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## Unconventional monetary policy and bank risk-taking in the euro area

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

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July 30, 2018

## Abstract

This paper studies risk-taking by European banks. 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 risk of the macroeconomic environment banks operate in to reflect whether credit standards react disproportionately 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 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 include our measure in a VAR in which structural innovations are identified with sign restrictions. The key outcomes of this paper are the following: Restrictive (expansionary) monetary policy shocks increase (decrease) our measure of risk-taking. Increases (decreases) in our measure are caused by disproportionately strong (weak) 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 restrictive (expansionary) monetary policy shocks than credit standards. We conclude that expansionary monetary policy shifts the portfolio of banks to overall riskier asset holdings. The credit granting reaction depends on the category: In general, credit to non-financial corporations are less sensitive to monetary policy shocks while mortgages seem to be affected.

## Keywords:

monetary policy, euro area, bank risk-taking, credit standards, sign restrictions VAR

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**JEL classification:**

E44, E52, G12

# 1 Motivation and Contribution

Risk-taking issues in the financial sector in general gain growing attention since Rajan (2006) 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 the portfolio of assets financial intermediaries hold. In this paper, the ex ante assessment of the riskiness of additionally acquired assets, here newly granted credit, 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 by mapping survey based changes in credit standards compared to the previous quarter to the bank lending channel. Major results relevant for this paper are that indeed 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) focusing on individual data of banks' credit granting decisions. They also use a survey based measure of risk appetite of banks by linking 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 is that bond investors show no similar increase in risk appetite during prolonged periods of low interest rates. Neuenkirch & Nöckel (2017) elaborate that expan-

sionary monetary policy induces a quick and strong downward adjustment of credit standards by euro area banks to keep the lending margins, a measure for banks' core business profitability, stable. Although operating in a long lasting low yield environment for about 9 years, euro area banks seem to be able to stabilize their net margins, primarily for newly granted loans, as depicted in Fig. (1). Thereof

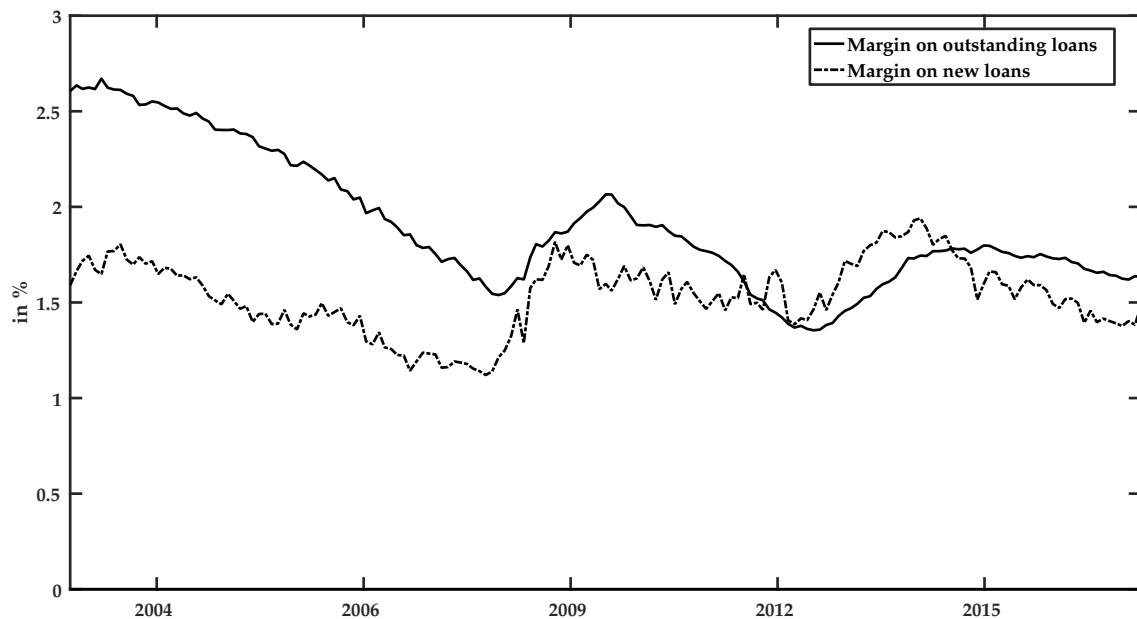


Figure 1: Average euro area net bank margins for outstanding and newly granted loans.

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.

results the question if credit supply and the 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 monetary rates is quite heterogeneous in the euro area and attest that, especially in mortgage standards, excessive risk taking occurs in a low interest rate environment. Here 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 these 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 of 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: Bond markets. The advantage of using bond markets is that they explicitly reflect the markets' perception of riskiness of the bonds under considering the macroeconomic environment with its implications for e.g. distances to default. The tight relationship between business-cycle-fluctuations and various bond market spreads is elaborated e.g. in Gilchrist & Zakrajšek (2012) who 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) connect the unobservable tension of Value-at-Risk constrained bank-balances and their resulting propensity to grant credit explicitly to their market-based and thus observable financial substitutes. This results in 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 these ideas 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 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 a bond spread index by Gilchrist & Zakrajšek (2012). Major outcome is that their credit supply indicator induces a negative GDP and borrowing capacity reaction as well as increased bond premia and a monetary easing when shocked negatively. 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 responses to a probability function which describes the tightening decision conditional on a set of macro variables as well as additional Bank Lending Survey based information. They show that tightening in credit standards leads non-financial corporations to evade bank loans and increase financial market funding. This emphasizes the complementary nature and interchangeability of both kinds of debt financing. 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 construct a variable that relates credit standard changes to macroeconomic conditions. For this purpose, we first estimate a measure that reflects the degree of riskiness of the macroeconomic environment by using information extracted from European bond markets. This macro risk premium, as suggested by Adrian, Moench & Shin (2010), will help us to evaluate changes in credit standards non-financial private agents are confronted with. By relating these credit standard changes to this macro risk premium (MRP hereinafter), we can figure out in how far e.g. monetary policy shocks drive numerator and denominator of this ratio in the same manner or if they show differences. To account for the various non-



financial sector credit categories queried in the Bank Lending Survey of the ECB, we explicitly distinguish between credit standards for non-financial private corporations, loans for house purchases (for simplicity "mortgages", hereinafter<sup>1</sup>) 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 a sign restriction approach, as suggested by Uhlig (2005). 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 unexpected 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 all four categories of credit we use 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. We also conduct a historical decomposition to get a first indication about the contribution of monetary policy shocks to movements in our new risk-taking indicator and credit granting. Here we can see that monetary policy shocks impact the indicator overall positively, but the pattern varies a lot over time. 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.

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<sup>1</sup>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.

## 2 Data

As mentioned in the introduction, our aim is to get a measure that relates private sector credit standard adjustments to the prevailing and expected macroeconomic conditions. This results in an assessment of the overall riskiness of current credit granting standards:

$$excessiveness = \frac{credit\ standard\ adjustments}{macro\ risk}. \quad (1)$$

Thus, in this section we describe the data we use and how we construct this indicator for the judgment of appropriateness of credit standard adjustments.

### Euro Area Credit Standards

Since Q1 2003, the ECB quarterly conducts the Bank Lending Survey. It contains questions about expected changes in the applied credit standards in the forthcoming three months for different non-financial private sector categories. Questions 8 and 21 of the survey are the focal point of interest in our paper. Unfortunately, the complete survey results for all 140 survey participants are not available, only net-percentage changes are published due to the confidential nature of the questionnaire.<sup>2</sup> 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. (2):

$$CS_{NFPS} = \sum_{i=1}^3 w_i CS_i, \quad (2)$$

with  $i$  = non-financial corporations credit standards, mortgages credit standards and consumer credit standards net-percentage changes.

We can see that loans to non-financial corporations account for the largest amount of overall non-financial private sector credits, followed by mortgages and consumer credits.

Fig. (3) depicts the raw data of the net-percentage changes in the relevant questions of the ECB Bank Lending Survey, amended by our constructed overall non-financial

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<sup>2</sup>In the context of credit standards, the net percentage 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".

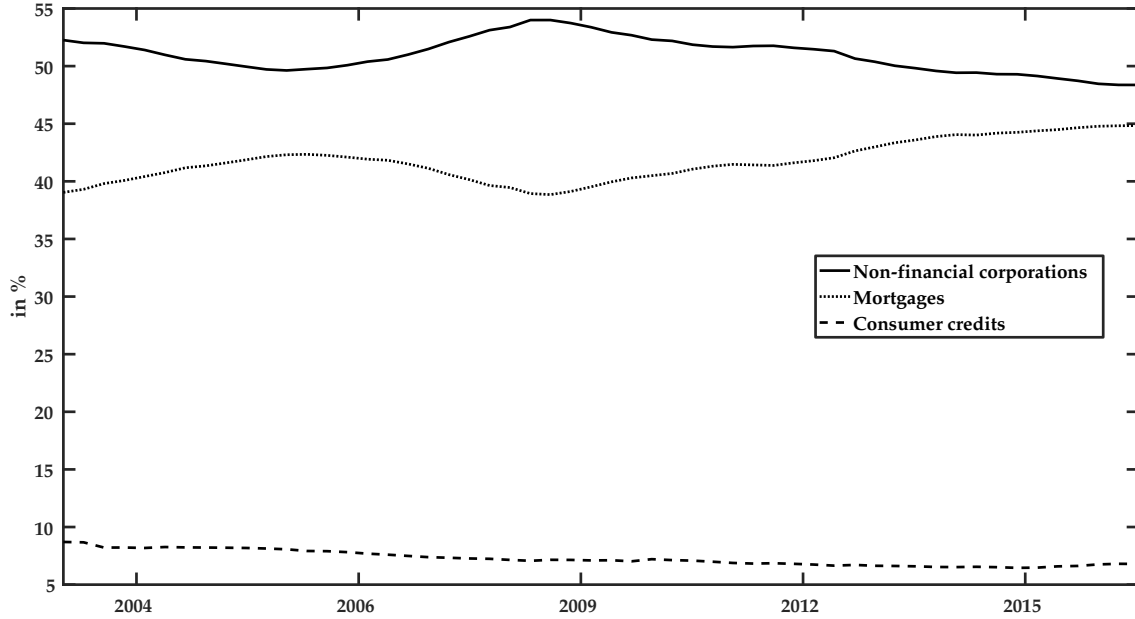


Figure 2: Shares of the three queried non-financial private sector credit categories on the overall outstanding amount of non-financial private sector loans.

Notes: Non-financial corporation loans (solid line), Mortgages (dotted line), consumer credits (dashed line). Source: ECB, authors' calculations.

private sector credit standard changes<sup>3</sup>. Per construction, the range of possible outcomes of the net-percentage changes is bounded to  $[-100; 100]$ .<sup>4</sup> The course of the European economy with its dominant events is quite well reflected by the series: The echo of the dotcom bubble, the financial crisis and the European Sovereign Debt Crisis are peaks in credit standard tightening stages.

### Measuring Macroeconomic Risk

Based on former work<sup>5</sup>, 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 overall macroeconomic environment

<sup>3</sup>We do not want to conceal that there might be a systematic bias in the answers of survey participants. The survey conductor ECB since November, 2014 is also the participants' supervisory authority and thus banks might have an incentive to understate their intended alignment of credit standard policies. We leave this possible issue for further research.

<sup>4</sup>100 = all banks tighten their standards (considerably), -100 = all banks ease their standards (considerably).

<sup>5</sup>Adrian, Estrella & Shin (2010) and Adrian & Shin (2010).

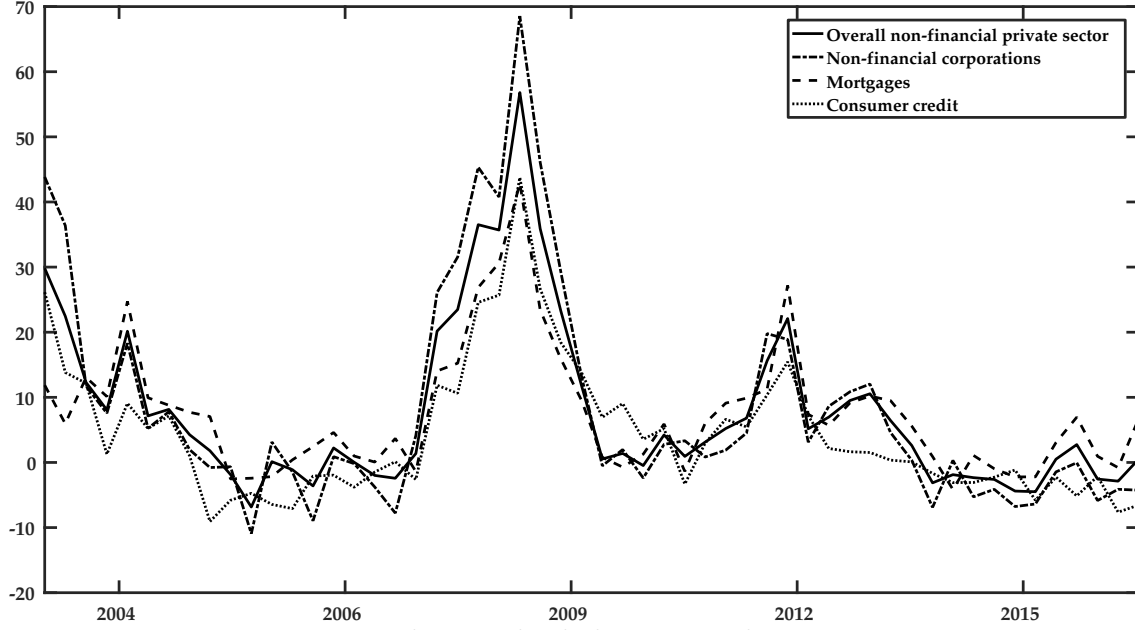


Figure 3: Net-percentage credit standard changes in the euro area.

Notes: Weighted overall credit standards (solid line), Non-financial corporation credit standards (narrow dashed line), Mortgage standards (dashed line), Consumer credit standards (dotted line). Source: ECB, authors' calculations

they operate in, 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 or credits 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. First, we regress GDP-growth on spreads constructed with the information euro area bond markets carry within them, exploiting the high correlation between 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 deducting German BUNDs from differently rated European corporate

bond yields. Equation (3) depicts this procedure, with  $\varepsilon_t \sim N(0, \sigma^2)$ :

$$\begin{aligned} \Delta \ln GDP_t = & \alpha_0 + \alpha_1 t p_t^{10Y} + \alpha_2 r p_t^{AAA10Y} + \alpha_3 r p_t^{AA10Y} \\ & + \alpha_4 r p_t^{A10Y} + \alpha_5 r p_t^{BBB10Y} + \varepsilon_t \end{aligned} \quad (3)$$

The resulting coefficients, collected in  $\hat{\alpha}$ , are then multiplied by the different yields used in equation (3) (equals  $\mathbf{X}$  in equation (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 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. Equation (4) reflects our approach and the idea of the information content of yields on macroeconomic conditions:

$$\widehat{MRP} = -(\hat{\alpha}\mathbf{X}) \quad (4)$$

Similar to the net-percentage changes of credit standards, the estimated MRP reflects the major pattern of the euro area economy in our sample. Fig. (4) plots the resulting MRP and, for the ease of interpretation, euro area GDP-growth. The similarity between net-percentage changes in credit standards 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. When looking at the ordinate axis of the MRP and credit standard changes, we see that their values are hardly comparable. Although the series are highly positively correlated<sup>6</sup> they can not be related in one fraction. Credit standard adjustments are extracted from an ordinal scaled, query-based variable and the resulting net-percentage changes

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<sup>6</sup>Correlation coefficient  $\rho = 0.7635$  for MRP and  $CS_{NFPS}$ .

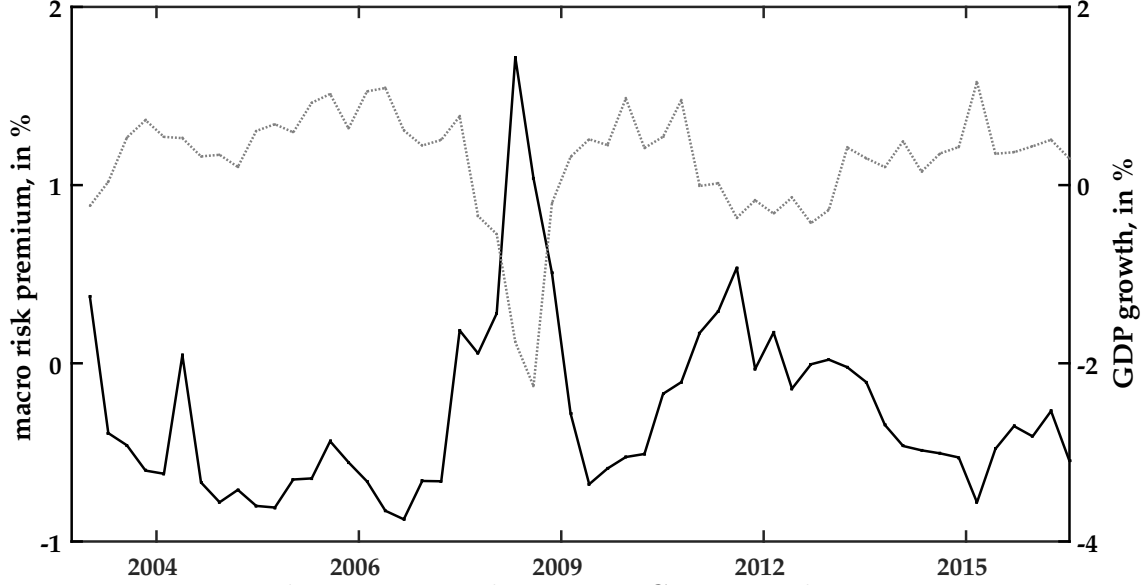


Figure 4: Macro Risk Premium and euro area GDP-growth.

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

are measured in a specific type of bounded cardinal scale  $([-100,100])$ , the MRP is purely cardinal and (theoretically) not restricted to a predetermined value range. We overcome this problem by standardizing both variables to make their movement more comparable and therefore relatable:

$$RRTM_{i;t} = \frac{(NPC_{i;t} - \overline{NPC_i})\sigma_{NPC_i}^{-1}}{(MRP_t - \overline{MRP})\sigma_{MRP}^{-1}} \quad (5)$$

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 equation (5), results in four different Relative Risk-Taking Measures (RRTMs, hereinafter).

### 3 Vectorautoregressions

We use quarterly euro area (log-differentiated) seasonally adjusted data in a five variable reduced form VAR model<sup>7</sup>:

$$Y_t = A_p(L)Y_{t-p} + T + \varepsilon_t \quad (6)$$

<sup>7</sup>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.

$Y_t$  contains GDP growth, Harmonized Consumer Price Index inflation, the ECB shadow rate provided by Wu & Xia (2016), the respective four different RRTMs and the distinct credit growth variables.  $A_p(L)$  is a lag-polynomial of order  $p$  in lag-operator  $L$ <sup>8</sup>,  $T$  is a constant and  $\varepsilon_t$  is the column vector of white noise error-terms and covariance matrix  $\Sigma_\varepsilon$ . The sample starts in Q1 2003 due to the availability of Bank Lending Survey data and ends in Q2 2016.

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

$$B_0 Y_t = B_p(L) Y_{t-p} + D + u_t, \quad (7)$$

identifying restrictions are needed to reduce the amount of required parameter estimations and to account for the (non-zero) covariance  $\Sigma_\varepsilon$  between reduced form error terms. To examine a structural form of the underlying VAR-model and structural innovations ( $u_t$ ) linked to it, we use two identification approaches: Theory driven sign restrictions 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.

Table (1) shows the imposed restriction scheme on the reaction of model variables to a restrictive monetary policy shock:

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<sup>8</sup>The lag length is set to one due to heterogeneous outcomes in lag length specification in the different model setups when using common lag length criteria.

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

Table 1: Sign restrictions for a (restrictive) 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: restrictive (expansionary) monetary policy does not increase (dampen) output and inflation via higher (lower) interest rates (see Uhlig (2005)). 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<sup>9</sup>.

## 4 Results

The presentation of results is split into two parts: In the first part, impulse response functions are outlined, focusing on two different samples, In the second part, historical decompositions are depicted and discussed. Each part distinguishes between the four categories dealt in this paper: overall non-financial private sector, non-financial private corporations, mortgages and consumer credit.

### 4.1 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 presented, too.

#### 4.1.1 Full sample

##### Non-financial Private Sector

Fig. (5) shows impulse response functions to a restrictive monetary policy shock in the VAR model described in section (3) with overall non-financial private sector credit. As we can see, restricted responses of key macro-variables (output and consumer prices) are (per construction) in line with the majority of results presented

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<sup>9</sup>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).



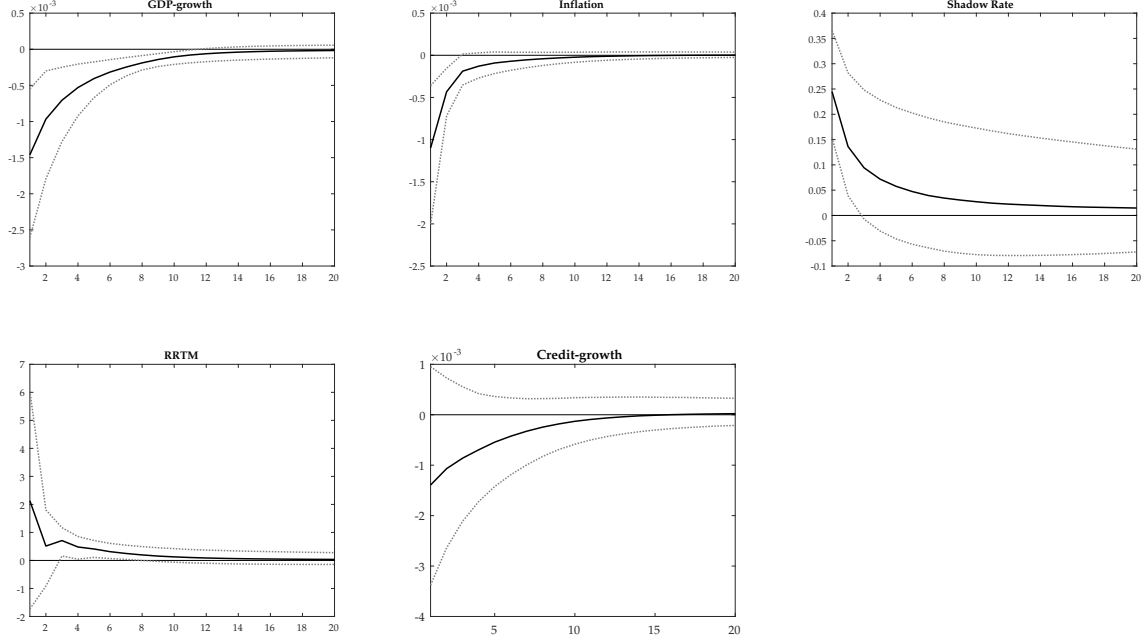


Figure 5: Impact of a restrictive monetary policy shock in a model with overall non-financial private sector credit growth, full sample.

Notes: The solid line reflects the median response, the dotted lines are the 16<sup>th</sup> and 84<sup>th</sup> percentiles.

in most of macro-related VAR literature. The key variables of interest, RRTM and credit granting to non-financial private sector, are focused hereafter. Credit standards react stronger than the overall macroeconomic risk variable, extracted from financial substitutes, which indicates excessive risk-taking by financial intermediaries in periods of expansionary monetary policy, notable after three quarters. This reaction fits in the existing empirical evidence to the implications of the risk-taking channel and emphasizes amplification of monetary policy via credit standard adjustments. Thus, we can conclude that an increase in our measure of relative risk-taking implies that banks tighten their credit standards more than proportional, relative to the change in the inherent macroeconomic risk when facing restrictive monetary policy shocks. However, private non-financial sector credit growth does not react in a notable manner (but the median shows the expected sign).

### Non-financial Private Corporations

Fig. (6) displays the results for a more specific perspective, focusing on non-financial private corporations. Again, we observe a more-than-proportionately strong reac-

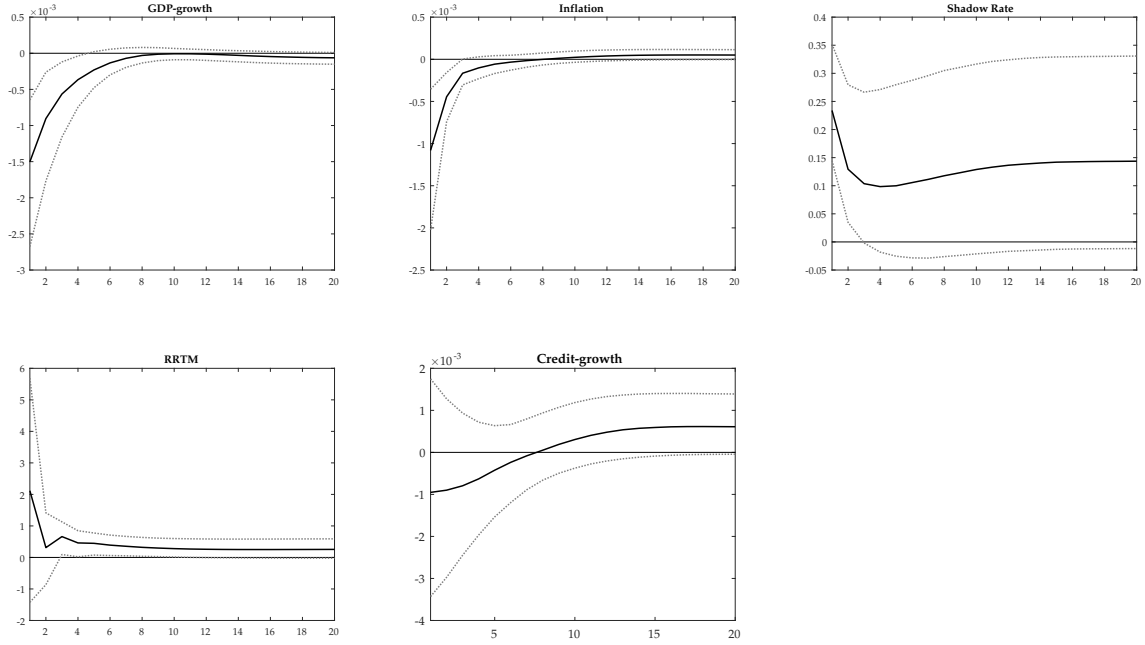


Figure 6: Impact of a restrictive monetary policy shock in a model with non-financial corporation credit growth, full sample.

Notes: The solid line reflects the median response, the dotted lines are the 16<sup>th</sup> and 84<sup>th</sup> percentiles.

tion in the credit standards while the overall amount of granted credit does not react in a significant manner, in the longer horizon there is nevertheless an inverse reaction compared to what can be expected when monetary transmission works.

### Mortgages

As depicted in Fig. (2), the second important and since the financial crisis continuously growing lending category for euro area banks are mortgages. Compared to the reactions described before, the initial reaction of the median model is larger which indicates a relative strong risk-taking behavior in the field of mortgage credit standards. Also here the quantitative dimension seems to be almost unaffected, but show a stronger reaction as well as narrower percentile boundaries when compared to the other lending categories. Although the results lie within the boundaries, this result might confirm the strong tendency of euro area banks to engage in mortgage/real estate markets.

### Consumer Credits

The least important lending subcategory based on the share on overall private sec-

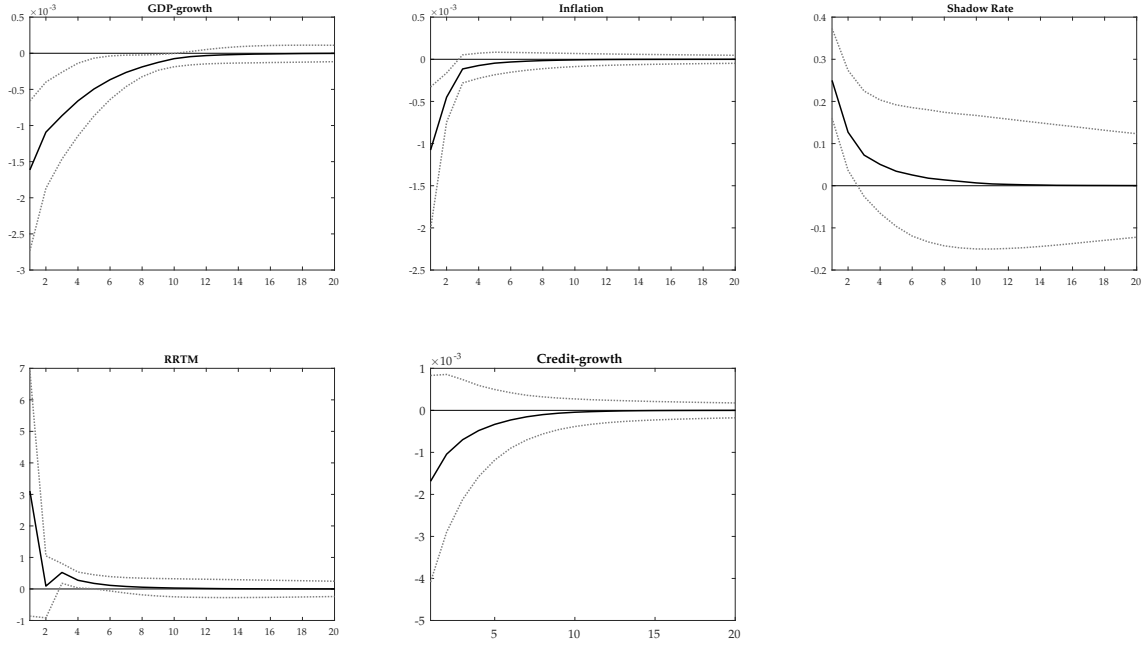


Figure 7: Impact of a restrictive monetary policy shock in a model with mortgage growth, full sample.

Notes: The solid line reflects the median response, the dotted lines are the 16<sup>th</sup> and 84<sup>th</sup> percentiles.

tor lending for euro area banks shows in both risk-taking aspects, RRTM and credit growth, notable reactions. Compared to the overall non-financial sector, the RRTM reacts stronger and also consumer credit growth is impacted by monetary policy shocks. Thus, consumer credits seem to be the only subcategory in which the intended quantitative reaction of ECB monetary policy seems to occur. However, due to low importance on overall non-financial private sector lending it is a negligible result<sup>10</sup>. The impulse response functions are available on request.

#### 4.1.2 Financial Crisis Sample

Changing the sample such that it starts in Q3 2008, the reaction of our key variables shows notable differences compared to our full sample model. The increase in the RRTMs are more persistent for the categories of major relevance, corporate loans and mortgages, respectively, and, due to their dominating share, also for the overall non-financial private sector. While credit growth in the private firm sector shows in this setup the opposite reaction to what can be expected by theory about monetary

<sup>10</sup>Cholesky identification yields no significant reaction in credit growth in this subcategory, see online appendix.

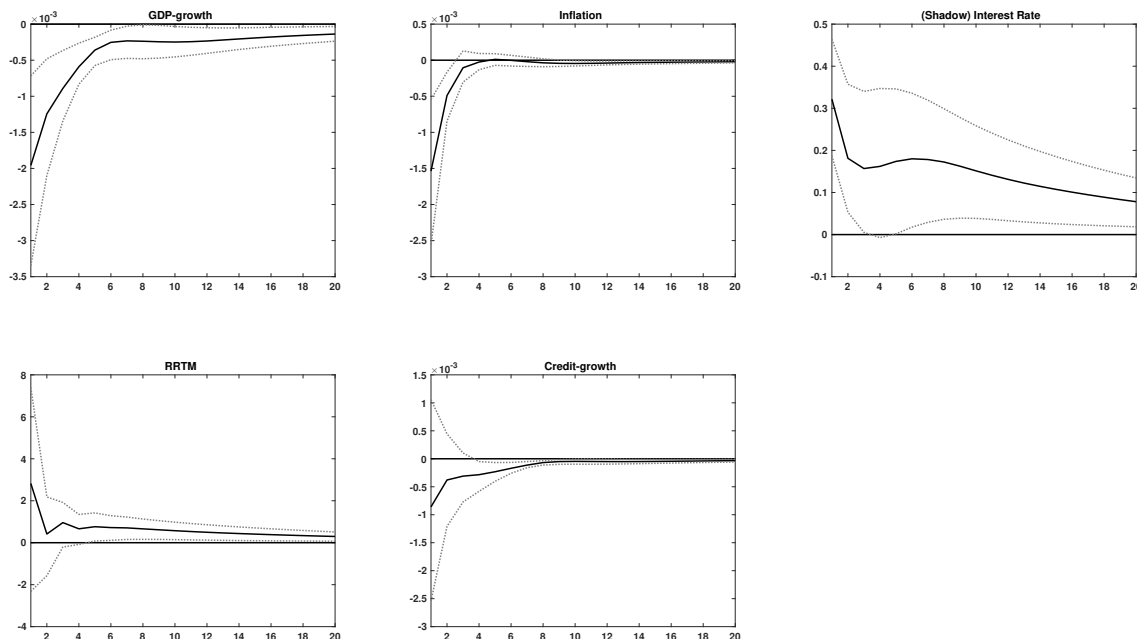


Figure 8: Impact of a restrictive monetary policy shock in a model with overall non-financial private sector credit growth, financial crisis sample.

Notes: The solid line reflects the median response, the dotted lines are the 16<sup>th</sup> and 84<sup>th</sup> percentiles.

policy transmission, mortgage growths' reaction to a monetary policy shock intensifies.

### Non-financial Private Sector

We can see in Fig. (8) that the private-sector-wide relative risk taking is stronger when comparing the median responses of the two different samples as well as more persistent when taking a look at the percentiles. This indicates that the amplifying nature of the risk-taking channel is enhanced in periods of extraordinary expansionary monetary policy.

### Non-financial Private Corporations

When focusing on non-financial corporations, depicted in Fig. (9), we can also observe the persistent disproportion in credit standard adjustments relative to the macroeconomic environment, expressed via the category-specific RRTM. Interestingly, the growth in credit to private non-financial firms reacts opposite to what can be expected when monetary transmission works<sup>11</sup>.

<sup>11</sup>Recall that the main motivation for recent unconventional monetary policy measures in the euro area was to restore credit provision to non-financial private sector, especially non-financial corporations.

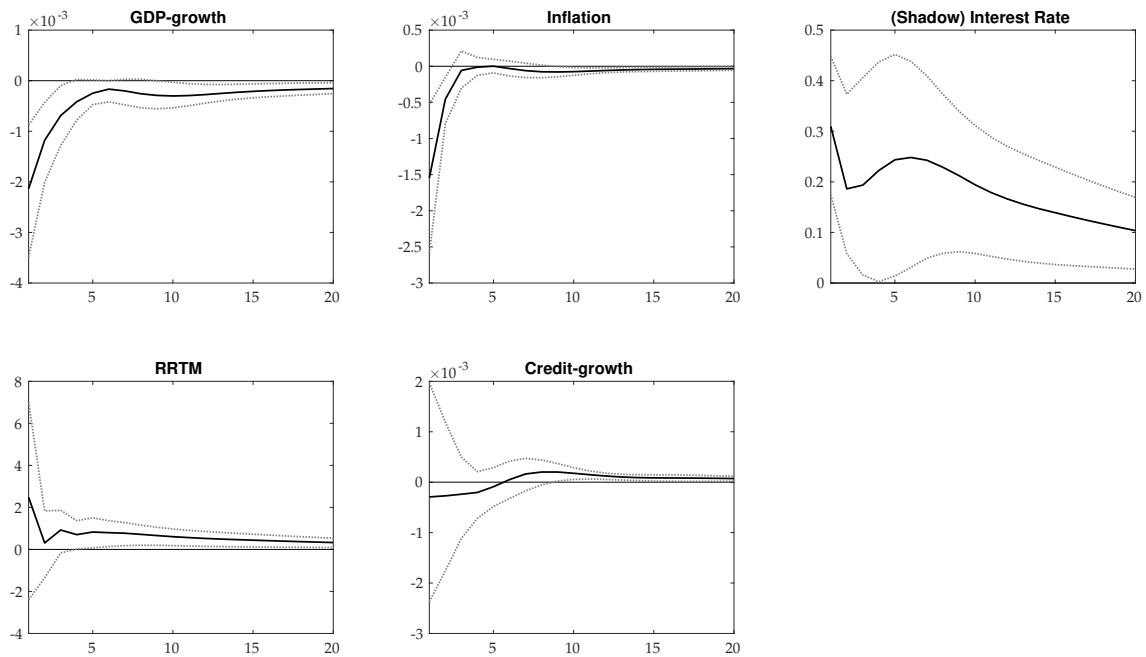


Figure 9: Impact of a restrictive monetary policy shock in a model with non-financial corporation credit growth, financial crisis sample.

Notes: The solid line reflects the median response, the dotted lines are the 16<sup>th</sup> and 84<sup>th</sup> percentiles.

## Mortgages

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 sector discussed before. In Fig. (10) 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 strongly 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.

## Consumer Credits

Interestingly, and in contrast to the results of other credit categories, the smallest category, credit standards for consumers, do not react in a disproportionate man-

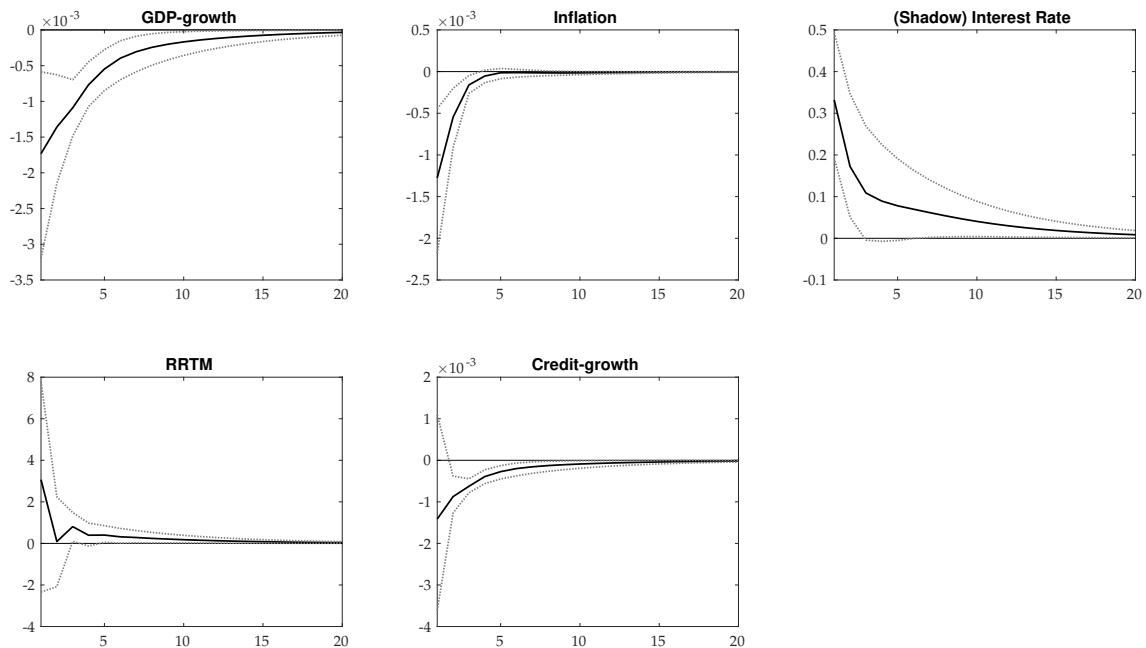


Figure 10: Impact of a restrictive monetary policy shock in a model with mortgage growth, financial crisis sample.

Notes: The solid line reflects the median response, the dotted lines are the 16<sup>th</sup> and 84<sup>th</sup> percentiles.

ner in this subsample. Credit granting is impacted similar to mortgages. Impulse response functions are available on request.

## 4.2 Historical Decomposition

The basic idea of historical decompositions is to quantify and disentangle the contribution of distinct structural shocks to the movement of our endogenous model variables. Thus, we can use it to capture the impact of certain unexpected monetary policy actions. Nonetheless, the presented insights and remarks in this section are only a first, superficial glance and should be treated with caution.

Fig. (11) to Fig. (13) show the contribution of monetary policy shocks to changes in the respective variables in the model focusing on non-financial private sector as a whole for 2003 - 2016. We see that there is no clear pattern, neither in the RRTMs nor in credit growth during the recent financial crisis until 2012. After 2012, historical decompositions show a similar, positive contribution of monetary policy shocks to the different RRTMs and a negative one for credit growth in the period Q1 2012 to Q4 2014. These findings vary only in dependence of the respective category.

Rises in the RRTM can be rooted in disproportionately strong rises in credit standards *or* disproportionately strong reduced macroeconomic risk. One possible explanation for the observed movement is Mario Draghis' "Whatever it takes"-speech on July, 26<sup>th</sup> 2012 and the subsequent introduction of Forward Guidance about the ECBs' key interest rates. It might have reduced system inherent uncertainty and macroeconomic risk which resulted in reduced bond premia and, per construction of the MRP, in a reduced denominator of the RRTM via lower expected future short term rates as well as shortened risk premia. This interpretation emphasizes the key role of controlling expectations.

When focusing on credit growth, some interesting points have to be outlined. Initially, the contribution of monetary policy shocks on granted credit was positive until the financial crisis, indicating that monetary policy was unexpectedly loose in the period between mid 2004 and 2006. During the critical stage of the financial crisis and the European sovereign debt crisis, the contribution of monetary policy shocks to credit growth varies. During the European sovereign debt crisis, monetary policy shocks did not contribute positively to credit granting. Since the recent onset of various asset purchase programs with a clear intention of economic stimulus, monetary policy shocks contributed positively to euro area non-financial private sector credit growth and all its subcategories.

## Non-financial Private Sector

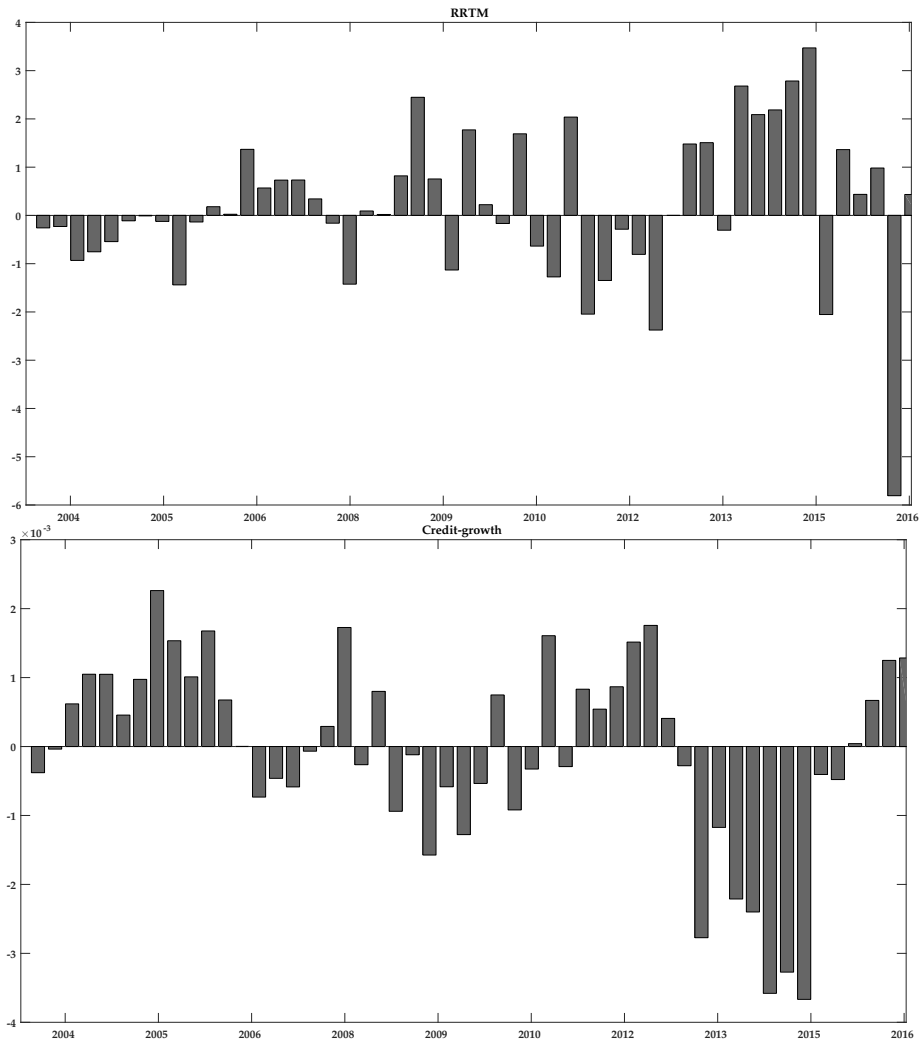


Figure 11: Historical Decomposition, upper graphic: RRTM of non-financial private sector, lower graphic: Non-financial private sector credit-growth.  
Notes: Contribution of the monetary policy shock, based on the median model identified with sign restrictions.



## Non-financial Private Corporations

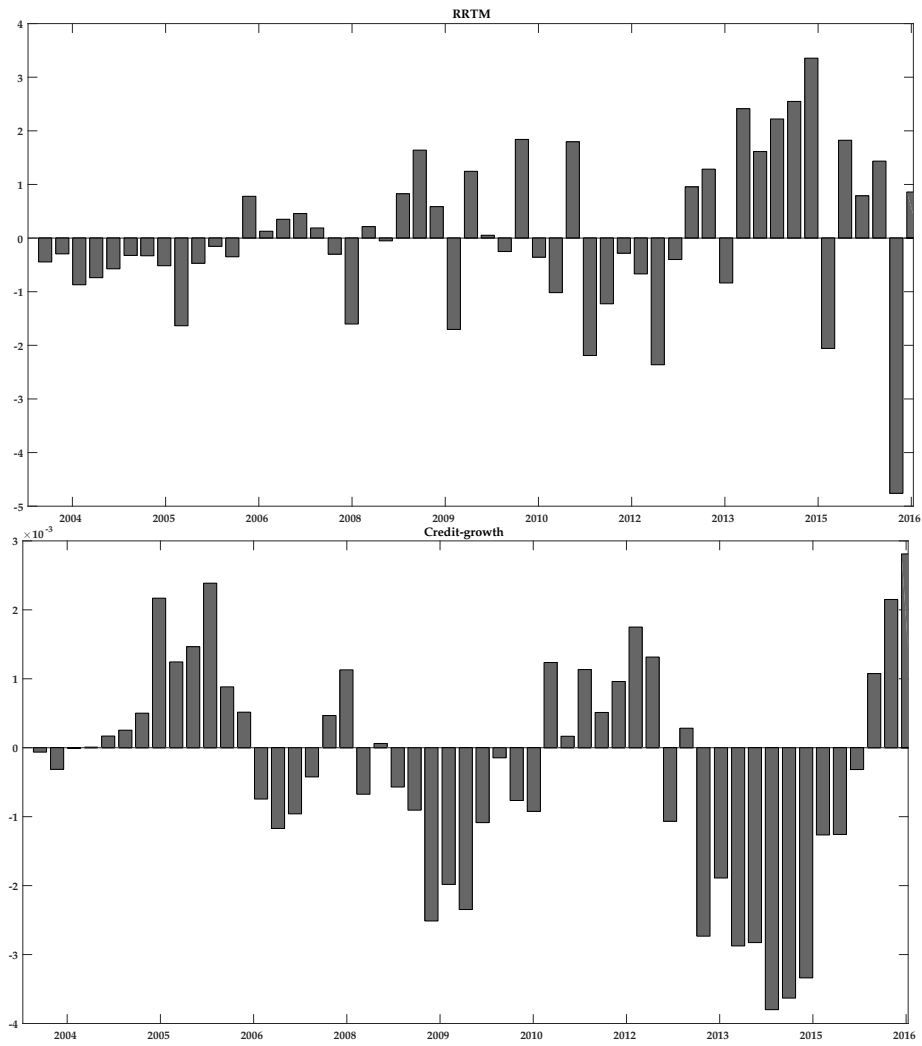


Figure 12: Historical Decomposition, upper graphic: RRTM of non-financial corporations, lower graphic: Non-financial corporations credit-growth.  
Notes: Contribution of the monetary policy shock, based on the median model identified with sign restrictions.

## Mortgages

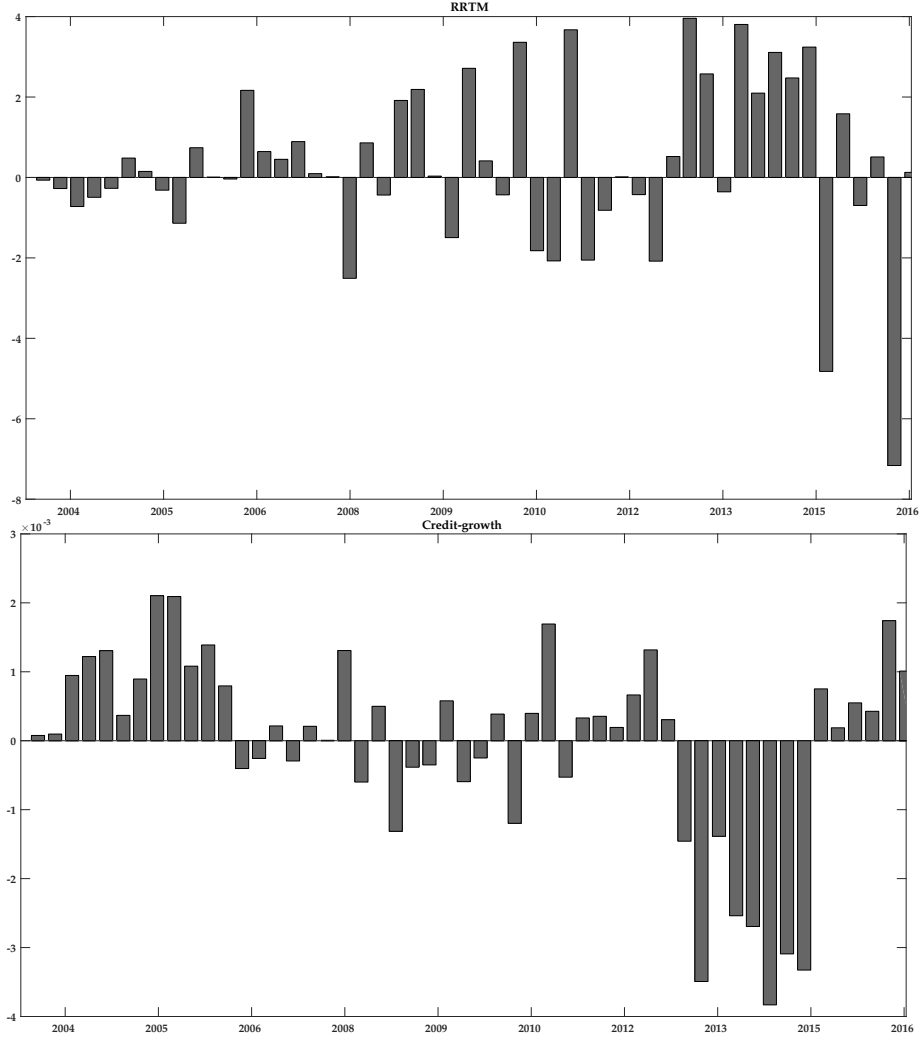


Figure 13: Historical Decomposition, upper graphic: RRTM of mortgages, lower graphic: mortgage-growth.

Notes: Contribution of the monetary policy shock, based on the median model identified with sign restrictions.

## 5 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:

$$Y_t = [GDP_t \ HICP_t \ interest\ rate_t \ RRTM_{i,t} \ Credit_{i,t}]' \quad (8)$$

Fig. (14) 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 (8). Although the variables of major interest, RRTM and credit-growth, show a less significant<sup>12</sup> reaction to a monetary policy shock, the mean responses indicate the same underlying mechanisms. For the RRTM median responses shown in the previous chapter lie all within the boundaries of the results of the Cholesky approach. Also in this approach credit variables do not react significantly either. All four categories<sup>13</sup> analyzed in this paper show the same behavior in the RRTM and also the corresponding credit growth variable does not react significantly.<sup>14</sup> Thus, the results presented in the previous section are confirmed: Restrictive (expansionary) monetary policy shocks lead to disproportionately strong increases (decreases) in credit standards to the non-financial private sector while the credit-growth-variable is in general not affected for the observed period. These findings are even stronger when focusing on the recent financial crisis.

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<sup>12</sup>All confidence bands presented in this section are bootstrapped 90 % confidence intervals.

<sup>13</sup>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.

<sup>14</sup>Except for a short period in the non-financial corporations category, surprisingly with unexpected sign which are similar to the results lined out for the financial crisis sample with sign-restriction-identification.

## Non-financial Private Sector

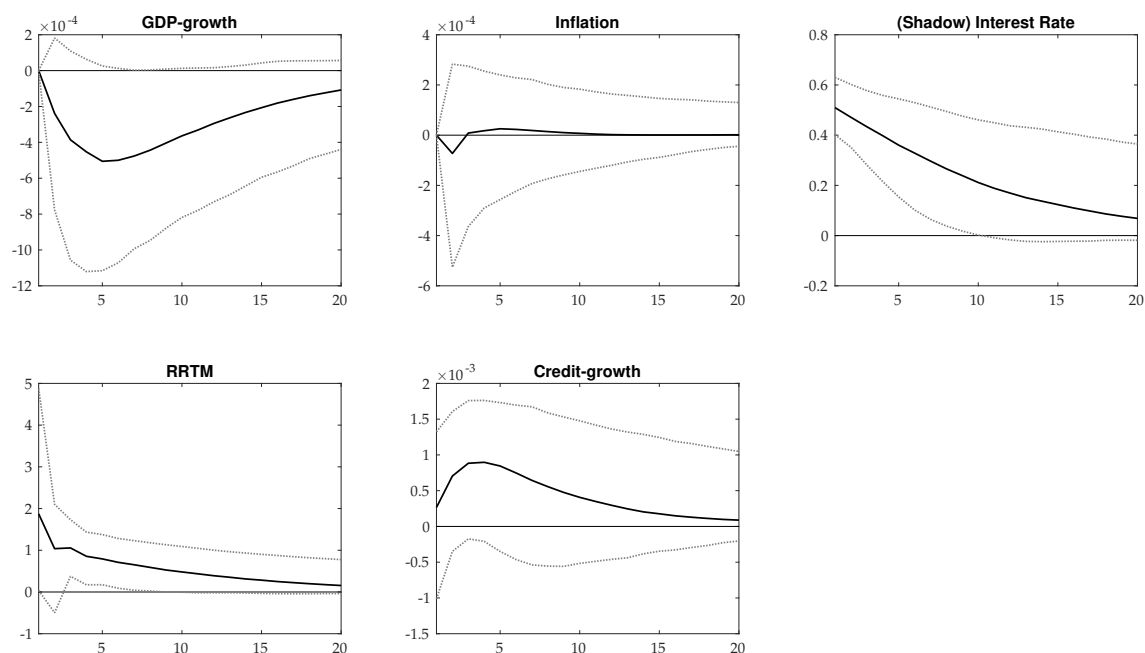


Figure 14: Impact of a restrictive monetary policy shock in a model with overall non-financial private sector, full sample.

Notes: Shock size is one standard deviation, the solid line reflects the mean response, the dotted lines are 90% error bands.

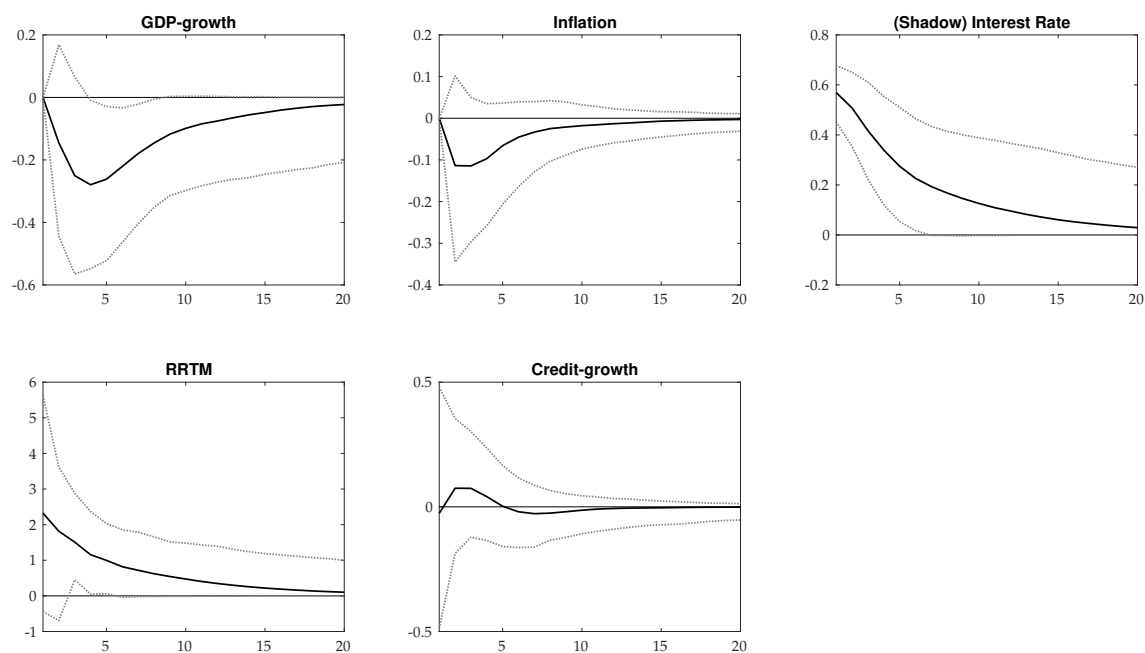


Figure 15: Impact of a restrictive monetary policy shock in a model with overall non-financial private sector, financial crisis sample.

Notes: Shock size is one standard deviation, the solid line reflects the mean response, the dotted lines are 90% error bands.

## 6 Conclusion and Outlook

The assessment of risk-taking by euro area banks remains a challenging issue. We suggest a new measure to evaluate changes in credit standards with an estimated macroeconomic risk measure that 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 monetary policy shocks, as indicated by the presented impulse response functions. These findings can be testified for all four categories of the non-financial private sector, with the most intense movement in mortgages. Reactions of credit growth indicate severe distortions in monetary policy transmission, especially in the sample characterized by the financial crisis. The results remain similar if our VAR model is identified with an assumed recursive 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 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.

Historical decompositions indicate that the contribution of monetary policy shocks to our measure vary over the observed period. Since 2012 the contribution of the structural monetary policy shocks to the various Relative Risk-Taking Measures is primarily positive which could root in a reduced macroeconomic risk or the markets' perception of it, respectively. For credit growth the contribution of monetary policy shocks fit in some narratives about the "too low for too long" debate as well as the lack of effectiveness of balance sheet related ECB unconventional monetary policy measures. After the outbreak of the recent financial crisis, the contribution is in general negative.

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.

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