2012} \\ 0, & \text{otherwise} \end{cases} \tag{2}$$

(considerably).

margin_{new}	2008Q1 - 2018Q3		2003Q2 - 2018Q3	
c	1.45***	1.17***	1.35***	1.18***
	(0.05)	(0.10)	(0.05)	(0.05)
cs (-1)	0.0004	0.007**	0.003*	0.007***
	(0.002)	(0.003)	(0.002)	(0.002)
tp (-1)	0.08**	0.16***	0.12***	0.16***
	(0.03)	(0.04)	(0.03)	(0.02)
UMP (-1)		0.24**		0.23***
		(0.07)		(0.04)
adj. R^2	0.10	0.28	0.22	0.49

Table 1: Regression results for Equ. (2).
HAC standard errors in parenthesis. *, **, and *** indicate 10%, 5%, and 1% significance levels.

We estimate two distinct samples: A complete one, starting in 2003Q2 and ending 2018Q3, and a sample that starts 2008Q1, when financial turmoil started, and ends also 2018Q3. Tab. (1) contains the results. As we can see, higher credit standards in general lead to significantly higher bank margins. This overall small absolute effect is weaker in the sample starting 2008, indicating that the impact of credit standards on margins is weaker since the financial crisis. As expected, higher term premia increase the margins significantly as well. Also here, we see a weaker effect compared to the full sample.[7] A third finding stands out: the announcement of OMT and Draghis "Whatever it takes ..." statement, reflected by our dummy variable, have had significant positive effects on banks' profitability. One might conclude that European banks' profitability largely benefited from these ECB actions. This interpretation is in line with Szczerbowicz et al. (2015) who states that primarily refinancing costs of banks sank after the introduction of various unconventional measures.

The second causal direction, efforts to hold margins constant, is reflected by Equ.

[7]This might be rooted in the overall lower and less volatile term premium which was shrinked due to the overall very expansionary monetary policy regime since 2008 Quelle noch einbauen.

$cs_{avg.}$	2008Q1 - 2018Q3		2003Q2 - 2018Q3	
c	56.60**	35.47***	25.86	4.82
	(26.01)	(12.40)	(23.84)	(18.20)
margin (-1)	-29.91**	-2.15	-10.19	12.07
	(14.62)	(8.18)	(14.70)	(10.63)
tp (-1)	-2.91	-10.30***	-3.40	-8.79***
	(3.33)	(2.22)	(3.69)	(3.44)
UMP (-1)		-21.57***		-15.10***
		(4.26)		(4.49)
adj. R^2	0.23	0.71	0.07	0.343

Table 2: Regression results for Equ. (3.).
HAC standard errors in parenthesis. *, **, and *** indicate 10%, 5%, and 1% significance levels.

(3):

$$cs_t = \alpha_1 c + \alpha_2 margin_{t-1} + \alpha_3 tp_{t-1}(+\alpha_4 ump_{t-1}) + \varepsilon_t \tag{3}$$

Tab. (2) shows the regression results. A change in the lagged margin induces only in the model without the UMP dummy for the sample beginning in 2008 a significant effect, but with a negative sign. A one percentage point increase in the margin lowers (net-percentage-change-) credit standards by almost 30, but the effect vanishes when accounting for unconventional monetary policy measures which have in both samples a strong lowering impact on credit standards.

We can summarize that while the margin is affected by (past) credit standards, the term premium, and unconventional monetary policy, credit standards seem to be primarily driven by the term premium and unconventional monetary policy, not by the margin. In this context, Neuenkirch & Nöckel (2018) elaborate within a VAR framework that expansionary monetary policy induces a quick and strong downward adjustment of banks' credit standards to keep lending margins stable. Beside heterogeneous rates of success across euro area member states, on average these efforts to stabilize their margins seem to work.

The presented results give a superficial idea about the existence of the risk-taking-channel and about the role unconventional monetary policy plays in it. Our aim

is to get a measure that relates private sector credit standard adjustments to the prevailing and expected macroeconomic conditions. This might help to quantify the phenomenon of risk-taking via adjusted credit standards. Thus, in the following section we will discuss our measure to evaluate the prevailing macroeconomic environment.

3 Assessing Macroeconomic Risk

The tight connection between bond market spreads and (future) macroeconomic performance is outlined e.g. by Favara et al. (2016). They emphasize the ability of various spreads in predicting economic downturns. Especially the slope of the yield curve, the term spread, has high informative power about future economic conditions because it reflects the expected future yield environment, conditional on a central bank reaction to future economic circumstances. Various risk premia for a set of corporate bonds with different ratings reflect their sensitivity to probable defaults when overall economic conditions deteriorate. Gilchrist & Zakrajšek (2012) introduce a corporate bond credit spread index based on a rich set of micro-level bond market data and extract an excess bond premium that is independent from idiosyncratic risk components of the underlying bonds. This residual component captures changes in the overall default risk of the set of underlying bonds and thus reflecting the economy-wide risk of defaults. For this paper, we pick up these connections in a slightly different manner. Based on former work[8], Adrian, Moench & Shin (2010) describe how to construct a measure that reflects the (in principal unobservable) tension of bank balance sheets and thus their propensity to grant additional credit. The tension of bank balances is closely related to the overall macroeconomic conditions, because financial intermediaries are confronted with a binding Value-at-Risk constraint and their (unobservable) assets face valuation effects depending on the

[8] Adrian, Estrella & Shin (2010) and Adrian & Shin (2010).

overall macroeconomic environment they operate in[9], especially in the presence of shocks. Adrian, Moench & Shin (2010) suggest to use bond premia to approximate these value fluctuations due to the fact that bonds and loans are close substitutes for borrowers and thus face similar valuation reactions. GDP growth serves as a measure for current macroeconomic conditions. They regress GDP-growth on a set of U.S. yield spreads, extracted from bond markets. Adrian, Moench & Shin (2010) use term- and idiosyncratic risk-spreads of different corporate bond classes, distinguished by their respective rating. The intention of this approach is the following: term-spreads and risk-spreads reflect the view of market investors regarding hurdle rates of their risky investments. We pick up these ideas and construct a euro area MRP in a similar way. We regress GDP-growth on spreads constructed with the information euro area bond markets carry within them, exploiting the high correlation between (future) macroeconomic circumstances and the respective spreads. The term premium, tp^{10Y}, is constructed by subtracting the three month redemption yield of German government bonds from the 10 year German BUND redemption yield. Various risk premia, rp, are constructed by subtracting German BUNDs from a set of European corporate bond yields with the same maturity. Equ. (4) depicts this procedure:

$$\begin{aligned} \Delta lnGDP_t &= \alpha_0 + \alpha_1 tp_t^{10Y} + \alpha_2 rp_t^{AAA10Y} + \alpha_3 rp_t^{AA10Y} \\ &\quad + \alpha_4 rp_t^{A10Y} + \alpha_5 rp_t^{BBB10Y} + \alpha_6 rp^{high-yield} + \varepsilon_t \end{aligned} \tag{4}$$

with $\varepsilon_t \sim N(0, \sigma^2)$. The resulting coefficients, collected in $\hat{\boldsymbol{\alpha}}$, are then multiplied by the different yields used in Equ. (4) to capture the pure information effect of yields about current GDP-growth. In contrast to Adrian, Moench & Shin (2010), we do not subtract the mean of the risk spread of the AA rated corporate bond and divide

[9]The BLS also contains questions (2c and 11c) about the perceived general economic risk by banks and its impact on credit standard changes. Fig. (12) displays them. We do not use this measure for two reasons: first, we do want to focus on expected changes, three months ahead, and not past impacts. Second, the focus lies on a assessment of banks' risk-taking based on market assessment of the overall risk inherent in the economy, not banks' own assessment.

the resulting time series by the standard deviation of this bond. We explicitly want to use the movement in the underlying series based on the various rating classes to obtain a risk measure that reflects the variety of customers banks face instead of a representative, "one fits all" measure. Due to the fact that high macroeconomic risk and the resulting spreads are linked to low or negative economic growth and especially low or negative term spreads are linked to high future macroeconomic risk, the estimated coefficients here enter the MRP estimation negatively. Equ. (5) reflects our approach:

$$\widehat{MRP} = -(\hat{\boldsymbol{\alpha}}\mathbf{X}) \tag{5}$$

Fig. (4) plots the resulting MRP and, for the ease of interpretation, euro area GDP-growth. Similar to the net-percentage changes of credit standards, the estimated MRP reflects the major pattern of the euro area economy in our sample. The similarity between net-percentage changes in credit standards, Fig. (3), and the MRP underline the outcome of Adrian, Moench & Shin (2010) that the MRP can be interpreted as a *market-based* view of the ease of banks' credit conditions.

Figure 4: Macro Risk Premium and euro area GDP-growth.
Notes: Macro Risk Premium (dotted red line, left ordinate), quarterly euro area GDP-growth (solid blue line, right ordinate).
Source: Thompson Reuters Datastream, authors' calculation.

As mentioned in the introduction, we want to relate the credit standard adjustments

to the market-based assessment of macroeconomic risk. This is what we do in the next section.

4 Relative Risk-Taking

Our understanding of risk-taking does not only reflect pure changes in credit standards but moreover tries to evaluate them with the prevailing and expected economic conditions. This results in a judgment of appropriateness of credit standard changes. If they react stronger than the overall macroeconomic risk indicator, this can be a sign of excessive risk-taking. Thus, we relate both variables shown and derived in previous sections in one variable:

$$excessiveness = \frac{credit\ standard\ adjustments}{macro\ risk}. \tag{6}$$

Although the two series are highly positively correlated[10] they can not be directly related in one fraction. When looking at the ordinate axis of the MRP and credit standard changes, we see that their values are hardly comparable. Credit standard adjustments are extracted from an ordinarily scaled, query-based variable and the resulting net-percentage changes are measured in a specific type of bounded cardinal scale, the MRP is purely cardinal and (theoretically) not restricted to a predetermined range. We overcome this problem by standardizing both variables to make their movement more comparable and therefore relatable:

$$RRTM_{i;t} = \frac{(NPC_{i;t} - \overline{NPC_i})\sigma_{CS_i}^{-1}}{(MRP_t - \overline{MRP})\sigma_{MRP}^{-1}} \tag{7}$$

Of course, one problem associated with this approach is the mean and standard deviation sensitivity to the observed period, but, as mentioned earlier, the availability of survey data limits our sample to start in Q1 2003. This approach, depicted in Equ.

[10] Correlation coefficient $\rho = 0.77$ for MRP and CS_{NFPS}.

(7), results in four different Relative Risk-Taking Measures (RRTMs, hereinafter) which we will include in a VAR model for the euro are in the next section.

5 Vectorautoregressions

We use quarterly log-differentiated, seasonally adjusted data in a five variable reduced form VAR model[11]:

$$Y_t = A_p(L)Y_{t-p} + T + \varepsilon_t \tag{8}$$

Y_t contains GDP growth, Harmonized Consumer Price Index inflation, the ECB shadow rate provided by Krippner (2013), the respective four different RRTMs and the distinct credit growth variables. $A_p(L)$ is a lag-polynomial of order p in lag-operator L[12], T is a constant and ε_t is the column vector of white noise error-terms and covariance matrix Σ_ϵ. We use two distinct samples: the first starts in Q1 2003 due to the availability of BLS data and ends in Q3 2018 (full sample, hereinafter), the second begins in Q1 2008 and ends in Q3 2018 and is motivated by the introduction of a wide set of unconventional monetary policy measures (financial crisis sample, hereinafter).

To conduct structural analysis which accounts for the contemporaneous interdependences of the implied underlying structural VAR-model of the form

$$B_0 Y_t = B_p(L)Y_{t-p} + D + u_t, \tag{9}$$

identifying restrictions are needed to separate orthogonal, structural error-terms from the covariance matrix Σ_ϵ. We use two identification approaches: sign re-

[11] One point necessary to mention is that, in general, the reduced form VAR models in log-levels face stationary problems, e.g. in most cases the coefficient matrix $\hat{A}_p$ has at least one absolute eigenvalue greater than one. Thus, we estimate the VAR-model in growth rates.

[12] The lag length is set to two for all presented models, because it was the most frequent lag length specification in the different model setups when using common lag length criteria.

strictions, motivated by common theoretical and empirical wisdom, and cholesky decomposition with its implied recursive ordering for robustness.

Sign Restrictions

Identifying a VAR model with sign restrictions needs specific plausible relations between the structural innovation of interest, i.e. the monetary policy shock, and the endogenous model variables. Uhlig (2005) provides a detailed overview about underlying ideas and procedures.

In this paper, we only focus on the identification of monetary policy shocks since we are primarily interested in the effects of monetary policy on risk-taking and credit granting behavior of euro area financial institutions. Other structural innovations to the model are ignored further on.

Tab. (3) shows the imposed restriction scheme on the reaction of model variables to a expansionary monetary policy shock:

Variable	GDP growth	HICP Inflation	Interest Rate	RRTM	Credit growth
Restriction	+	+	-	none	none

Table 3: Sign restrictions for an expansionary monetary policy shock.
Notes: The assumed restrictions last for two quarters to account for the duration of monetary policy implementation in the euro area but the results are not very sensitive to the imposed duration.

The underlying assumptions of this identification scheme are quite common, theoretically plausible and empirically confirmed: expansionary monetary policy does not dampen output and inflation via lower interest rates. In order to get an unfiltered perspective of the underlying data generating process, the variables of major interest, RRTM and credit granting, are kept unrestricted[13].

6 Results

The presentation of results is split into two parts which differ by the sample.

[13]Imposing a reaction on credit growth via the implications of the credit channel might be an option for periods of well working monetary transmission but is kept unrestricted to account for possible distortions during the recent financial crisis, see ECB (2015).

Impulse Response Functions

As mentioned before, we focus on monetary policy shocks only. Because the reactions of macroeconomic variables output, prices and interest rates are per construction in line with the well confirmed reaction patterns, they are not discussed hereinafter. Nevertheless, they are available on request. For the ease of interpretation and to emphasize the disproportionality that drives the reaction of our measure, Fig. (13) in the appendix, shows impulse response functions of credit standards and credit growth to expansionary monetary policy shock. As a side effect, this confirms the existence of the risk-taking channel of monetary policy in the euro area via credit standard adjustments. All monetary policy shocks discussed in this paper are 25 bp interest rate reductions.

6.1 Full sample

Fig. (5) shows response functions of our four RRTMs. As we can see, the median response is in all four cases negative. A negative reaction of the RRTM can be a result of a more than proportional lowering of the numerator, the credit standards, or in an more than proportional increase in the denominator, macroeconomic risk. The first scenario is indicated in Fig. (13), the last one is counterintuitive and unlikely: expansionary monetary policy can not be expected to increase macroeconomic risk, at least not in the short and medium term.

Fig. (5, a) shows the response of overall non-financial private sector. Credit standards seem to react stronger than the overall macroeconomic risk variable extracted from loans substitutes, which indicates excessive risk-taking by financial intermediaries in periods of expansionary monetary policy, significant after 6 quarters. The most pronounced reaction when looking at the three subcategories can be observed for non-financial corporations' credit standards, Fig.(5, c), while credit standards for house purchase, Fig. (5, b), do almost not react significantly, overall. Surprisingly, consumer credit standards show a significantly positive reaction between 3 and 5

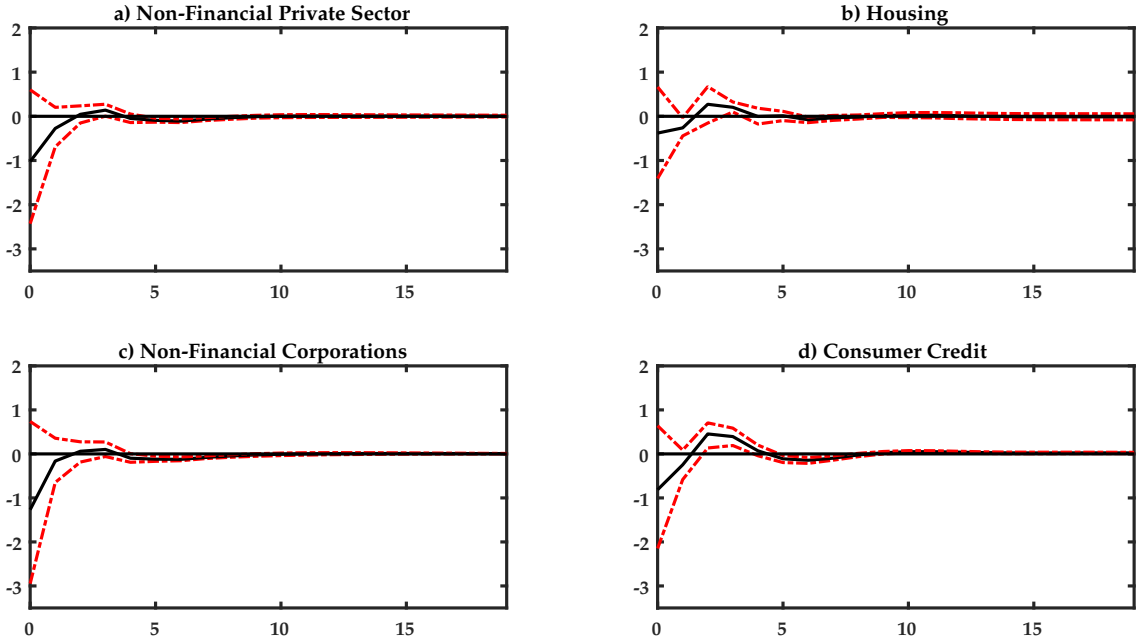

Figure 5: Impact of a 25 bp expansionary monetary policy shock on the RRTM of the respective category, full sample.
Notes: The solid black lines reflect the median response, the dotted red lines are the 16^{th} and 84^{th} percentiles.

quarters after the shock before turning negative, too.

When taking a closer look at the quantitative perspective, granting credit, Fig.(6), non-financial sector credit growth shows the expected positive sign, but with a lack of significance for the here presented percentiles. This finding alike holds for all sub-categories and the missing significance fits in the narrative of impaired monetary policy transmission via the bank lending channel, as stated in ECB (2015).

6.2 Financial Crisis Sample

Changing the sample such that it starts in Q1 2008, the reaction of our key variables shows slight differences compared to our full sample model. Fig. (7) displays the results. Decreases in the RRTMs are stronger and more persistent for the categories of major relevance, corporate loans and mortgages. For mortgages, Fig. (7, b), we can observe a short, but significant reaction already after two quarters. Again, in the business area of consumer credits we can not observe this disproportional lowering

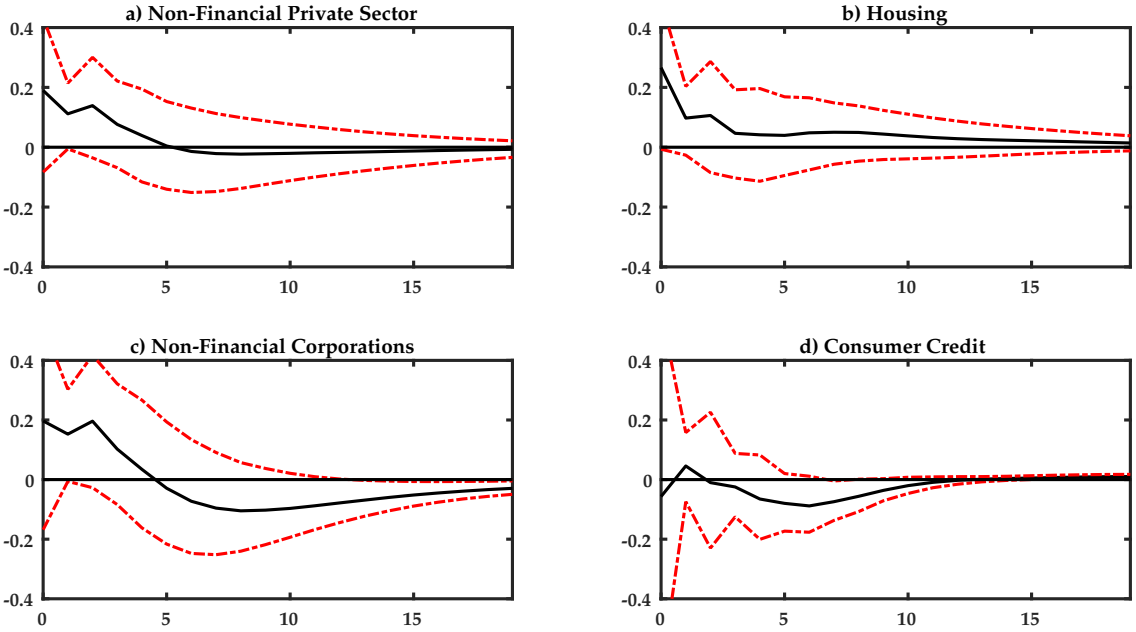

Figure 6: Impact of a 25 bp expansionary monetary policy shock on the credit growth of the respective category, full sample.
Notes: The solid black lines reflect the median response, the dotted red lines are the 16^{th} and 84^{th} percentiles.

of standards, our variable even increases significantly between 2 and 4 quarters after the shock. This indicates that the amplifying nature of the risk-taking channel is enhanced in periods of extraordinary expansionary (unconventional) monetary policy for mortgages and, to a lesser extend, for non-financial corporations' loans.

Fig. (8) shows the responses of credit growth to a monetary policy shock. The overall non-financial private sector, Fig. (8, a) shows the expected positive reaction, which remains significant for 3 quarters. This finding is primarily driven by the growth in mortgages, see Fig. (8, b), while credit growth in the non-financial corporation sector shows a positive, but non-significant reaction[14]. Consumer credit growth, Fig. (8, d) again shows, similar to the full sample model, no significant reaction.

Beside the similar and more persistent reaction in the relative risk-taking, the reaction related to real estate financing is most noteworthy from the credit growth perspective and opposite to the reaction in the model dealing with the corporate

[14]Recall that one motivation for some unconventional monetary policy measures in the euro area was to restore credit provision to non-financial private sector, especially to non-financial corporations.

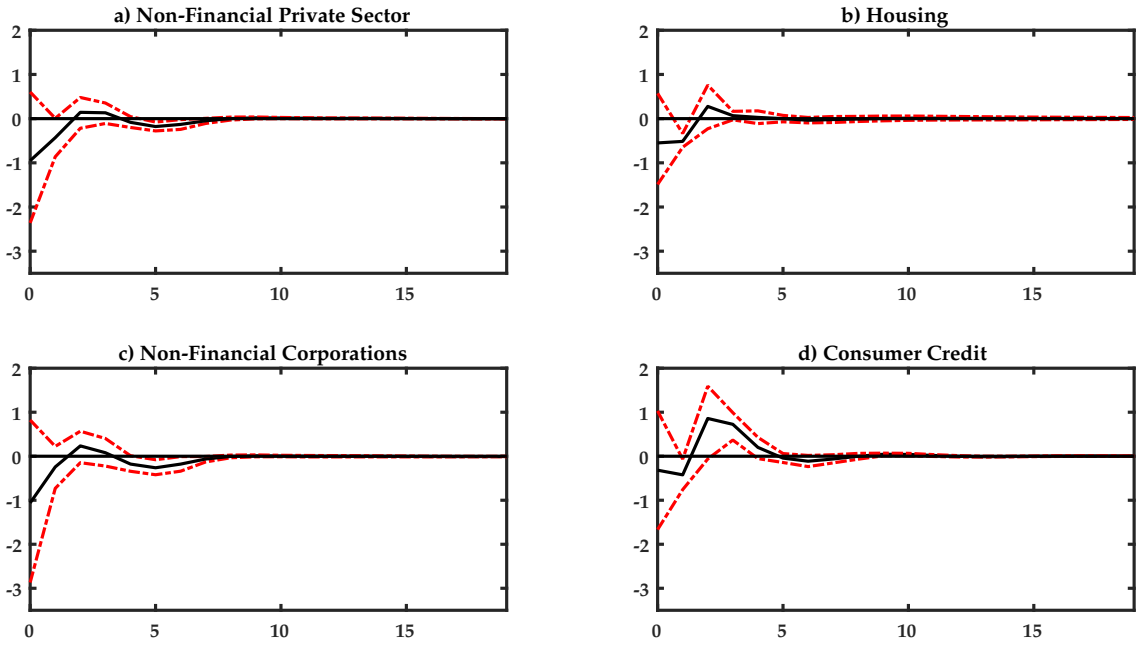

Figure 7: Impact of a 25 bp expansionary monetary policy shock on the RRTM of the respective category, financial crisis sample.
Notes: The solid black lines reflect the median response, the dotted red lines are the 16^{th} and 84^{th} percentiles.

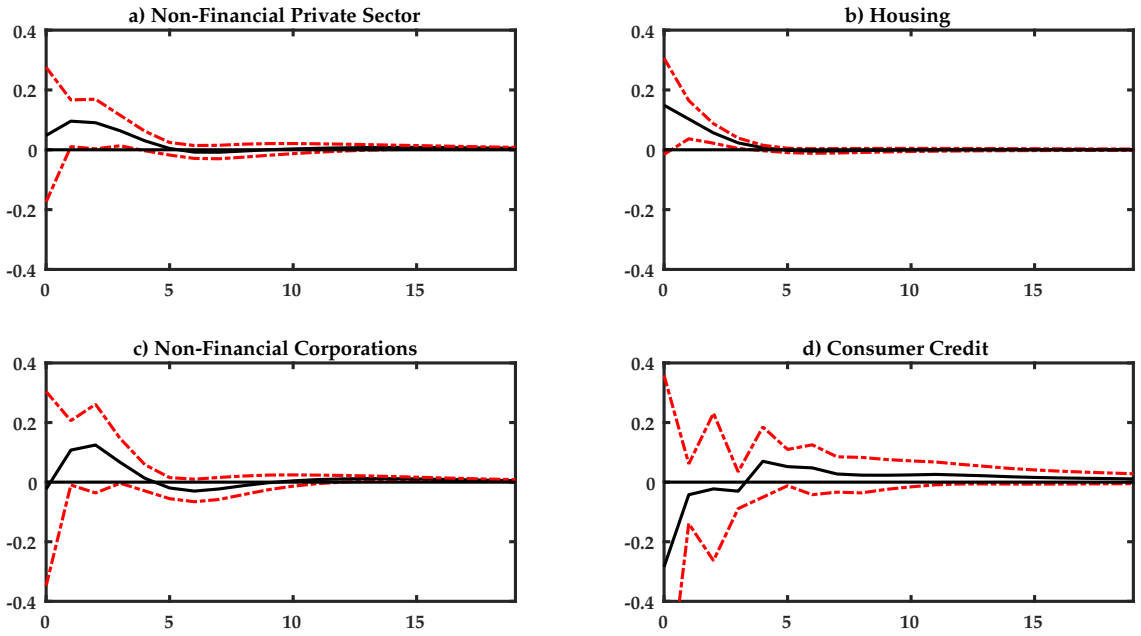

Figure 8: Impact of a 25 bp expansionary monetary policy shock on the credit growth of the respective category, financial crisis sample.
Notes: The solid black lines reflect the median response, the dotted red lines are the 16^{th} and 84^{th} percentiles.

sector discussed before. In Fig. (8, b) we see that the amount of granted credit to finance housing reacts most intense, compared to the residual categories and thus seems to drive the reaction in overall non-financial sector credit growth, as discussed before. This indicates that, in contrast to lending to firms, mortgages are more affected by monetary policy shocks. These findings are in line with the Ausschuss für Finanzstabilität (2017) who emphasize that in the euro area biggest economy, Germany, primarily real estate related private sector investments expanded during the recent extraordinary long low yield environment. Interestingly, and in contrast to the results of other credit categories, the smallest category, credit standards for consumers, do not react in a risk-taking-indicating manner in both subsamples, but due to the low share this finding does not have a sizable effect on the findings for overall non-financial private sector.

Summing up, we find indeed a disproportionality in the adjustment of credit standards while credit growth seems to be impaired.

7 Robustness

Cholesky Identification

As outlined by Sims (1986) and in contrast to the sign restriction approach, Cholesky based identification utilizes the recursive order of variables in Y_t to restrict contemporaneous interactions of the reduced form VAR model. GDP and prices react slower due to nominal rigidities, implying that they are ordered first. Central banks adjust their monetary policy periodically to recent developments in macroeconomic key variables GDP and HICP, thus the monetary policy variable is ordered behind them. Fast reacting financial variables are impacted by macroeconomic as well as by monetary policy (and money market) changes. This results in the following order which is in line with the vast variety of macroeconomic VAR literature:

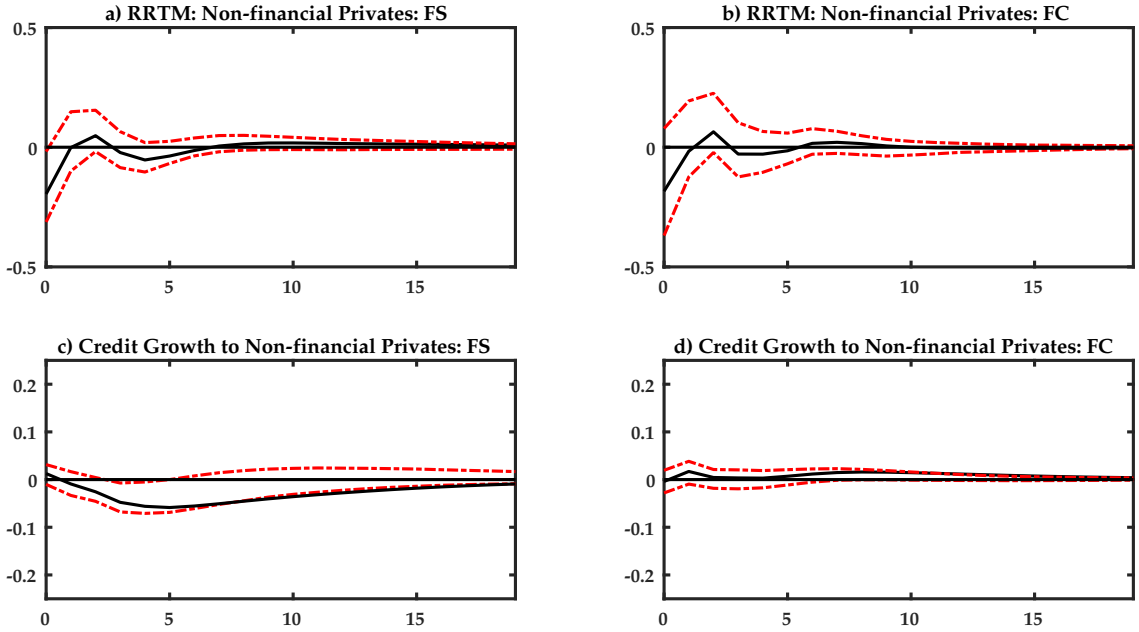

Figure 9: Impact of a 25 bp expansionary monetary policy shock on credit standards and credit growth: non-financial private sector, cholesky identification.
Notes: The solid black lines reflect the mean response, the dotted red lines are +/- one std. dev. confidence bands.

$$Y_t = [GDP_t \quad HICP_t \quad interest\ rate_t \quad RRTM_{i;t} \quad Loans_{i;t}]' \tag{10}$$

Fig. (9) shows the impulse response functions for the set of VAR models described in section 3, now identified via an assumed underlying temporal relationship regarding reaction inertia, expressed in Equ. (10).

Although the variables of major interest, RRTM and credit-growth, show a less significant reaction to a monetary policy shock, the mean responses indicate the same underlying mechanisms. All four categories[15] analyzed in this paper show the same behavior in the RRTM and also the corresponding credit growth variable does not react significantly. Thus, the results presented in the previous section are, to a weaker extend, confirmed: expansionary monetary policy shocks lead to disproportionately strong decreases in credit standards to the non-financial private sector while the credit-growth-variable is in general not affected for the observed

[15] Although we present for the sake of clarity only results for the non-financial private sector, the complete set of impulse response functions of the robustness section is available on request.

period.

8 Conclusion and Outlook

The assessment of risk-taking by euro area banks remains a challenging issue. After a short overview about banking in the euro area, we suggest a new measure to evaluate changes in credit standards with an estimated macroeconomic risk measure. This variable captures the risk prevailing in the economy via bond market information. Bond markets are suiting for this purpose because they contain various information about current and expected economic performance and they are close substitutes for financing issues. Thus, the co-movement between system inherent macro-risk and changes in credit standards can be used to assess *excessiveness* of risk-taking in the financial sector. This can help to better unveil the role of banks as financial accelerator and might be one additional measure to uncover unintended developments in the financial system in general due to monetary policy shocks to the economy.

Our suggested Relative Risk-Taking Measure shows that credit standards fluctuate *more than proportionately* relative to the overall risk when confronted with loose monetary policy, as indicated by the presented impulse response functions. These findings can be testified for three out of the four categories focused in this paper. Reactions of credit growth indicate severe distortions in monetary policy transmission. The results remain similar if our VAR model is identified via cholesky and its implied ordering. When focusing on the recent financial crisis the magnitude of these findings in our Relative-Risk-Taking-Measure increases emphasizing the problematic aspect of long lasting low interest rate periods. Credit growth in the non-financial private sector is primarily driven by growth in housing finance while credit granting to non-financial corporations shows a contra-intuitive and opposing reaction. The implications of these outcomes are probably problematic: (unexpected) long-lasting

periods of low interest rates might cause credit standards to adjust in a way which can bear the risk of vulnerable bank balances in the long term because of newly acquired overly riskier assets: credits to less credit-worthy borrowers. This caveat might occur especially in the real estate sector and, in turn, might cause systemic imbalances in the overall financial system and thwart monetary policy intentions of calming and stabilizing financial markets in the long run.

Some interesting points for further research are e.g. the extension of our model to capture international components like credit granting to non-euro-area-residents. Furthermore, a detailed look at the different categories queried in the Bank Lending Survey might unveil new insights about monetary policy effects in dependence of firm size or credit duration. Also a more precise differentiation between the various kinds of unconventional monetary policy measures and announcements to achieve a clearer distinction between e.g. balance-sheet policy and forward guidance could shed light on the effects of ECBs' unconventional monetary policy and its conduction on bank risk-taking.

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Appendix

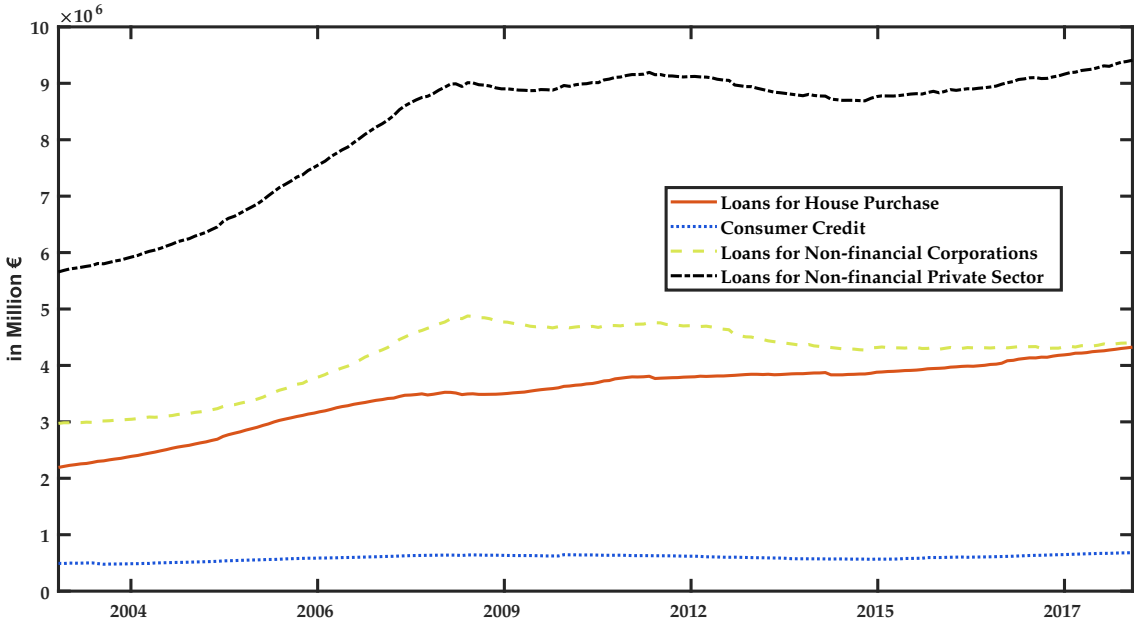

Figure 10: Stock of outstanding loans of the three in the BLS queried non-financial private sector credit categories.

Notes: Non-financial corporation loans (dashed yellow line), Mortgages (red solid line), consumer credits (blue dotted line, and sum of them (dotted-dashed black line)). Source: ECB, authors' calculations.

8. Please indicate how you expect your bank's credit standards as applied to the approval of loans or credit lines to enterprises to change over the next three months. Please note that we are asking about the change in credit standards, rather than about their level.

	Overall	Loans to small and medium-sized enterprises	Loans to large enterprises	Short-term loans	Long-term loans
Tighten considerably					
Tighten somewhat					
Remain basically unchanged					
Ease somewhat					
Ease considerably					

21. Please indicate how you expect your bank's credit standards as applied to the approval of loans to households to change over the next three months. Please note that we are asking about the change in credit standards, rather than about their level.

	Loans for house purchase	Consumer credit and other lending
Tighten considerably		
Tighten somewhat		
Remain basically unchanged		
Ease somewhat		
Ease considerably		

Figure 11: Bank Lending Survey, Questionnaire to expected Credit Standard Changes.

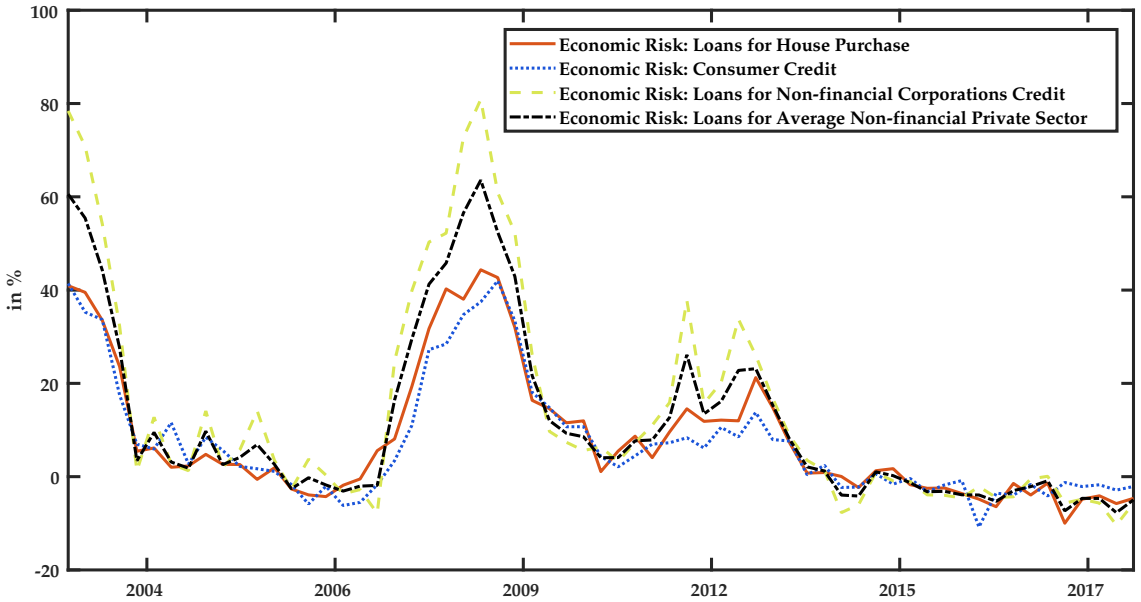

Figure 12: BLS: Net effect of economic risk on private sector credit.
Notes: Housing Credit (solid red line), Consumer Credit (dotted blue line), Non-financial Corporations (dashed yellow line), and Non-financial Private Sector (dashed-dotted black line).
Source: ECB, authors' calculations.

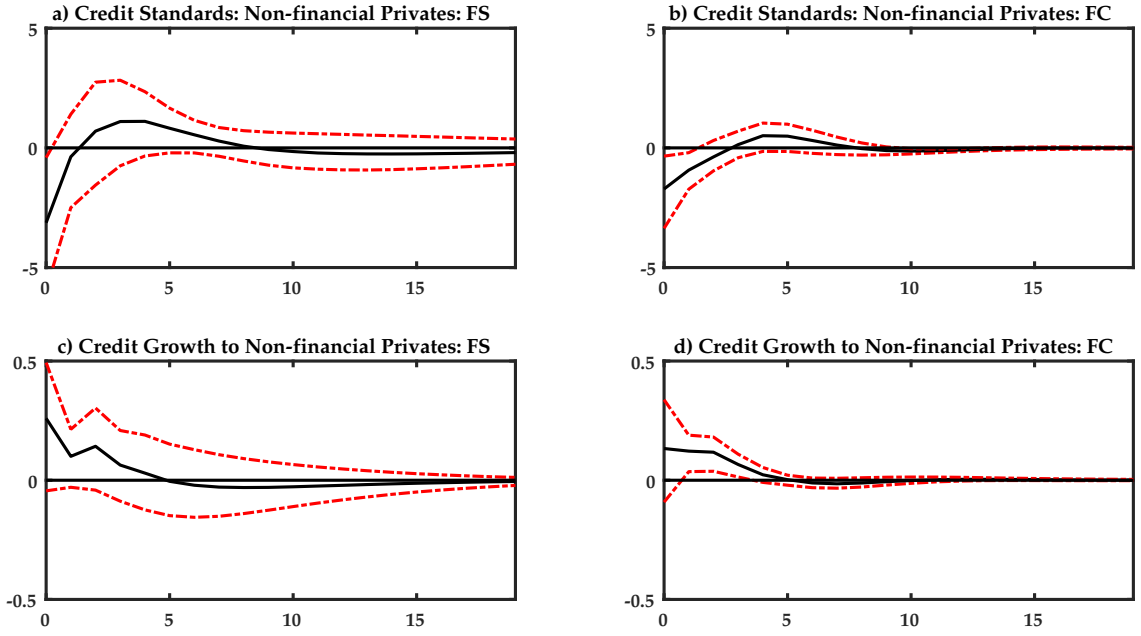

Figure 13: Impact of a 25 bp expansionary monetary policy shock on credit standards and credit growth: non-financial private sector.
Notes: The solid black lines reflect the median response, the dotted red lines are the 16^{th} and 84^{th} percentiles. a) and c) stem from the model of the full sample, b) and d) from the financial crisis sample.