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The financial market effects of the ECB's balance sheet policies

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The Financial Market Effects of the ECB's Balance Sheet Policies*

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Abstract

The European Central Bank's balance sheet policies have been criticized as ineffective or even harmful to the economy. This paper aims at gauging the effects on financial markets, the banking sector and lending to non-financial firms. Using a structural vector autoregression analysis, we find that balance sheet innovations help to decrease financial stress, stock market risk and default rates initially. However, these beneficial effects on financial markets are overturned in the medium run. Credit expands significantly and persistently. While output rises immediately, the positive effect is short-lived and economically small. Prices do not respond significantly to the shock.

Keywords: Balance sheet, unconventional monetary policy, central bank, shock identification, VAR

JEL classification: C32, E44, E52, E58

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1 Introduction

Recent economic developments within the euro area macroeconomy have led the European Central Bank (ECB) and the European System of Central Banks (ESCB) to develop new tools in order to fulfill their mandate and keep prices stable. Following the collapse of Lehman Brothers in September 2008, financial markets all over the world experienced turbulent times, impairing bank lending and monetary policy transmission. This financial shock also had significant effects on the financial system of the euro area. Due to increased uncertainty, the interbank market broke down, which induced a liquidity shortfall for the euro area banking system. Consequently, bank lending to non-financial firms declined, which had severe consequences for the real economy. Output dropped sharply and inflation rates fell far below the ECB's definition of price stability. In a situation with a policy rate approaching the zero lower bound, the ECB reacted with a basket of measures, among which it implemented several asset purchase programs in order to provide banks with liquidity and to improve bank lending. Subsequently, the euro area sovereign debt crisis followed in the end of 2009 which again induced pressure on financial markets and made new policy actions necessary.

Our study contributes to the debate on the effectiveness of the ECB's policy actions in terms of balance sheet expansions. We use a vector autoregression (VAR) model to estimate the dynamic effects of asset purchase programs on the macroeconomy. We propose a novel identification strategy which makes the model well suited to consider possible side effects on financial markets. Compared to existing empirical studies, our approach is more agnostic on the effects of measures on financial markets because we refrain from restricting the respective responses ex ante.

While the transmission channel of *conventional* interest rate policy is well understood and many - empirical as well as theoretical - studies exist on that topic, the effects of the diverse set of *unconventional* measures, of which balance sheet policy is one particular example, are still to be explored. In fact, it is not even clear to which extent those measure are effective in bringing inflation and output back to their target levels, let alone potential unintended side effects which may unfold particularly within financial markets. Therefore especially macroprudential policy,

which is supposed to address financial market imbalances and to maintain a well-functioning financial system, should be interested in identifying and characterizing risks to financial stability which may emerge from untested policy measures. Since macroprudential policy in the euro area is also assigned to national institutions, insights from a country-specific exercise are particularly useful.

There is a small but growing literature on the effects of euro balance sheet policies on the macroeconomy. Some studies approach the question with event studies like Eser and Schwaab (2015), who show that the Securities Market Programme (SMP) had a significant impact on sovereign yields. They consider common factors to control for aggregate developments. Krishnamurthy and Vissing-Jorgensen (2011) show that in the US, the quantitative easing programs QE1 and QE2 were both effective in lowering nominal interest rates but the magnitude of the effect differs across asset classes. Lambert and Ueda (2014) consider US banks and their reaction to policy news. They do not find a positive effect on bank returns but bank credit risk increases over the medium term. Szczerbowicz (2014) emphasizes the effectiveness of different unconventional measures in the euro area. In particular, she shows that the interconnectedness between banks and sovereigns amplifies the effect of policy announcements.

While those studies focus on specific purchase programs, they cannot estimate a *dynamic* effect on the aggregate economy. In this respect, Casiraghi et al. (2013) use a combination of two strategies. They investigate the effects of the SMP, Outright Monetary Transactions (OMTs) and Longer Term Refinancing Operations (LTROs) within an event study. Subsequently, they feed their results into a macroeconomic model of the Italian economy. They find that the SMP as well as the OMTs were effective in decreasing government bond yields, while LTROs improved lending conditions. Lenza et al. (2010) estimate a Bayesian VAR model and compute counterfactual developments of key macro variables. They show that monetary policy in exceptional times, represented by central bank liquidity management, is effective. Notably, their analysis refers to the fixed rate full allotment policy of the ECB and therefore highlights demand-driven liquidity provisioning of the banking system. Gambacorta et al. (2014) apply a mean group estimator to their cross-country VAR model to show that balance sheet expansions have a positive effect on output and prices. They consider information from 8 currency

areas which helps them to overcome the problem of a relatively short sample. Peersman (2011) compares conventional interest rate policy responses to unconventional balance sheet policy. He finds that both measures have a positive effect on output and prices, while the transmission of a balance sheet expansion is more sluggish. However, the analysis cannot distinguish exogenous policy shocks from endogenous demand-driven effects originating in the banking sector. Similarly, Darracq Pariès and De Santis (2013) use information in the Bank Lending Survey in order to compute dynamic effects of a credit supply shock. They show that the ECB 3-year LTRO program from December 2011 is expansionary with respect to output and inflation.

Our analysis is closely related to the one of Boeckx et al. (2014) who set up a VAR model and consider the dynamic effects of the ECB's asset purchase programs. Their analysis focuses on non-financial macroeconomic developments. They show that an increase in the ECB balance sheet has a positive effect on output, prices, and bank lending. In general they find favorable effects with respect to balance sheet policy, with heterogeneity among euro area countries. To identify a balance sheet shock, they impose a negative reaction of euro area financial stress. Our approach uses an alternative identification strategy of the balance sheet shock, which, we argue, is more agnostic with respect to financial market variables. More specifically, we do not restrict financial market stress in our shock identification scheme. We find favorable effects of balance sheet policies with respect to financial stress and output within the first months. In the months thereafter, the effect on output vanishes while financial stress even increases above its pre-shock level. The identified effect on output and prices are subject to a high degree of uncertainty where the price responses remain insignificant. Output, inflation and financial stress respond much more strongly to a financial stress shock than to an unconventional monetary policy shock in the form of direct asset purchases.

We add to the literature a country-specific impact study, with a focus on the German economy. Krishnamurthy and Nagel (2014) have shown that the ECB's SMP and OMT were successful in reducing government bond yields in periphery countries. They also find beneficial spillover effects with respect to core countries, while they do not determine the transmission channel. We show that balance sheet

policy benefits the German banking and corporate sector by reducing liquidity risk. Bank lending to non-financial firms is positively affected and market risk aversion declines, such that overall output increases initially. Generally, effects on output and prices are found to be economically small and exhibit a high degree of uncertainty.

The remainder of this paper is organized as follows. Section 2 discusses our dataset and gives a brief outline over the recent policy measures. Section 3 describes the econometric framework, as well as our identifying assumptions. The estimation results are discussed in Section 4. Section 5 concludes.

2 Data and ECB balance sheet

For the analysis, we consider a time series dataset at a monthly frequency which ranges from January 2008 to December 2014. The short time period makes it necessary to consider monthly observations in order to have sufficient information available to estimate the VAR model. While there exist monthly data before January 2008 it is important for our analysis to focus on the particular episode where the ECB and the ESCB injected liquidity through asset purchase programs. The following paragraph gives a short overview of the recent actions undertaken in response to the financial crisis and the subsequent European sovereign debt crisis. Figure 1 depicts the asset purchase programs of the ECB as parts of the balance sheet item "securities held for monetary policy purposes" and Figure 2 contrasts those securities with ECB's main refinancing operations (MROs) and longer term refinancing operations (LTROs).

During the sample period, the ECB decided to conduct several asset purchase programs in order to stabilize bank lending, and to maintain a functioning monetary transmission mechanism. Ultimately, inflation rates are targeted to approach 2% to conform with the ECB's definition of price stability. We consider events which we regard as ECB balance sheet policy within the time frame July 2008 to March 2015.[1]

In July 2008 the Eurosystem central banks started to buy covered bonds, which,

[1] Szczerbowicz (2014) provides a detailed timeline of the ECB's decisions, announcements and the design of policy measures.

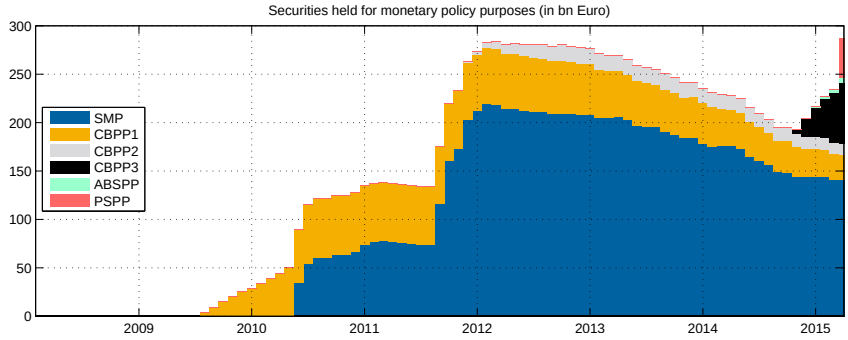

Figure 1: ECB balance sheet items linked to asset purchase programs.
Source: ECB website
(http://www.ecb.europa.eu/stats/monetary/res/html/index.en.html).

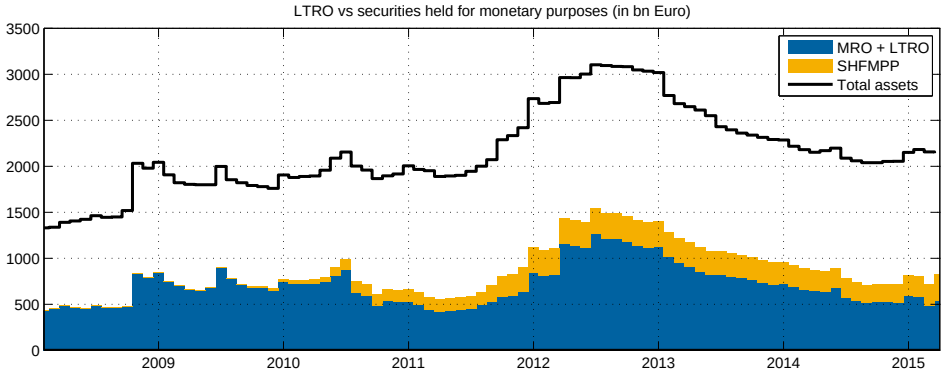

Figure 2: Main refinancing operations, longer term refinancing operations, and securities held for monetary policy purposes as parts of the total ECB balance sheet.
Source: ECB website
(http://www.ecb.europa.eu/stats/monetary/res/html/index.en.html) and ECB Statistical Data Warehouse.

as argued by the ECB, are an important source for banks' refinancing. The total aggregate value of the purchase program was 60 billion euros. Even though the first Covered Bond Purchase Programme (CBPP1) ended in June 2010, there is still a significant amount of assets on the ECB balance sheet as can be seen from Figure 1. In addition to this measure, the ECB announced a fixed rate full allotment policy in October 2008. It allows banks to obtain as much liquidity as needed, given adequate collateral and at a predetermined interest rate. The full allotment policy directly aims at improving the liquidity position of banks and it works through MROs and LTROs.[2] In May 2010, the Eurosystem started the SMP where it bought securities for 230 billion Euro. The second Covered Bond Purchase Programme (CBPP2) was conducted between November 2011 and October 2012. Bonds worth a total of 16 billion euros were purchased. In order to clearly communicate the willingness to improve bank lending, the ECB conducted forward guidance on future interest rates in July 2013. This included an official publication of ECB forecasts according to which interest rates would remain at low levels for an extended period of time. In November 2014, national central banks started the Asset-Backed Securities Purchase Programme (ABSPP). One month later, the third Covered Bonds Purchase Programme (CBPP3) was introduced and proposed to be conducted until June 2016. Finally, in March 2015 the Public Sector Purchase Programme was launched, where the Eurosystem plans to buy sovereign debt of a total value of 60 billion euros until September 2016.

With respect to the aforementioned measures, we separate two types of unconventional policy instruments. We label the first one, summarized by the ECB balance sheet item "securities held for monetary policy purposes" as direct asset purchases. The second comprises the balance sheet items "Main Refinancing Operations" and "Longer Term Refinancing Operations" and represents liquidity management by the ECB. While the first instrument is used by the central bank in a discretionary fashion, the second is adjusted to the liquidity demand of the financial sector.[3]

[2]One may argue that during the time frame considered, MROs and LTROs can, to some extent, be regarded as unconventional policy measures as well, especially because of the full allotment policy. Our analysis distinguishes asset purchase programs from other unconventional policy measures.

[3]A stylized representation of the ECB balance sheet can be found in Table B.1 in the ap-

In general, the aim of the three CBPPs, the SMP and the ABSPP was to encourage bank lending in order to repair the transmission channel of monetary policy and ultimately to bring inflation back to a value of below (but close to) 2%.[4] In this respect, President Mario Draghi stressed the ECBs willingness to consider any measure that will preserve the euro as a stable currency. In his "whatever it takes speech" at the Global Investment Conference in London in July 2012 he explicitly committed the ECB with all conceivable measures to its price stability mandate. However, government bond purchases were met with criticism within the ECB's Governing Council.

For the baseline specification of the VAR model we consider the MRO rate to represent the conventional monetary policy instrument. The monthly data frequency does not allow us to directly use GDP as a measure of output or economic activity. We instead interpolate the quarterly series using the Chow and Lin (1971) method[5] and the monthly industrial production index. Euro area prices are measured by the harmonised index of consumer prices (HICP); for Germany, we use the consumer price index (CPI). The total of ECB assets/liabilities provides a measure of the balance sheet size, while we consider the sum of the balance sheet items related to the main refinancing operations and the longer term refinancing operations separately from the rest. Differentiating balance sheet items helps us to identify the ECB balance sheet shock as will be discussed in detail in section 3.2. In order to measure financial stress in the euro area we use the Composite Indicator of Systemic Stress (CISS) of Holló et al. (2012) while for the German case we have collected the comparable Bundesbank Stress Indicator for the German Financial System. Most of the data is publicly available, where the main data sources are the ECB Statistical Data Warehouse (SDW) and the Bundesbank.[6] More detailed information on the data is provided in Table A.1 of the appendix.

pendix.

[4] See e.g. https://www.ecb.europa.eu/mopo/implement/omt/html/index.en.html.

[5] We want to keep our estimation results comparable to the literature and therefore follow Boeckx et al. (2014) and Gambacorta et al. (2014) in this respect.

[6] Data on the Stress Indicator for the German Financial System, presented in Bundesbank (2013), is not publicly available.

3 VAR Model

We analyze the effects of monetary policy with a vector autoregression (VAR) model, where we employ a novel set of identifying assumptions on the balance sheet shock. The VAR allows us to model the effects of shocks dynamically, while imposing a minimum set of assumptions about the structure of the economy. In this respect, we build on the approaches of Peersman (2011), Gambacorta et al. (2014), and Boeckx et al. (2014), who investigated the effects of balance sheet shocks at an aggregate level.

3.1 Specification

Let us first consider the following reduced form VAR equation,

$$\boldsymbol{y}_t = \boldsymbol{c} + \sum_{j=1}^{p} \boldsymbol{B}_j \boldsymbol{y}_{t-j} + \boldsymbol{u}_t, \quad \text{with } t = 1, \ldots, T, \tag{1}$$

where $\boldsymbol{y}_t$ is an $N \times 1$ vector of endogenous variables, $\boldsymbol{u}_t \sim \mathcal{N}(\boldsymbol{0}, \boldsymbol{\Sigma})$ is an $N \times 1$ vector of reduced form residuals, $\boldsymbol{c}$ is an $N \times 1$ intercept vector, and $\boldsymbol{B}_j$ are $N \times N$ matrices containing the VAR coefficients. In order to generate results comparable to the literature, we opted for a lag length of $p = 4$.[7] We propose the following list of endogenous variables for the medium scale model:

$$\boldsymbol{y}_t = \begin{bmatrix} r_t & y_t & p_t & b_t & s_t & b_t^D \end{bmatrix}', \tag{2}$$

where r_t denotes the policy rate, y_t denotes the logarithm of output, p_t denotes the logarithm of the price index, b_t denotes the logarithm of total central bank assets, s_t is an indicator of financial stress or another financial market variable, and b_t^D is the logarithm of the sum of MRO and LTRO volumes.

Since the reduced-form VAR is not suited for structural analysis, we identify

[7] Throughout the analysis and across different specifications, we keep the specification comparable by using the same lag length. Robustness checks with different lag lengths showed similar results and are available upon request.

the following model,

$$\boldsymbol{A}_0 \boldsymbol{y}_t = \boldsymbol{a} + \sum_{j=1}^{p} \boldsymbol{A}_j \boldsymbol{y}_{t-j} + \boldsymbol{e}_t, \quad \text{with } t = 1, \ldots, T, \tag{3}$$

where $\boldsymbol{A}_0$ is an $N \times N$ matrix such that $\boldsymbol{A}_j = \boldsymbol{A}_0 \boldsymbol{B}_j$, $\boldsymbol{a} = \boldsymbol{A}_0 \boldsymbol{c}$ and $\boldsymbol{e}_t = \boldsymbol{A}_0 \boldsymbol{u}_t$ with $\boldsymbol{e}_t \sim \mathcal{N}(\boldsymbol{0}, \boldsymbol{I}_N)$, $\boldsymbol{I}_N$ is the $N \times N$ identity matrix and $\mathbb{E}(\boldsymbol{u}_t \boldsymbol{u}_t') = (\boldsymbol{A}_0' \boldsymbol{A}_0)^{-1} = \boldsymbol{\Sigma}$. Since the estimated model (1) does not allow us to identify the structural form (3) without additional assumptions, we impose identifying restrictions on the impulse response functions (IRFs) of shocks. The literature has developed several methods to determine $\boldsymbol{A}_0$ based on economic considerations. We identify the shocks using a combined sign and zero restrictions approach. We rely on the method of Arias et al. (2014), who develop an algorithm which is robust to erroneous credible intervals and unintended additional sign restrictions.[8]

3.2 Identification

The literature has considered different identifying assumptions on the unconventional monetary policy shock. Given the ECB's conversion to fixed rate full allotment provisioning during the considered time frame, banks can in principle obtain as much liquidity as they need at a given interest rate. Both exogenous balance sheet policy decisions and higher liquidity demand by banks lead to an expansion of the central bank balance sheet. Similarly, Szczerbowicz (2014) discriminates between "asset purchases" and "other exceptional liquidity provisions". Peersman (2011) does not distinguish demand-driven expansions from asset purchase programs. He argues that even though a balance sheet expansion is demand-driven, the policy decision to provide the banking sector with as much liquidity as needed when financial stress occurs, is still taken by the ECB and as such represents a policy decision. Boeckx et al. (2014) and Gambacorta et al. (2014) use variables which indicate financial stress periods or periods with high risk aversion. They require those measures to be non-increasing if an expansionary unconventional

[8]The authors show that other algorithms may lead to additional sign restrictions on variables which are seemingly unrestricted. Consequently, point estimates and confidence bands are estimated with error.

Variable	Balance sheet shock	Financial shock
r_t	0 (3 months)	
y_t	0 (1 month)	0 (1 month)
p_t	0 (1 month)	0 (1 month)
b_t	$\uparrow$ (3 months)	$\uparrow$ (1 month)
s_t		$\uparrow$ (1 month)
b_t^D	$\downarrow$ (3 months)	$\uparrow$ (1 month)

Table 1: Identifying restrictions of shocks.

shock hits the economy. This assumption excludes demand-induced balance sheet expansions which occur in stress periods.

In order to investigate the effects of an unconventional policy shock, it has to be defined and identified unambiguously. In particular, the shock should be orthogonal to other possible shocks in the model. We impose a mixture of sign and zero restrictions on the impulse responses of certain variables in our VAR model. Our identifying restrictions are summarized in Table 1.

For our analysis, unconventional monetary policy measures are represented by ECB balance sheet adjustments.[9] For this reason we necessarily require total central bank assets (b_t) to increase if a positive *balance sheet shock* hits the economy. The literature on monetary policy transmission traditionally assumes that output (y_t) and prices (p_t) are not contemporaneously affected by the policy measure. In the same vein, it can be argued that an expansion of the central bank's balance sheet should not change output and prices on impact. With this restriction we exclude that other aggregate demand shocks, which increase both output and prices, are interpreted as unconventional policy shocks. As discussed above, the ECB's fixed rate full allotment policy requires us to distinguish the balance sheet shock from a demand-driven balance sheet expansion. Generally, an increase in the balance sheet can be attributed either to the endogenous response to demand

[9]We abstract from other unconventional measures, such as loosening of collateral requirements, maturity transformations of refinancing operations or forward guidance.

factors b_t^D or to an exogenous unconventional monetary policy shock ε_t^B, i.e.[10]

$$b_t = b_t^D + \varepsilon_t^B. \tag{4}$$

Identifying the shock component ε_t^B requires an additional restriction to disentangle the endogenous from the exogenous component of the balance sheet. Since demand-driven balance sheet expansions operate through either MROs or LTROs, we require the sum of both (b_t^D) not to increase. The restriction on the MRO and LTRO volumes is a convenient way to identify the shock without restricting the responses of financial stress. The policy rate (r_t) does not react when an unconventional shock hits the system.[11]

For comparison, we also identify a *financial shock* that increases stress on financial markets (s_t). Differently from the balance sheet shock, banks are assumed to increase the ECB's balance sheet mainly through MROs or LTROs, while the policy instrument remains unrestricted. Output and prices are sluggish and do not react contemporaneously to the shock. One could view the dynamic responses to this shock as picking up the ECB's fixed rate full allotment policy at work. As we impose banks to demand liquidity through MROs and LTROs in response to the shock, the dynamics tell us something about the effectiveness of those measures. In this spirit, Lenza et al. (2010), focus on effects of those demand-driven measures which should not be confused with the balance sheet policy shock in column 2 of Table 1.[12]

3.3 Estimation

The model is estimated with Bayesian methods, where we use a flat prior distribution. In particular, we employ the specification in Uhlig (2005) and set the respective prior matrices to zero which yields the posterior distribution with respect to the reduced form model (1). Regarding the structural model (3), we employ the algorithm in Arias et al. (2014) to draw the contemporaneous impact

[10] Here we abstract from other less relevant parts of the balance sheet.

[11] To discriminate between conventional and unconventional policy shocks, we also identified a policy rate shock in a separate exercise. Results are available upon request.

[12] Peersman (2011) does not distinguish between these two types of measures and analyzes the effectiveness of a mixture of both.

matrix $\boldsymbol{A}_0$. As suggested by the authors, we obtain the reduced form estimates $\boldsymbol{B} = [\boldsymbol{B}_1, \ldots, \boldsymbol{B}_p]$ and $\boldsymbol{\Sigma}$ first, then a candidate random matrix $\boldsymbol{A}_0$ is proposed. If the sign restrictions are satisfied, we keep the matrices $\{\boldsymbol{B}, \boldsymbol{\Sigma}, \boldsymbol{A}_0\}$. Otherwise, we discard the triple. This procedure is repeated until we have generated a sample of 15,000 draws from the posterior distribution, where the first 5,000 draws are discarded in order to minimize the impact of the starting point.

4 Results

The analysis is performed in two steps. First, we consider impulse response functions with respect to aggregate euro area data. Estimates for the euro area aggregate are useful because they allow us to compare our results to the existing literature. Beyond that, we discuss the validity of the identified balance sheet shock and identify a financial stress shock. Thereafter, we estimate the model on German data in order to assume a country-specific perspective. In particular, we focus on variables that contain information on firms' and financial market responses.

4.1 Euro area

Let us first consider our baseline specification, where the euro area composite stress index (CISS) captures effects on financial markets. The CISS has been proposed by Holló et al. (2012), consists of five sub-indices and lies on the unit interval. Since we employ a novel identification scheme, the baseline specification helps us to assess the appropriateness of our identifying assumptions.

First, we assume that an expansionary exogenous balance sheet shock hits the economy in period 0. According to column 2 in Table 1, the ECB balance sheet increases for 3 months, while monetary policy is not allowed to use its conventional interest rate instrument for three periods[13], while at the same time the sum of the

[13] We choose more than one month because the ECBs purchase programs are generally quite persistent. In Boeckx et al. (2014), restrictions are imposed on impact and the period following the shock. In addition, we impose prolonged zero restrictions on r_t for two reasons. First, we do not want to mix up conventional policy shocks with balance sheet policy which leads us to keep this restriction at least as long as the sign restriction on the balance sheet prevails. Second,

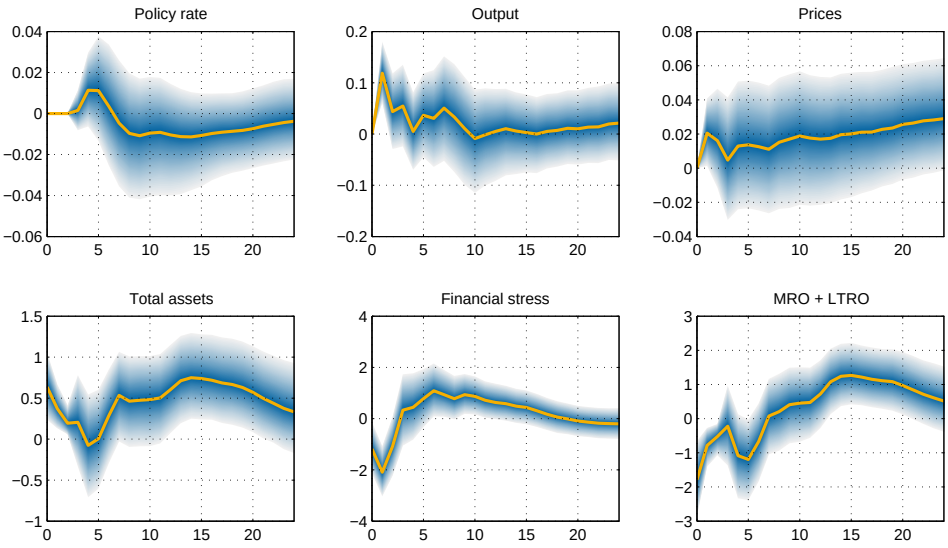

Figure 3: Euro area. Impulse response functions to a one standard deviation balance sheet shock.

balance sheet positions related to the ECB's MROs and LTROs are assumed not to increase. Inflation and output react only with a one-period lag to policy decisions. The key innovation of our identification scheme is that we explicitly leave the stress index unrestricted because we want to let the data speak on the response of financial stress. The literature restricts financial stress to be non-decreasing after policy interventions. We argue that, if our interest lies in financial market reactions - as for instance represented by the CISS -, the respective responses may be biased ex ante towards decreasing stress.

The results of this first exercise can be seen in Figure 3. Throughout the paper, solid lines depict the median and the blue-shaded area represents the respective 16-86% quantiles of the posterior distribution.

Let us first comment on the appropriateness of our identifying assumptions. Initially, our balance sheet shock drives down financial stress as measured by the CISS without imposing this as a restriction. Results are therefore directly comparable with the balance sheet shocks identified in the literature[14], while this

our results should contain some information about constrained conventional monetary policy environments, i.e. under the zero lower bound restriction. We provide results with respect to an alternative identification scheme in Figure A.1 in the appendix.

[14] Boeckx et al. (2014) impose that financial stress falls after an expansionary balance sheet

approach gives us more flexibility in terms of analyzing effects on other variables. At the same time, the shock has a temporary expansionary effect on the real economy such that output increases by about 0.1 percent in the period after the shock, while in the following periods this effect cannot be distinguished from zero. Prices increase slightly though not significantly. While the median of the policy rate increases slightly, the response remains insignificant. The tendency to increase the policy rate might be explained by a late reaction to the initial positive output response. Beginning in the second month after the shock, stress increases and finally overshoots its pre-shock level. This stress episode may be associated with higher liquidity needs of banks such that they demand more central bank funding through MROs and LTROs after approximately 7 months. Eventually, this reaction seems to bring stress smoothly towards its pre-shock level again.

Note that results have to be considered with caution because the estimation period is quite short and we cannot analyze the robustness of our results to sample splits. Since the short sample size burdens the estimation with additional uncertainty, we decided to identify policy shocks with restrictions imposed not only in the impact period. A prolonged period of liquidity provision is more likely to generate measurable effects while it is realistic to assume that the balance sheet will increase not only for one period. Dynamic effects are less clear when restrictions are imposed on impact only, as can be seen in Figure A.1 in the appendix. The robustness exercise does not call into question our main conclusion that balance sheet policy is hardly effective with respect to output and prices and may potentially generate risks in the financial sector.

Comparing our impulse response functions to those in Boeckx et al. (2014), we find qualitatively similar results, while the size of the reaction is smaller in our case and responses of output and prices are insignificant in the medium run. One could criticize that our approach may mix up heterogeneous effects of the asset purchase programs undertaken by the ECB. However, as Szczerbowicz (2014) has shown, the interconnectedness between banks and governments leads to similar effects for different market participants and to an amplification of policy measures.

As our discussion about the identifying assumptions of the balance sheet shock has shown, it is important to disentangle such a shock from unanticipated exoge-

shock.

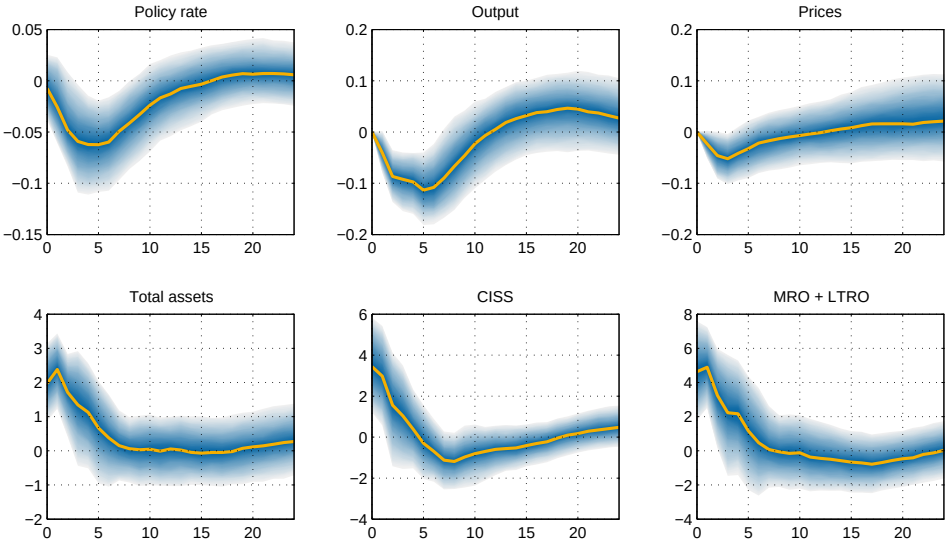

Figure 4: Euro area. Impulse response functions to a one standard deviation shock to financial stress.

nous financial stress shocks. In order to show the differences in the transmission, we identify a financial shock which endogenously induces banks to obtain liquidity also from MRO or LTRO operations. According to column 3 in Table 1, a financial shock is assumed to initially increase financial stress such that banks demand more liquidity from the ECB through MROs and LTROs.

The dynamic responses to this shock are shown in Figure 4. Increased stress in the economy raises uncertainty and thereby reduces aggregate demand by slightly more than 0.1 percent, which leads to a drop in consumer prices. Policy reactions to the shock are twofold. First, banks are assumed to demand more liquidity from the central bank. Note that even though we imposed the restrictions on impact only, the liquidity demand rises for at least three periods and financial stress shows some persistence as well. Second, the ECB tries to counteract the fall in demand and prices and possibly also the rise in financial stress by lowering interest rates. The combination of decreasing interest rates and providing liquidity through MROs and LTROs is quite effective in boosting aggregate demand and also in lowering stress. While after about five months stress is back to its pre-shock level, it takes output almost one year to recover. There is a negative short-run effect on prices, though at medium and long horizons the confidence bands include

zero.

Inspecting the results carefully, at least one question arises with respect to the effectiveness of policy interventions. If the central bank policy interest rate had been constrained by the zero lower bound, would the negative effects on stress, and aggregate demand have been stronger or longer lasting? We conducted another exercise, where we assume that, similar to the balance sheet policy shock, interest rates are tied to zero for at least three periods. The respective results are depicted in Figure A.2 in the appendix. Qualitatively, responses are similar but, except for financial stress, exacerbated. Interestingly, the response of stress is dampened if the policy rate is restricted. This behavior supports the hypothesis that a monetary policy that lowers interest rates in response to financial stress may promote unsustainable lending and thereby may have undesirable effects on financial stability. Monetary policy actions potentially have adverse effects on financial stress. When it comes to aggregate demand and especially price developments, the policy rate seems to be the most important driver. As the interest rate does not drop for the first three months, the recovery of aggregate demand is postponed and consequently consumer prices do not increase, neither in the short- nor in the long run. We conclude that the interest rate might be the right instrument to stabilize output and prices while it may be harmful with respect to financial stability.[15]

4.2 Germany

The responsibility for financial stability is not exclusively assigned to euro area institutions but lies also at the national level. Since one might argue that the euro area is not a group of homogeneous countries, it is insightful to investigate the effects of the asset purchase programs for specific cases. In fact, the German position has long been skeptical about the programs undertaken by the ECB and the ESCB. An evaluation of the recent measures is therefore particularly interesting for the German case.

[15] We compared our identified unconventional policy shock to a conventional expansionary interest rate shock. Results are consistent with the findings of Abbassi and Linzert (2012), who observe a loss in conventional policy effectiveness. In fact, the impact of conventional policies on financial stress remains uncertain in our sample. Results in terms of impulse response functions are available upon request.

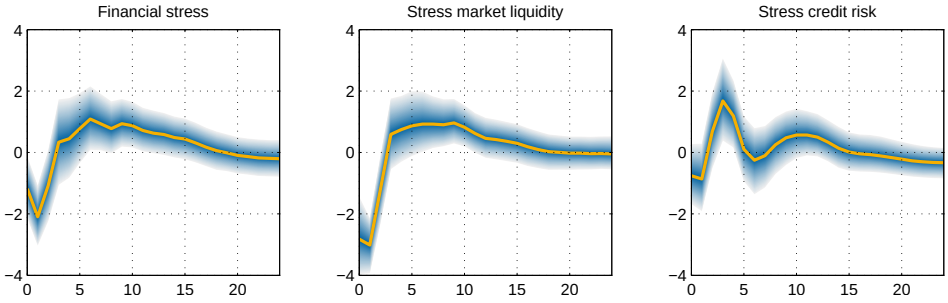

Figure 5: Germany. Impulse response functions of financial market variables to a balance sheet shock.

We conduct similar experiments as for the euro area case. First, we estimate impulse response functions for the baseline specification. Then we replace the financial stress index by other variables of interest. We consider the same time horizon, lag length, and identification scheme as for the euro area. Compared to the euro area exercise, responses show a very similar pattern and are therefore omitted and available upon request.

In order to get a more detailed picture on how the asset purchase programs affect the economy especially in the corporate and financial sectors, we consider alternative specifications to our baseline choice of variables (2). In particular, we successively replace the financial stress index s_t with a series from a set of variables that contain information on the policy transmission channel. Figures 5 and 6 contain the responses of those variables with respect to a monetary policy balance sheet shock.[16]

The German financial stress index consists of 7 sub-indices which might contain additional specific information on how the shock affects financial markets. Let us consider the "market liquidity stress index" and the "credit risk" indicator. While the indices are strongly correlated, the impulse response functions do exhibit some differences. Both indices drop on impact, but cross the zero line again within the first months after the shock, indicating a significant but short-lived effect of policy interventions. However, we find that the purchase programs reduce market liquidity stress more than credit risk.[17] Similar to the composite stress index, we

[16]Due to space constraints we omit plots with respect to the other 5 variables included in the VAR.

[17]Robustness checks with respect to the EONIA-MRO rate spread show that credit risk is

observe that after a few months, indicators may even become positive, pointing to undesirable second round effects of the shock. One reason for the unfavorable effects on credit risk might be that banks grant riskier loans in response to the shock, which has adverse effects on credit risk. Eser and Schwaab (2015) find a strong but temporary reduction of liquidity risk premia due to the SMP in Greece, Ireland, Portugal, Italy, and Spain, while bid-ask spreads widened again afterwards. A part of credit risk is also represented by implicit default rates of German non-financial firms. This indicator also drops sharply on impact and reverts back gradually. Lambert and Ueda (2014) find for US data that credit risk increases over the medium term in response to unconventional policy news. Our dynamic analysis allows us to consider effects that do not necessarily emerge on impact but may unfold in subsequent months.

Asset purchases may in principle generate unsustainable lending to non-financial firms. As a consequence, default rates of those firms could rise in response to the shock. We observe that non-financial firms are initially less likely to default. This may be explained by the positive effect on output and aggregate demand which improves firms' conditions. In the medium term, the median response becomes positive. While this effect may be attributed to unsustainable lending, the responses are hardly significant which makes it difficult to draw firm conclusions.

The VDAX-NEW index reflects risk aversion in the stock market. Results show that market participants immediately become more optimistic about future stock market developments. However, this short boost to optimism is overturned later which may be attributed to the above arguments of unsustainable lending.

We proxy credit risk by loan write-offs as a fraction of German banks new lending. Angbazo (1997) or Dick (2006) have considered measures based on loan write-offs to proxy credit default risk. One concern related to liquidity injections is that banks might roll over existing loans or extend new loans to nonviable firms which would be reflected in an increased number of net loan write-offs.[18] The median response shows that, at least in the short run, liquidity provisioning induces banks to reduce their loan write-offs. While this result is associated with

not effectively eliminated by the policy measures.

[18] Lambert and Ueda (2014) find US banks to avoid repairing their balance sheet and call this "evergreening".

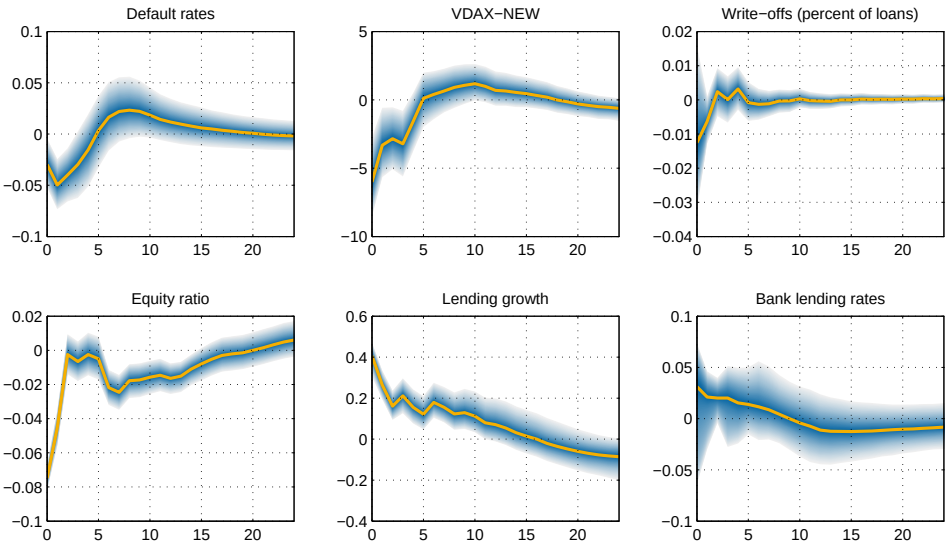

Figure 6: Germany. Impulse response functions of financial market variables to a balance sheet shock.

estimation uncertainty, it may point to the avoidance of balance sheet repair.

The ECB usually argues that its unconventional measures help to restore the monetary transmission channel. They involve supporting banks' credit provision to non-financial firms in order to finance new investment projects. The impulse response of bank lending indicates a significant and persistent expansion of credit. Indicators thus suggest that the ECB was successful in restoring bank lending to non-financial firms, painting a rather optimistic picture of sustained credit growth.

Considering the reactions of the equity ratio suggests that the banks do not use the liquidity provided by the central bank in order to recapitalize their balance sheets by obtaining more equity financing. The equity ratio falls initially since banks expand their balance sheets but do not adjust their equity enough to keep the ratio constant. In the medium run balance sheets still seem exhibit a lower equity ratio, while after about 15 months, it reverts back, which may reflect target equity ratios of banks to be reached again.

The portfolio balancing channel has often been mentioned in connection with central bank asset purchase programs.[19] Among other things, it predicts a decline in interest rates. If the central bank undertakes large-scale asset purchases, the

[19]See e.g. Draghi (2014).

prices of those assets should rise and interest rates on these assets should decline accordingly. Since interest rates on assets fell and investors are equipped with liquidity from the central bank, they have an incentive to rebalance their portfolios and to buy comparable but more profitable assets. The increased demand will in turn induce asset prices to increase and interest rates to fall. We introduce bank lending rates in the VAR in order to test the pass-through to lending rates to non-financial corporations. Results show that lending rates do not decrease on impact. It takes more than eight months for the median response to fall below its pre-shock level. Consequently, we observe only a lagged and insignificant portfolio balance effect on bank lending rates. Looking at this result more closely, we note that interest rate are tightly connected to the policy rate. Since we require the policy rate not to change for at least three months, lending rates, too, are unlikely to fall.[20]

We find that most variables' reactions are quite short-lived and show a clear reaction only for less than five months, while credit supply is positively affected by the shock for about ten months. The reaction of bank lending rates seems to be heavily influenced by the policy rate which prevents them from falling in response to an exogenous balance sheet expansion.

5 Conclusion

This paper estimates the effects of ECB's balance sheet policies, focussing on financial market variables. We disentangle unconventional monetary policy shocks and endogenous monetary policy reactions through changes in the balance sheet. We find that ECB balance sheet policies, in the form of direct asset purchases, bring down financial stress, stock market uncertainty and defaults in the euro area only initially. The positive effects are reversed within a horizon of around 2 years. At the same time, unconventional policy shocks improve corporate lending and have an expansionary (but mild) effect on economic activity, while the effect on prices

[20] We considered a robustness exercise, where we require the policy rate to stay unchanged only on impact instead of three months. As a consequence, the policy rate is lowered in response of the shock, which allows bank lending rates to decline. Considering instead the spread between bank lending rates and the policy rate yields much uncertainty around a zero response of the spread. The respective impulse response functions are not shown but are available upon request.

remains insignificant. Our approach differs from the existing literature in that we do not impose restrictions on financial stress in order to identify an expansionary balance sheet shock. Initially, a shock to financial stress has a contractionary effect on the economy, while subsequent liquidity provision and a reduced policy rate help to lower stress and to restore economic activity. In sum, liquidity provision through direct asset purchase programs seem to have the desired effect on financial stress and also on output within the first months. Given that the financial market effects of direct asset purchase programs are quickly overturned, output effects are small and temporary, and financial stress shocks have potentially large adverse effects, this may suggest that direct asset purchases are a less effective instrument than are endogenous balance sheet policy measures such as the fixed rate full allotment scheme.

Implications of the asset purchase programs for the German economy are generally favorable but short-lived. Financial stress declines mainly through a reduction in liquidity risk. Also stock market volatility and risk aversion decrease in response to the policy measure. The ECB is successful in restoring credit creation. Bank lending rates, however, do not decrease as suggested by the portfolio balancing channel. The risk of unsustainable lending seems to be rather small; neither default rates nor the loan write-offs ratio rise significantly, indicating that bank lending does not appear to become distinctly more risky. Consequently, our analysis shows that risks to financial stability are limited while the effects on output are relatively small and estimated with uncertainty. We do not find a considerable effect on prices.

The question remains to which extent unconventional measures influence single financial institutions and how effects feed back to the macroeconomy. It would be particularly interesting to consider data at an institutional level in order to overcome the small sample size problem. Considering more disaggregated data within more sophisticated models is left for future research.

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Appendix

A Data

Table A.1 gives a detailed overview of the data series used in our analysis. Some of the series were transformed before estimation. Data on real GDP is not available on a monthly frequency. For this reason we imputed the missing values using the Chow and Lin (1971) method as it is done in Boeckx et al. (2014) and Gambacorta et al. (2014). In general, we used seasonally and working day adjusted data where applicable. In the case of German loan write-offs, adjusted series were not available and we constructed seasonally adjusted data by applying the X-13ARIMA method. We found that seasonal adjustment does not significantly influence the results. The data on loan write-offs and the equity ratio are taken from the monthly balance sheet statements (Monatliche Bilanzstatistik) which consists of confidential data on German banks' balance sheets. The former are net write-offs, depreciation less revaluation of credit to the non-banks sector as an aggregate over the German banking sector, while the latter is aggregate equity divided by total assets of German banks. Bank lending comprises lending to non-monetary financial institutions (MFIs) excluding the government sector. The variable measures annual growth rates is adjusted for sales and securitization.

B Additional tables and figures

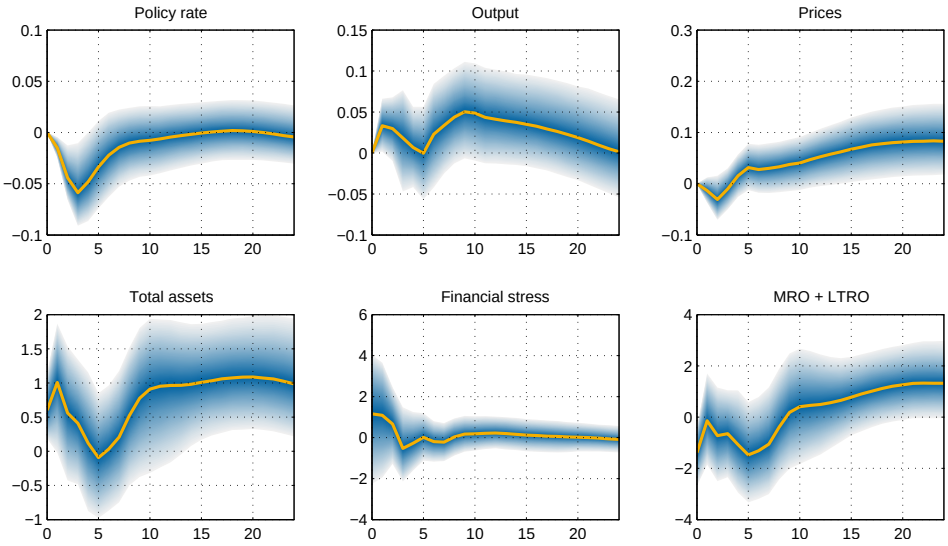

Figure A.1: Euro area. Impulse response functions to a one standard deviation balance sheet shock with alternative identifying assumptions.

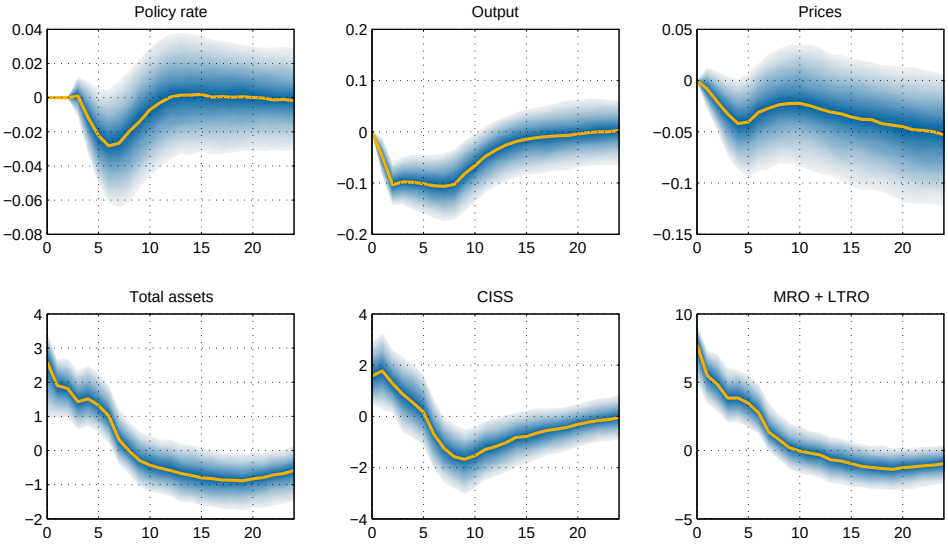

Figure A.2: Euro area. Impulse response functions to a one standard deviation shock to financial stress with additional constraint on the policy rate.

Series	Source	Identifier
Euro area		
ECB total assets	ECB SDW	ILM.W.U2.C.T000.Z5.Z01
Real GDP	Eurostat	namq_10_gdp
Industrial production	ECB SDW	STS.M.I8.Y.PROD.NS0010.4.000
HICP	ECB SDW	ICP.M.U2.S.000000.3.INX
CISS	ECB SDW	CISS.D.U2.Z0Z.4F.EC.SS_CI.IDX
MRO rate	ECB SDW	FM.B.U2.EUR.4F.KR.MRR_FR.LEV
EONIA rate	ECB SDW	FM.M.U2.EUR.4F.MM.EONIA.HSTA
MRO volumes	ECB SDW	ILM.W.U2.C.A051.U2.EUR
LTRO volumes	ECB SDW	ILM.W.U2.C.A052.U2.EUR
Base money	ECB SDW	ILM.M.U2.C.LT01.Z5.EUR
Germany		
CPI	Bundesbank	BBDP1.M.DE.Y.VPI.C.A00000.I10.A
Real GDP	Eurostat	namq_10_gdp
Industrial production	Bundesbank	BBDE1.M.DE.Y.BAA1.A2P300000.G.C.I10.A
Composite stress index	Bundesbank	Internal data
Market liquidity index	Bundesbank	Internal data
Credit risk index	Bundesbank	Internal data
Implicit default rates	Bundesbank	Internal data
VDAX-NEW	Datastream	VDAXNEW
Write-offs	Bundesbank	Internal data
Equity ratio	Bundesbank	Internal data
Lending	ECB SDW	BSI.M.DE.N.A.A26.A.I.U2.2200.Z01.A
Lending rates	ECB SDW	MIR.M.DE.B.A2I.AM.R.A.2240.EUR.N

Table A.1: Data and corresponding sources.

Assets	Liabilities
Gold and gold receivables	Banknotes in circulation
Claims on non-euro area residents in foreign currency	Liabilities to euro area credit institutions in euro
Claims on euro area residents in foreign currency	Current accounts
Claims on non-euro area residents in euro	Deposit facility
Lending to euro area credit institutions in euro	Fixed-term deposits
Main refinancing operations	Fine-tuning reserve operations
Longer-term refinancing operations	Deposits related to marginal calls
Fine-tuning reverse operations	Other liabilities to euro area credit institutions in euro
Structural reverse operations	Debt certificates issued
Marginal lending facility	Liabilities to other euro area residents in euro
Credits related to margin calls	Liabilities to non-euro area residents in euro
Other claims on euro area credit institutions in euro	Liabilities to euro area residents in foreign currency
Securities of euro area residents in euro	Liabilities to non-euro area residents in foreign currency
Securities held for monetary policy purposes	Counterpart of special drawing rights allocated by the IMF
Other securities	Other liabilities
General government debt in euro	Revaluation accounts
Other assets	Capital and reserves
Total assets	Total liabilities

Table B.1: Stylized ECB balance sheet. Source: ECB Statistics Bulletin.