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Research Papers in Economics
No. 3/18

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First Draft: June 11, 2018
This Version: June 6, 2019

Abstract

In this paper, we provide evidence for a risk-taking channel of monetary policy transmission in the euro area that works through an increase in shadow banks' total asset growth and their risk assets ratio. Our dataset covers the period 2000Q1–2018Q3 and includes, in addition to the standard variables for real GDP growth, inflation, and the monetary policy stance, the aforementioned two indicators for the shadow banking sector. Based on vector autoregressive models for the euro area as a whole, we find that a portfolio reallocation effect towards riskier assets is more pronounced for conventional monetary policy shocks. For unconventional monetary policy shocks we partly detect stronger evidence for a general expansion of financial assets. Country-specific as well as sector-specific estimations confirm these findings for most of the euro area countries and all shadow bank types, but also reveal some heterogeneity in the shadow banks' reaction.

JEL Codes: E44; E52; E58; G11; G23; G28.

Keywords: European Central Bank; Macroprudential Policy; Monetary Policy Transmission; Risk-Taking Channel; Shadow Banks; Vector Autoregression.

*We offer our gratitude to Yesmine Arousse, Christian Hott, Tobias Kranz, Ulrike Neyer, and participants of the Workshop on Monetary and Financial Macroeconomics in Hamburg as well as seminar participants at Heinrich-Heine-University Düsseldorf, University of Hagen, Bundeswehr University Munich, and Julius-Maximilians-University Würzburg for their helpful comments on earlier versions of the paper.

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1 Introduction

Some prominent economists have argued over the role played by monetary policy in the Global Financial Crisis (GFC). Taylor (2007) argues that the period of low policy rates in the United States triggered the Great Recession through the creation of a house price bubble. Three years later, Bernanke (2010) questioned the claim that policy rates were too low during the early-2000s. According to Bernanke, who was the Federal Reserve Chairman at that time, the easing of lending standards and innovations in financial engineering are to be blamed.

This ongoing debate sparked an interest in investigating the effects of (expansionary) monetary policy, and uncovering the missing links in the transmission of monetary policy that occur via financial intermediaries (e.g., Borio and Zhu 2012). Over the recent years, it has become clear that the underlying risk-taking in the financial sector, stemming from macro-financial linkages, is one of the key factors that fueled the GFC and the subsequent recession. Loose monetary policy may not only result in an increase of lending and investments, as in line with traditional transmission mechanisms, but could also result in lending and investments becoming more risky. Indeed, the prolonged period of low interest rates is now considered a key source of risk to financial stability due to excessive risk-taking activities in such an environment (Deutsche Bundesbank 2017).

Recent empirical literature has documented a risk-taking channel of monetary policy in the "conventional" banking sector. Lower interest rates are found to result in reduced lending standards, higher leverage, and increased asset risks in the United States (e.g., Maddaloni and Peydro 2011; Angeloni and Faia 2013; Angeloni et al 2015; Dell'Ariccia et al 2017) and the euro area (e.g., Maddaloni and Peydro 2011; Altunbas et al 2014; Jimenez et al 2014; Neuenkirch and Nöckel 2018). However, financial stability cannot be monitored by solely looking at the conventional banking sector anymore, as other parts of the financial system may also have a substantial influence (Rajan 2006). It is, for instance, common knowledge that the bankruptcy of Lehman Brothers deepened the GFC. However, less known is the fact that Lehman Brothers was

a so-called "shadow bank," that is, a bank-like institution that does not take deposits and formally is not a bank. These types of financial institutions do not have access to central bank liquidity or deposit guarantees and are not constrained by the regulations imposed on traditional banks; hence, they remain "in the shadows" (Pozsar et al 2013).

The fact that the non-bank financial sector has been substantially less explored and is barely regulated in comparison to its traditional counterpart, is in sharp contrast to its significance. Financial assets held or managed by the non-bank financial sector in the euro area have doubled over the previous decade (Doyle et al 2016). According to Eurostat, the amount of total financial assets of non-banks reached 43.25 trillion euros (76% of which are attributed to shadow banks) in the third quarter of 2018, which is more than half the size (54%; see also Figure 1 in Section 2.2) of all financial assets of euro area financial corporations. Research by the European Central Bank (ECB) (2016) indicates that the increasing role of shadow banks and the structural shift from monetary financial institutions (MFIs) to non-MFIs may accelerate the transmission of monetary policy shocks, particularly through the risk-taking channel. Hence, it is important to capture the dynamics of risky behavior of both financial sectors, banking and non-banking, to ensure financial stability.

The intention of this paper is to shed more light on the risk-taking channel of monetary policy in the euro area with a specific focus on the role of shadow banks, given their growing importance and the rather scant previous research, in particular for the euro area (see also the literature review in Section 2.3). Consequently, this paper's contribution is to complement previous studies about the conventional banking sector. For that purpose, we augment a standard vector autoregressive (VAR) monetary policy transmission model for the euro area using data for the period 2000Q1–2018Q3, with two indicators for the shadow banking sector: (i) total financial asset growth and (ii) the risk assets ratio. In addition to providing VAR evidence for the euro area as a whole, we also test for differences in the shadow banks' reaction across twelve euro area countries and four groups of non-banks. Finally, we are able to establish the effects of conventional monetary policy shocks with the help of the (i) main refinancing

rate (MRR) and a mixture of conventional and unconventional monetary policy shocks with the help of the (ii) shadow rate (SR; Wu and Xia 2016).

Our paper, indeed, provides evidence for a risk-taking channel of monetary policy transmission in the euro area that works through an increase in the shadow banks' total asset growth and their risk assets ratio. We find that a portfolio reallocation effect towards riskier assets is more pronounced for conventional monetary policy shocks. For unconventional monetary policy shocks we detect stronger evidence for a general expansion of financial assets. Country-specific as well as sector-specific estimations confirm these findings for most of the euro area countries and all shadow bank types, but also reveal some heterogeneity in the shadow banks' reaction.

The remainder of this paper is organized as follows. Section 2 provides some background information on shadow banks and the risk-taking channel of monetary policy transmission. Section 3 introduces the dataset and the econometric methodology. Section 4 presents the results for the euro area as a whole and twelve of its member states as well as for four groups of non-banks. Section 5 concludes.

2 Conceptual Background

2.1 Risk-Taking Channel

In addition to the traditional monetary policy transmission channels, the recent literature has identified a risk-taking channel. Changes in interest rates affect not only the quantity of credit (via the credit channel), but also the quality of credit and investment (Dell'Ariccia et al 2017). The "risk-taking channel" concept dates back to Borio and Zhu (2012) and reflects agents' willingness to expose themselves to risk when interest rates are low or declining, while not being compensated by a raise in the risk premium. Borio and Zhu (2012) identify the following primary mechanisms of the channel: (i) the "search for yield" effect, (ii) the "valuations, incomes, and cash flows" effect, and (iii) the "central bank communication" effect.

The search for yield effect (Rajan 2006) is defined as the pursuit of higher returns, typically in the context of a low interest rate environment and a large gap between market and target returns. Financial intermediaries with fixed long-term liabilities and a shorter duration of assets, such as insurance companies and pension funds, are tempted to reach for yield as they face an unfavorable maturity mismatch leading to compressed or negative margins (Chodorow-Reich 2014; Becker and Ivashina 2015). Portfolios are likely to change in favor of risky assets, that is, shifting from fixed income into riskier equities (Hau and Lai 2016). Particularly under unconventional monetary policy measures at the zero lower-bound rate, that is, when the yield curve gets flatter, the interest margins of banks get squeezed, which mitigates profits (Meaning and Zhu 2011; Claessens et al 2017). Similarly, low interest rates might affect financial intermediaries' incentives because they are bound to rigid nominal yield targets by their stockholders (Altunbas et al 2014). Hence, they are encouraged to reach for yield in order to distinguish themselves and improve their relative performance. Indeed, the development of securitization, which could increase the risk exposure of financial intermediaries, is partly driven by the managerial pursuit of reaching better performance indicators (Rajan 2006).

The second set of effects is based on the link between changes in interest rates and the pricing of risk through the adjustment of valuations, incomes, and cash flows. The ability of financial intermediaries to take on more risk increases because low policy rates raise their asset and collateral value, as well as their liquidity. This enhances their risk-bearing capacity and results in taking more leverage (Adrian and Shin 2011). A balance sheet expansion, either through additional lending or asset purchases, lifts asset prices up and reduces the price of risk. The proliferating use of Value-at-Risk models with the main input of valuations, incomes, and cash flows intensifies monetary policy transmission via this channel (IMF 2016). As an upshot of underestimated expected risks, rising market valuations encourage financial companies to take positions and utilize their risk budgets.

Finally, the way a central bank communicates its policy can influence agents' risk aversion. Central bank policy messages conveyed in a predictable and transparent way reduce market uncertainty and allows the asset management sector to take on more risk (Gambacorta 2009). In the event of an adverse economic shock, economic agents expect the central bank to ease monetary policy. This so-called "insurance effect" creates a typical moral hazard problem (Altunbas et al 2014).

2.2 Shadow Banking

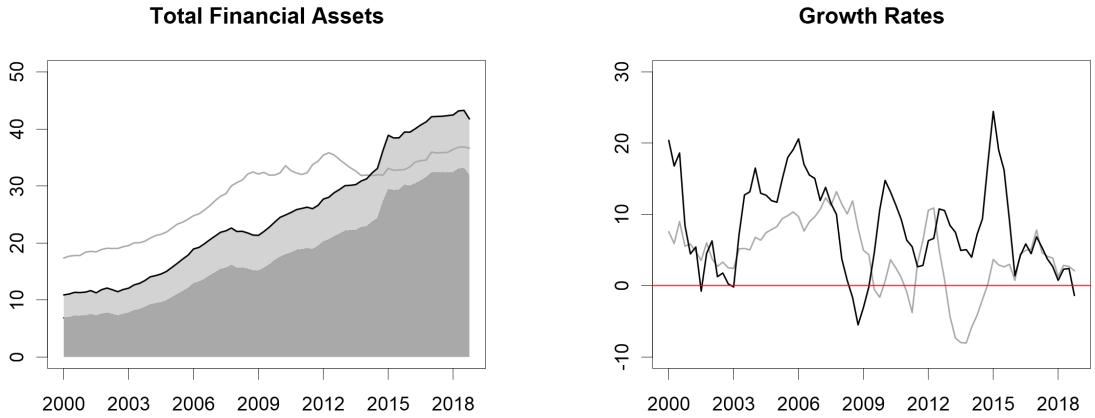
Conventional banks play an important role in the transmission of monetary policy to the real economy (e.g., via the credit channel). However, the core bank business of accepting loans funded by deposits has been deteriorating (Mishkin 2016). In recent years, a part of the business has been largely substituted by the shadow banking system with wholesale funding and securitization as fundamental building blocks.

Securitization is pooling together small and otherwise illiquid financial assets into marketable securities. On the one hand, it provides several advantages, such as the provision of liquidity, risk sharing (Rajan 2006), triggering economic growth in advanced economies, and decreasing the indebtedness of emerging markets (Bauer et al 2008). On the other hand, securitization also has its drawbacks as opaque, risky, long-term assets are transformed into short-term liabilities by the shadow banking intermediation chain veiling the volume of risk-taking in the system and facilitating the buildup of tail risk (Adrian and Ashcraft 2012; Claessens et al 2012). Hence, it creates moral hazard through lenders' risk being passed on to investors and insurance firms and promotes excessive risk-taking. Moreover, hidden leverage, off-balance sheet activities, as well as massive and hard-to-measure involvement of derivatives (e.g., credit default swaps) make the monitoring of creditworthiness more difficult (Simkovic 2009). All of these characteristics of securitization put structured securities at the center of the recent financial crisis (Adrian and Ashcraft 2012).

The term "shadow banking" was originally coined by McCulley (2007) who defined it as "the whole alphabet soup of levered up non-bank investment conduits, vehicles,

and structures." In this paper, we define non-banks based on the European Commission's (2013) categorization of non-MFIs, which include non-money market investment funds (non-MMIFs), insurance companies and pension funds (ICPF), and other financial corporations (OFCs).[1] This definition provides a conceptualization of the entire non-bank financial intermediary sector and is in line with the available data used for the empirical estimations in this paper. Since the shadow banking system is supposed to be a source of credit in the economy we define shadow banks as the core non-bank participants, which includes OFCs and non-MMIFs. Hence, ICPFs are excluded from that definition. However, as part of our analysis we will also consider all four non-bank participants (OFCs, non-MMIFs, insurance companies; ICs, and pension funds; PFs) separately (see Section 4.2).

Figure 1: Dynamics of Total Financial Assets in the Euro Area: MFIs vs. Non-MFIs



Notes: Gray lines show level (left panel; in trillions of euros) and growth rates to the previous year's quarter (right panel; in percent) of total assets of MFIs in the euro area (EA-19). Black lines show the corresponding values for non-MFIs. Dark-gray area in the left panel indicates the values for shadow banks as a part of non-MFIs. *Source*: Eurostat.

Figure 1 shows the total financial assets of MFIs, non-MFIs, and shadow banks (left panel) and the corresponding growth rates of MFIs and non-MFIs to the previous year's quarter (right panel) over time. In 2000, the total non-MFI sector was roughly two-thirds of the size of the conventional banking sector. However, due to almost twice as large average growth rates (8.3% for non-MFIs; 4.4% for MFIs), the non-MFI sector

[1] OFCs include other financial intermediaries (OFIs) except ICPFs, financial auxiliaries, captive financial institutions, and money lenders.

has become relatively more important over time. 2014Q2 marks the first time when total assets in the non-MFI sector exceeded those of the conventional banking sector. At the end of our sample period in 2018Q3, the volume of financial assets of non-MFIs (43.25 tn euros) is 17.5% larger than for MFIs (36.80 tn euros). Over time, the shadow banking sector (33.07 tn euros) as main part of the non-MFIs became almost as large as the conventional banking sector.

These figures, alongside the potential risks associated with the shadow banks' business, illustrate why it is important also to consider the non-bank financial sector when analyzing the risk-taking channel of monetary policy transmission.

2.3 Shadow Banks and the Risk-Taking Channel: Empirical Evidence

One the one hand, shadow banking is affected by the prevailing interest rate. On the other hand, shadow banks influence the transmission of monetary policy to the real economy (Claessens et al 2012). In particular, the IMF (2016) argues that non-banks may amplify policy transmission via the risk-taking channel, given that their appetite for risk is more susceptible to fluctuations in monetary policy. The empirical literature, however, is inconclusive. Some papers find that the risk-taking effect strengthens with the fraction of securitization activities (Delis and Kouretas 2011; Maddaloni and Peydro 2011; Aramonte et al 2015). Other parts of the literature, however, do not consider securitization as a factor that drives risk-taking in the financial intermediation industry (Jimenez et al 2014), or even find that securitization positively correlates with safer lending (Dell'Ariccia et al 2017) and higher external risk ratings (Altunbas et al 2014). In addition, shadow banks' balance sheets are found to react to laxer monetary policy rates through expansion (Adrian and Shin 2011; IMF 2016), but the opposite finding is documented as well (Nelson et al 2018). Risk appetite is found to increase in an environment of loose monetary policy (Adrian and Shin 2011; Becker and Ivashina 2015; Hau and Lai 2016; IMF 2016). After a decrease in the interest rate, portfolios shift in favor of riskier asset classes, high-yield assets, and assets located in countries with speculative-grade sovereign credit ratings.

To summarize, the extant literature provides some evidence for a risk-taking channel of shadow banks. However, most of the papers focus on the United States, adopt a shadow bank-level perspective, and establish a contemporaneous relationship between monetary policy and shadow banks' risk-taking behavior with the help of panel techniques. In contrast, our paper focuses particularly on the euro area and its member countries, and takes a macroeconomic perspective as we are especially interested in the dynamic impact of monetary policy shocks on shadow banks' risk-taking, which is obtained with the help of VAR models.

3 Data and Econometric Methodology

3.1 Data

Our data set covers quarterly data for the euro area (EA-19) for the period 2000Q1–2018Q3, and consists of five variables. First, we utilize the growth rate of real GDP as the measure of real economic activity. Second, we use the inflation rate based on the harmonized index of consumer prices, excluding energy and food. Using a core inflation measure precludes exogenous price movements stemming from these two sources, allowing us to establish a parsimonious model without an exogenous oil price indicator. Third, we make use of two different monetary policy indicators: (i) the MRR and (ii) the SR. The MRR is utilized to test for the influence of conventional monetary policy, whereas the SR allows for an assessment of conventional and unconventional monetary policy. Indeed, with short-term interest rates stuck at the zero lower bound, the SR should be helpful as it quantifies all unconventional monetary policy measures in a single interest rate and can take negative values.[2]

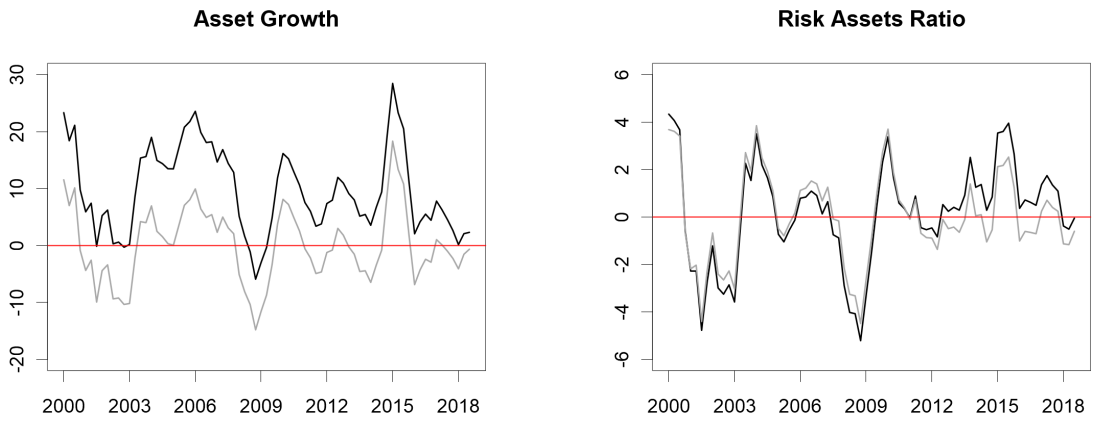
In addition to these three standard variables, our fourth and fifth variables are two indicators for the shadow banking sector. The European Commission recommends

[2]SR data starts in 2004Q3 and the MRR is utilized to replace the missing values at the beginning of the sample period. It has been debated whether the frequently used SR is a decent measure of the monetary policy stance (see, e.g., Krippner 2014). To explore the robustness of our results, we also employ the effective monetary stimulus (EMS; Halberstadt and Krippner 2016), which is derived from yield curve data, instead of the SR as indicator for conventional and unconventional monetary policy.

making inference about the risk appetite of non-bank financial institutions in the euro area by looking at (i) the growth rates (change over the previous year's quarter) of their balance sheets and (ii) their risky asset holdings (absolute change over the previous year's quarter) (see also, Delis and Kouretas 2011). Risky asset holdings are defined as equity securities (listed and unlisted shares) on the asset side of the balance sheet over total financial assets. The idea behind the choice of the latter variable is equity being, on average, the riskiest asset class one can invest in (Elton et al 2009), which makes it a useful approximation of asset risk in the absence of more granular data. Both variables are also utilized in the papers of Adrian and Shin (2011) and Nelson et al (2018). In the case of both variables, an acceleration of the growth rates (absolute changes) would be indicative of a risk-taking channel for shadow banks pursuing quantity over quality. In particular, additional risk can originate from shifting investments into asset classes yielding higher returns as, for instance, equities in place of investment grade debt (Chodorow-Reich 2014; Hau and Lai 2016).

Figure 2 plots the two shadow banking sector variables over time. The black lines show the actual series, the gray lines show the cyclical component obtained with the help of a Hodrick and Prescott (HP) (1997) filter ($\lambda = 1,600$). The corresponding plots for the standard monetary policy transmission variables can be found in Figure A1 in the Appendix.

Figure 2: Asset Growth and Risk Assets Ratio in the Euro Area

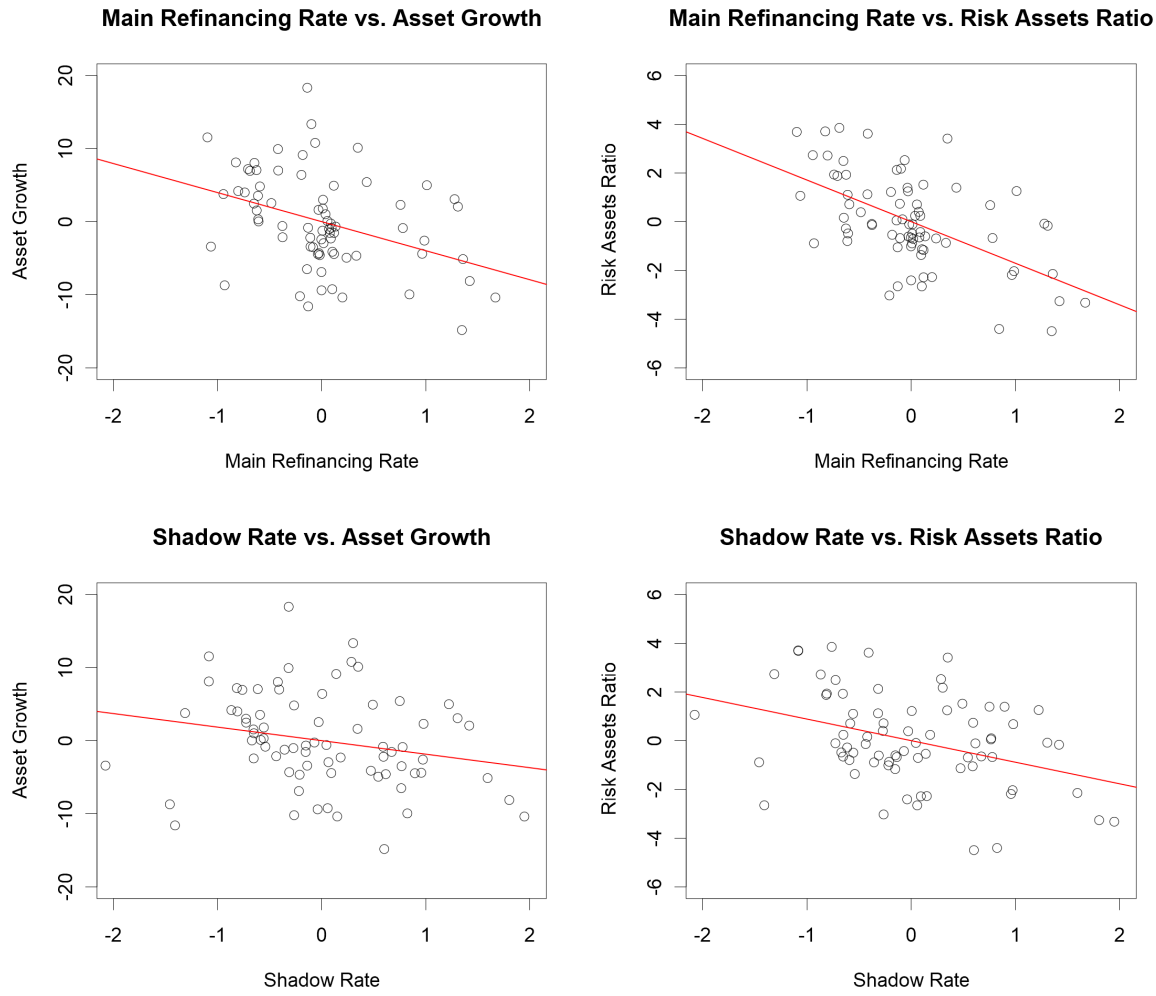


Notes: Black lines show the actual series and gray lines the HP-filtered ($\lambda = 1,600$) series. *Source*: Eurostat.

After a rapid increase in 2003–2005, total asset growth and the change in the risk assets ratio tend to decrease until the Lehman failure (2008Q3), a date that roughly coincides with the peak of the MRR. After a resurgence in 2009–2010, the asset growth rate and the change in the risk assets ratio remain more or less stable with the exception of a strong peak in both variables in 2015.

The top panel of Figure 3 shows scatter plots comparing both shadow banking sector variables and the indicator for conventional monetary policy (the MRR). The bottom panel repeat this exercise with the combined indicators for conventional and unconventional monetary policy (the SR).

Figure 3: Scatter Plots for Shadow Banking Sector Variables and Interest Rates



Notes: Top panel shows scatter plots comparing the MRR and (i) asset growth ($\rho = -0.38$) and (ii) the change in the risk assets ratio ($\rho = -0.56$). Bottom panel shows scatter plots comparing the SR and (i) asset growth ($\rho = -0.23$) and (ii) the change in the risk assets ratio ($\rho = -0.37$). All series are HP-filtered with $\lambda = 1,600$.

In line with previous research, we find a negative relationship between asset growth and both interest rate indicators. Specifically, lower interest rate levels are associated with higher asset growth rates. The correlation is less pronounced when employing the SR ($\rho = -0.23$) as compared to the MRR ($\rho = -0.38$). The relationship between the change in the risk assets ratio and the monetary policy stance is also negative, that is, lower interest rate levels are associated with a change towards riskier assets in the balance sheet. The negative relationship is more pronounced for conventional monetary policy (MRR: $\rho = -0.56$) as compared to the case when unconventional monetary policy is considered as well (SR: $\rho = -0.37$).

In the end, however, it remains to be seen if these bivariate contemporaneous relationships hold in a multivariate VAR model that also incorporates dynamics in the connections across variables.

3.2 Econometric Methodology

Our empirical strategy builds on a linear VAR model. In general, a VAR(p) model with n endogenous variables can be written in reduced form as follows:

$$X_t = \delta + \sum_{i=1}^{p} \mathbf{A}_i X_{t-i} + U_t \tag{1}$$

X_t is the 5×1 vector of endogenous variables including real GDP growth, core inflation, the monetary policy indicator (MRR or SR), asset growth, and the change in the risk assets ratio. All series are HP-filtered to remove deterministic trends.[3] In addition, according to an augmented Dickey-Fuller (1979) test, the null hypothesis of non-stationarity can be rejected for all HP-filtered variables at the 1% significance level. δ is the 5×1 vector of intercepts, U_t is the 5×1 vector of non-structural error terms, and the $\mathbf{A}_i$'s are 5×5 parameter matrices.

The Bayesian information criterion favors a lag length of $p = 1$ for our five-variable VAR models. However, for both monetary policy indicators, the residuals of at least

[3] To explore the robustness of our results, we also employ the unfiltered series in the estimation of Eq. (1).

one equation in a VAR up to order $p = 3$ exhibit significant autocorrelation at the 5% level. Hence, VAR(1)–VAR(3) models are not able to sufficiently capture the dynamics in the system. In contrast, the use of four lags, which is also recommended by the Akaike information criterion, eliminates serial correlation in the error terms of all equations at the 10% level and yields stable impulse responses.

To identify the effects of monetary policy shocks on the other variables in the system, we have to transform the reduced form VAR into a structural VAR and impose a recursive identification scheme. We order the three key monetary policy transmission variables in their standard way. Real GDP growth is ordered first, core inflation is ordered second, and the interest rate indicator is ordered third. This reflects the outside lag of the impact of monetary policy on prices and output (i.e., it takes some time before changes in the interest rate affect consumption and investment plans, which are typically made in advance) and the possibility that the central bank might react instantaneously to macroeconomic shocks, thus, precluding any inside lags in monetary policy. Since financial institutions can react immediately to changes in the monetary policy stance, we order both shadow banking sector variables last (see also, Angeloni et al 2011; Bekaert et al 2013; Bruno and Shin 2015; Nelson et al 2018). Total financial asset growth is ordered fourth and the change in the risk assets ratio is ordered last, reflecting that the latter variable, by definition, immediately adjusts to changes in total financial assets.

The fact that we do not allow for the possibility that the ECB reacts instantaneously to changes in the financial sector when making its decisions as, for instance, witnessed during the GFC (see also, IMF 2016), is explained by the nature of the time series employed in the analysis. We use quarterly averages of monthly interest rates to match the monetary policy indicators with the flow variable real GDP growth, which is only available at quarterly frequency. Both variables for the shadow banking sector are only available as end-of-quarter stock values, which makes an instantaneous reaction of monetary policy to these variables impossible.

We also employed a Bayesian estimation method with sign restrictions, the penalty function approach of Uhlig (2005), and assumed that an expansionary monetary policy shock leads to: (i) a decrease in the MRR or SR, (ii) an increase in core inflation, and (iii) an increase in real GDP growth on impact and for four quarters thereafter, so that the method remains agnostic with respect to the key responses of interest. The impulse responses (available on request) are weakly significant (exception: asset growth in the SR specification) and qualitatively in line with those presented in Section 4 but only when considering 68% credible sets. One reason for this weaker inference is stated by Uhlig (2005) himself. He points out that the major advantage of sign restrictions, that is, allowing for a contemporaneous reaction of all variables in the VAR to an expansionary monetary policy shock, comes at the cost of being more restrictive than in a recursive scheme. Hence, the identification is much less sharp as compared to the recursive scheme.

4 Results

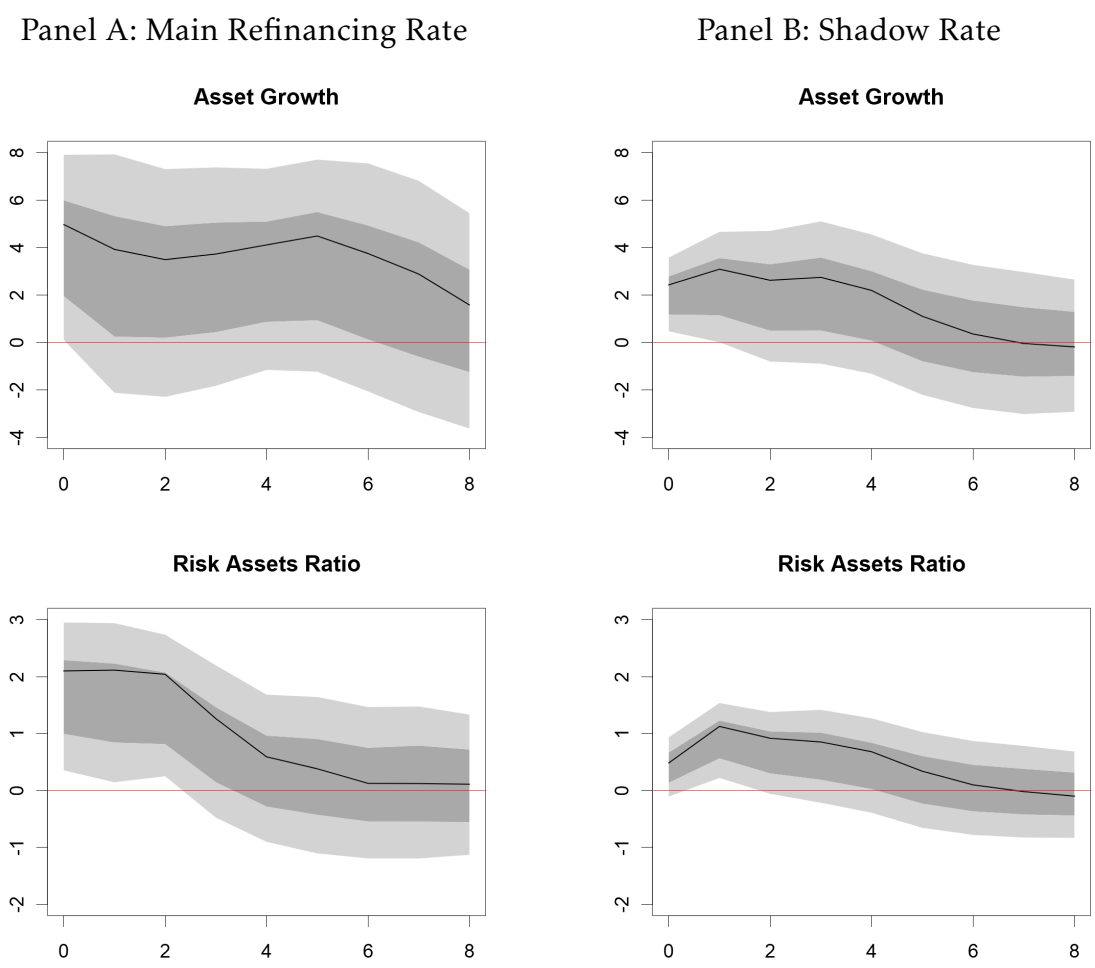
4.1 Euro Area

Figure 4 shows impulse response functions (IRFs) based on recursive identification for a 100 basis points (bps) expansionary shock in the MRR and the SR, respectively. The IRFs based on either monetary policy indicator are qualitatively very similar. We find significant increases in asset growth and the risk assets ratio after an expansionary monetary policy shock. The peak effects are found zero to two quarters after the shock and the effects die out within two years after the shock.

Nevertheless, there are some differences in terms of significance across monetary policy indicators. The reaction of asset growth is significant when considering the 95% confidence bands in the case of the SR. In the case of the MRR, we only find a significant reaction for the less conservative 68% confidence bands. Furthermore, we observe a smaller peak reaction of the risk assets ratio to shocks in the SR (1.12 pp) as

compared to shocks in the MRR (2.11 pp). The pattern of the reaction of asset growth is similar with peak responses of 4.97 pp (MRR) and 3.09 pp (SR).

Figure 4: Euro Area-Wide Impulse Responses



Notes: Solid lines represent mean impulse responses (in percentage points) to an expansionary monetary policy shock of 100 basis points. Dark gray shaded (light gray shaded) areas indicate 68% (95%) confidence bands derived by bootstrapping and 5,000 replications.

To evaluate the robustness of our findings we, first derive IRFs based on the non-HP-filtered dataset. Figure A2 in the Appendix shows the results. The positive responses of both shadow banking sector variables are qualitatively and quantitatively in line with those presented in Figure 4 with the only difference being the lower level of significance in the non-filtered series as compared to the filtered ones. Second, Figure A3 shows results where we employ the EMS as indicator for conventional and unconventional monetary policy (instead of the SR). Here, we find the strongest peak reaction of asset growth (among all monetary policy indicators) after a 100 bps shock

(8.20 pp). The maximum response for the risk assets ratio (1.73 pp) is only significant when considering the 68% confidence bands and lies between those of the MRR and SR specifications. Hence, our results do not depend on the choice of the indicator for unconventional monetary policy.

To summarize, we find evidence for both a general expansion of assets (see also, Adrian and Shin 2011; Cecchetti et al 2017) and a portfolio reallocation effect (see also, Delis and Kouretas 2011; Beck et al 2016; Hau and Lai 2016; IMF 2016) taking place after an expansionary monetary policy shock. When considering conventional monetary policy (i.e., shocks to the MRR), the portfolio reallocation effect is more pronounced, whereas for unconventional monetary policy (i.e., shocks to the SR or the EMS), we find stronger evidence for a general expansion of assets. Hence, the evidence for a risk-taking channel of shadow banks is more direct during "normal times" as compared to "crisis times." This also corroborates the ideas: (i) "excessive" risk-taking is one of factors that lead to the outbreak of the GFC, and (ii) unconventional monetary policy fuels additional growth of the financial sector as a "side effect."

To put these figures into perspective, one should consider the standard deviation of asset growth (6.45 pp) and the risk assets ratio (1.87 pp) in our sample. Hence, shadow banks increase the growth rate of their total financial assets by around 0.5–1.3 standard deviations after a 100 bps expansionary monetary policy shock. The increase in the risk assets ratio corresponds to 0.6–1.1 standard deviations. Consequently, the increase in risk-taking of shadow banks is somewhat smaller when compared to conventional banks, where Neuenkirch and Nöckel (2018) find a decrease in lending standards by 1.5 standard deviations after a 100 bps expansionary shock in the MRR.

4.2 Non-Bank Groups

To account for potential heterogeneity within the euro area non-banking sector we consider each of its four groups separately: (i) OFCs, (ii) Non-MMIFs, (iii) ICs, and (iv) PFs, where the sum of (i) and (ii) is utilized as the shadow banking sector aggregate in all analyses except for this one. Hence, we replace the two variables for

the shadow banking sector as a whole in the VAR model with their non-bank sector-specific counterparts, while leaving the standard monetary policy transmission variables unchanged. Table 1 summarizes the sector-specific impulse responses for for a 100 basis points (bps) expansionary shock in the MRR and the SR, respectively.

Table 1: Summary of Impulse Responses for Non-Bank Groups

Panel A: Asset Growth

	Main Refinancing Rate				Shadow Rate			
	Peak		Diff	Rk	Peak		Diff	Rk
OFCs	4.53	7q	−	3	2.53	0q	+	3
Non-MMIFs	8.60	7q	+	1	4.85	4q	+	1
ICs	4.25	2q	−	4	1.73	2q	−	4
PFs	5.93	1q	+	2	3.76	2q	+	2
SB (EA-19)	4.97	0q			3.09	1q		

Panel B: Risk Assets Ratio

	Main Refinancing Rate				Shadow Rate			
	Peak		Diff	Rk	Peak		Diff	Rk
OFCs	1.35	0q	−	4	1.29	1q	+	3
Non-MMIFs	4.18	2q	+	1	1.89	4q	+	1
ICs	1.37	2q	−	3	0.55	4q	−	4
PFs	2.32	7q	+	2	1.55	7q	+	2
SB (EA-19)	2.11	1q			1.12	1q		

Notes: Table 1 summarizes the impulse responses of asset growth and the risk assets ratio in the sector-specific models. Column "Peak" shows the maximum reaction alongside the number of quarters after which it is found. All responses are measured in pp. +/− indicates whether the peak response is significantly larger/smaller than the euro area-wide peak response, SB (EA-19), when considering 68% confidence bands. Column "Rank" orders the peak responses from the strongest to the weakest.

The group-specific results are in line with the outcomes of the baseline specification as we find evidence for a general expansion of assets and a portfolio reallocation effect taking place after an expansionary monetary policy shock in all groups. The IRFs of ICs are the least pronounced. This can be explained by the individual countries' rules as well as the strict EU directives for ICs and PFs that usually involve either a qualitative restriction or a quantitative investment limit, that is, a ceiling on invest-

ments in equities and other risky assets (OECD 2015).[4] However, ICs and PFs have dissimilarities in their nature of functioning that explain the differences in the results. It is well-known that institutional investors vary in their risk tolerance, income and liquidity needs, as well as investment time horizons (Byrne and Conroy 2017). The risk tolerance and income needs of ICs are typically quite low due to their high liquidity needs. PFs, in turn, have a long-term time horizon to manage their assets and, therefore, quite high risk tolerance and income needs with rather low liquidity needs. Hence, PFs are the second-riskiest non-bank institutions among the four groups, despite being highly regulated.

Non-MMIFs appear to be the most "risk-loving" type of non-banks with the highest financial asset growth in the euro area and peak effects up to two times the maximum values of the euro area-wide shadow banking aggregate. According to the European Fund and Asset Management Association (in 2018Q4), the biggest share of funds mainly specializes on stock markets, which makes non-MMIFs particularly sensitive to the portfolio rebalancing effect (EFAMA, 2019). As mentioned before, shadow banking incorporates activities that are unrecognized on the balance sheet, which is mostly the case for institutions engaged in securitization and wholesale funding, like OFCs. Therefore, it is difficult to directly assess the cycles of risk-aversion of this shadow bank group since our dataset allows us to measure only the asset risk that is not "hidden."

4.3 Individual Countries

Inspired by previous work on asymmetries in monetary policy transmission across euro area countries (see, e.g., Ciccarelli et al 2013; Neuenkirch and Nöckel 2018), we also analyze differences in the reaction of twelve euro area countries (Austria, Belgium, Germany, Greece, Finland, France, Ireland, Italy, Luxembourg, the Netherlands, Portugal, and Spain). For that purpose, we replace the two euro area-wide shadow banking sector variables in the VAR model with their country-specific counterparts, while leaving the standard monetary policy transmission variables at the euro area level to

[4] See also https://ec.europa.eu/info/business-economy-euro/banking-and-finance/insurance-and-pensions_en.

capture the ECB's decision-making process.[5] Table 2 summarizes the country-specific impulse responses, which are also visualized in Figure A4 in the Appendix.

The upper panel of Table 2 reveals that shadow banks in the twelve euro area countries under consideration increased their asset growth rate after both types of monetary policy shocks as indicated by the columns "Peak" and "SPV." In the case of both conventional and unconventional monetary policy, the strongest peak reactions can be found in Finland and Greece, followed by Austria and Luxembourg. In fact, the maximum response in Ireland (only in case of MRR) and the Netherlands is a decrease of financial assets. After seven and eight quarters, however, the corresponding IRFs also take significant positive values (column "SPV"), which indicates that shadow banks in these countries undergo a sharp decrease at the beginning and a recovery of almost the same size after roughly two years. When employing the SR, the Netherlands, Belgium, and Portugal show the smallest peak effects to monetary policy shocks. Here, the small reaction of Portuguese shadow banks might be reflective of the deep economic and financial crisis in this county since the onset of the GFC, where the unconventional measures might simply have been necessary to ensure the functioning of financial markets in the first place (see, Hubig 2013).

Turning to the response of the risk assets ratio in the lower panel of Table 2, we again find evidence that shadow banks in the twelve euro area countries under consideration increased their risk assets ratio after both types of monetary policy shocks as indicated by the columns "Peak" and "SPV" with Austria in the case of the SR being the only exception. We find the strongest reaction to conventional monetary policy shocks for Ireland, Greece, France, Germany, and Finland. When considering both, conventional and unconventional monetary policy shocks, Greece takes the top spot, followed by their counterparts in Ireland. Hence, we find particularly strong evidence of portfolio restructuring in favor of risky assets in Greece during the financial crisis, a

[5]Note that we also tried to implement a global VAR for the euro area as a whole and the twelve countries. However, the results turned out to be highly unstable, which is why we stick to the empirical setup below.

finding that might be explained by shadow banks swapping high-risk Greek sovereign bonds for arguably less risky equities during the debt crisis.

Table 2: Summary of Impulse Responses for Individual Countries

Panel A: Asset Growth

	Main Refinancing Rate					Shadow Rate				
	Peak		Diff	Rk	SPV	Peak		Diff	Rk	SPV
Austria	8.87	5q	+	3		6.61	5q	+	3	
Belgium	7.20	8q	+	6		2.52	8q	−	10	
Germany	6.29	5q	+	8		3.29	4q	+	7	
Greece	14.50	0q	+	2		7.04	5q	+	2	
Finland	18.39	3q	+	1		9.98	3q	+	1	
France	6.71	7q	+	7		4.11	4q	+	5	
Ireland	−10.27	0q	−	12	9.86|7q	3.20	4q	+	8	
Italy	4.13	1q	−	10		4.00	1q	+	6	
Luxembourg	8.64	1q	+	4		5.97	1q	+	4	
Netherlands	−3.43	3q	−	11	3.15|8q	−1.98	3q	−	12	1.00|0q
Portugal	7.75	0q	+	5		2.80	2q	−	9	
Spain	4.83	1q	−	9		***2.46***	3q		11	
Euro Area	4.97	0q				3.09	1q			

Panel B: Risk Assets Ratio

	Main Refinancing Rate					Shadow Rate				
	Peak		Diff	Rk	SPV	Peak		Diff	Rk	SPV
Austria	−3.73	4q	−	12	1.73|8q	−1.80	2q	−	12	
Belgium	2.92	7q	+	7		1.51	5q	+	7	
Germany	4.39	1q	+	4		1.73	4q	+	4	
Greece	5.46	1q	+	2		3.30	2q	+	1	
Finland	4.34	0q	+	5		1.63	1q	+	5	
France	4.49	2q	+	3		2.54	4q	+	3	
Ireland	9.06	2q	+	1		3.08	3q	+	2	
Italy	4.13	1q	−	10		4.00	1q	+	6	
Luxembourg	−1.70	4q	−	11	1.63|0q	−1.25	4q	−	11	1.00|0q
Netherlands	0.92	3q	−	10		0.68	0q	−	10	
Portugal	2.99	0q	+	6		1.59	4q	+	6	
Spain	2.77	0q	+	8		0.95	1q	−	9	
Euro Area	2.11	1q				1.12	1q			

Notes: Table 2 summarizes the impulse responses of asset growth and the risk assets ratio in the country-specific models. Column "Peak" shows the maximum reaction (absolute value) alongside the number of quarters after which it is found. All responses are measured in pp. +/− indicates whether the peak response is significantly larger/smaller than the euro area-wide peak response when considering 68% confidence bands. Column "Rank" orders the peak responses from the strongest to the weakest/most negative. Column "SPV" shows the maximum significant positive values for those countries with negative peak values.

The countries that consistently show the smallest responses of the risk assets ratio to either indicator are Austria, Luxembourg, and the Netherlands. The finding for the Netherlands is somewhat surprising as the traditional banking sector is found to show the strongest risk-taking behavior among the ten euro area countries analyzed in Neuenkirch and Nöckel (2018). The non-banking sector in the Netherlands is dominated by specialized financial corporations (ESRB 2018), one of the four subgroups of OFIs, incorporating venture capital, export/import financing, and central counterparties or, put differently, activities with a focus outside of stock markets (European Commission 2013).

We can also conclude that a portfolio rebalancing effect in favor of equity securities is not necessarily related to the absolute size of the shadow banking sector in the Eurozone. Ireland, with the second largest proportion of shadow banks in 2018Q3 (71% of financial assets are held by shadow banks; second after Luxembourg), and Greece, with the smallest shadow banking sector (4%), share the first place in risk-taking. The reasons are institutional, that is, Ireland with its deep financial sector and relatively lax regulations is an attractive place for traders and stock market investors. Moreover, the largest fraction of non-banks in Ireland are non-MMIFs which, as shown in the previous subsection, turn out to have the lowest risk aversion (ESRB 2018). In the "Silicon Docks," shadow banks primarily reshuffle portfolios towards riskier assets following monetary expansions, while at the same time shrinking financial assets in total (at least right after the shock).

The case of Luxembourg, where the largest share of non-banks are OFCs, reveals an interesting topic for further research (ESRB 2018). On the one hand, the balance sheets exhibit a very pronounced increase after expansionary monetary policy shocks but, on the other hand, the risk measure falls. This implies that, against the background of falling interest rates, the search for yield in Luxembourg operates through other financial instruments with hidden, transferred, or shared risk, like structured financial products and complex derivatives, which can be excessively risky, but are not captured by our indicator of asset risk.

5 Conclusions

In this paper, we investigate the risk-taking channel of monetary policy in the euro area for the period 2000Q1−2018Q3 by augmenting a standard monetary policy transmission model, with two indicators for the shadow banking sector: (i) total financial asset growth, and (ii) the risk assets ratio. In addition to providing VAR evidence for the euro area as a whole, we also test for differences in the shadow banks' reaction in twelve euro area countries and among four shadow bank groups.

Our results point towards the existence of a risk-taking channel for shadow banks in the euro area as a whole as these react aggressively to an expansionary monetary policy shock by increasing their rate of asset growth and their risk assets ratio. When considering conventional monetary policy measures, the portfolio reallocation effect towards riskier assets is more pronounced, whereas for the combination of conventional and unconventional monetary policy, we find stronger evidence for a general expansion of assets. Hence, the evidence for a risk-taking channel of shadow banks is more direct during "normal times" rather than during "crisis times." This also corroborates the ideas: (i) "excessive" risk-taking is one of factors that lead to the outbreak of the GFC, and (ii) unconventional monetary policy fuels additional growth of the financial sector as a "side effect." In general, the effects are smaller than those for conventional banks as found by Neuenkirch and Nöckel (2018).

We find evidence for a general expansion of assets and a portfolio reallocation effect taking place after an expansionary monetary policy shock in all four groups of non-banks (OFCs, Non-MMIFs, ICs, and PFs). Among these, insurance companies show the least pronounced responses, whereas non-money market investment funds exhibit the strongest adjustments to monetary expansions.

Country-specific estimations reveal that shadow banks in all twelve euro area countries increased their asset growth rate after both types of monetary policy shocks. The strongest reactions are found in Finland, Greece, Austria, and Luxembourg. All countries also increase their risk assets ratio after a monetary expansion with Austria (in the case of the SR) being the only exception. The strongest portfolio restructuring ef-

fects in favor of riskier equities are found in Ireland and Greece, whereas the weakest are documented in Austria, Luxembourg, and the Netherlands. This points towards a different, probably more complicated search for yield channel in these countries, especially in such large shadow bank hubs like Luxembourg and the Netherlands.

The findings presented in our paper have some policy implications. Since we find that monetary policy also affects risk-taking behavior of shadow banks, central bankers should be aware of this when setting interest rates or when deciding on unconventional policy measures. The effect of monetary policy has to be assessed against the trade-off between stimulus to the real economy and potential risks to financial stability. (Unconventional) monetary policy shocks themselves might lead to an increase in risk-taking behavior. Macroprudential policies, however, are designed to counteract excessive risk-taking, and their effectiveness might be counteracted by expansionary monetary policy.

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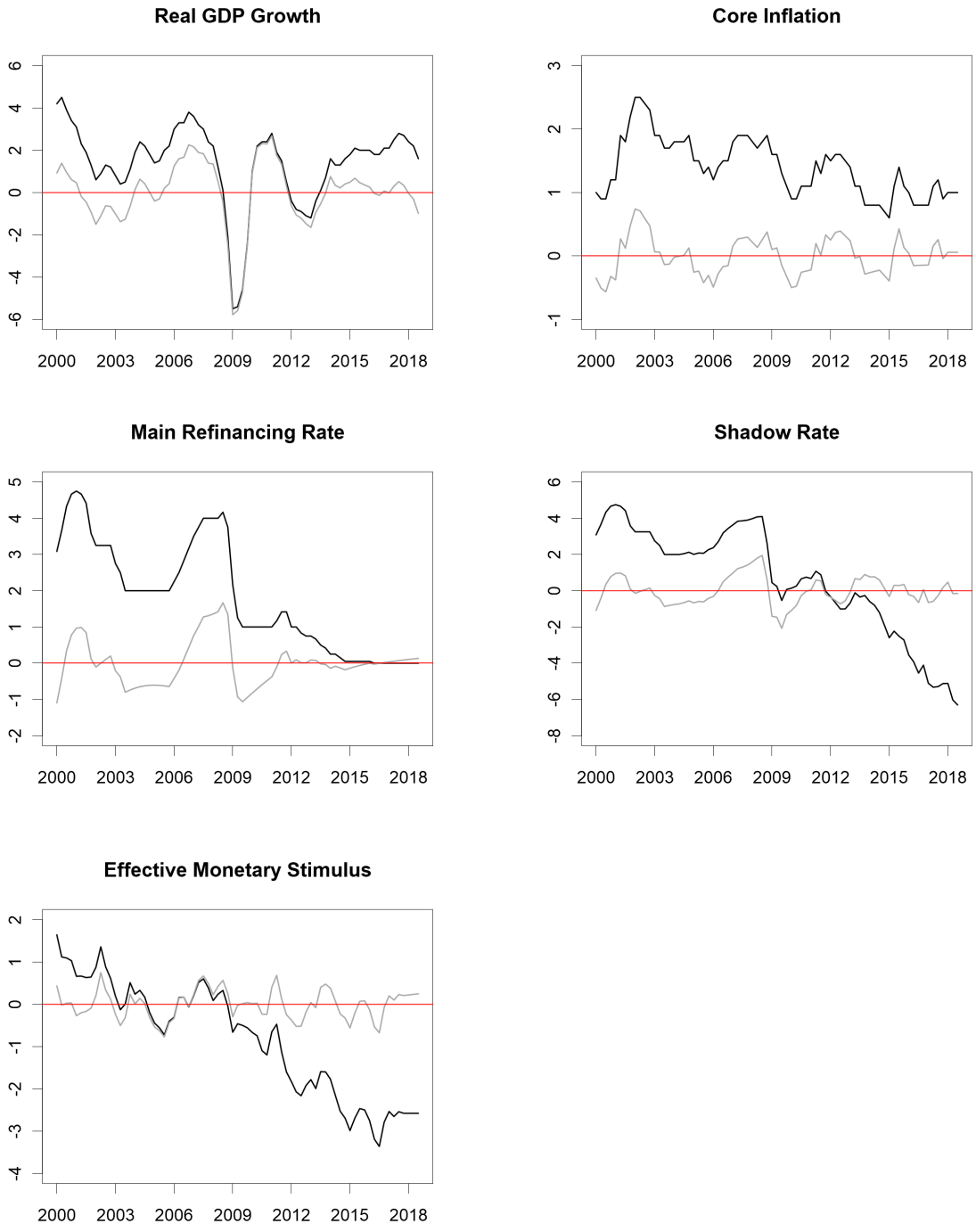
Appendix

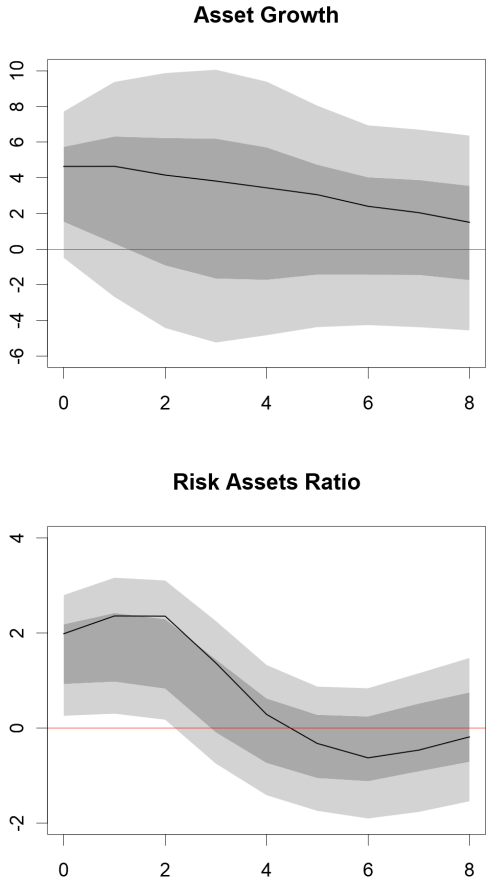
Figure A1: Macroeconomic Variables for the Euro Area



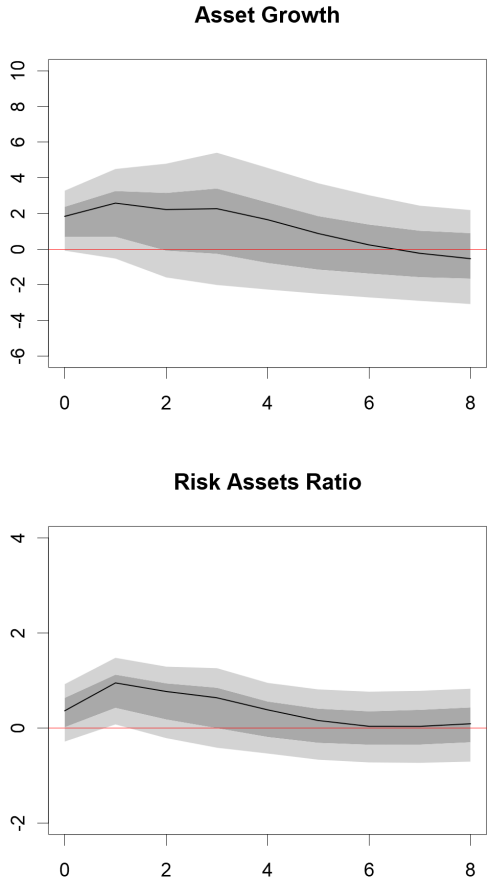
Notes: Black lines show the actual series and gray lines the HP-filtered ($\lambda = 1{,}600$) series. *Source*: Eurostat, Wu and Xia (2016; SR) and Krippner (2014; EMS).

Figure A2: Euro Area-Wide Impulse Responses: Non-Filtered Data

Panel A: Main Refinancing Rate

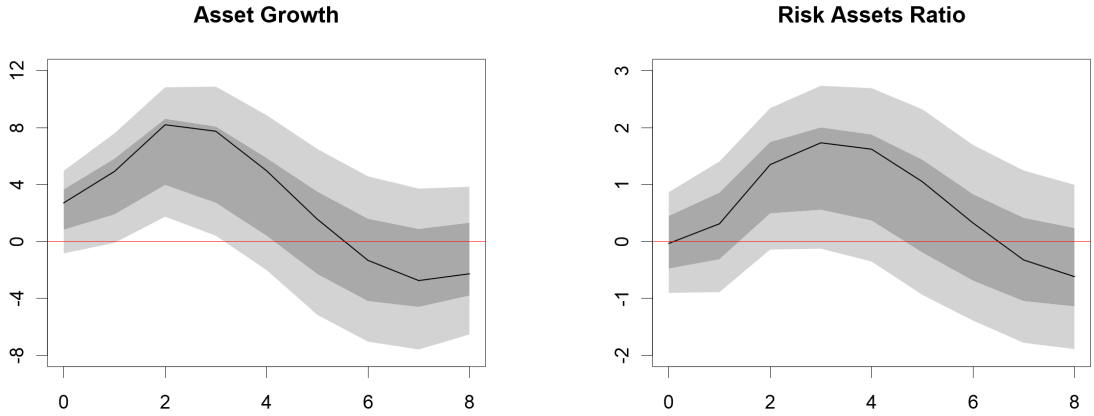


Panel B: Shadow Rate



Notes: Solid lines represent mean impulse responses (in percentage points) to an expansionary monetary policy shock of 100 basis points. Dark gray shaded (light gray shaded) areas indicate 68% (95%) confidence bands derived by bootstrapping and 5,000 replications.

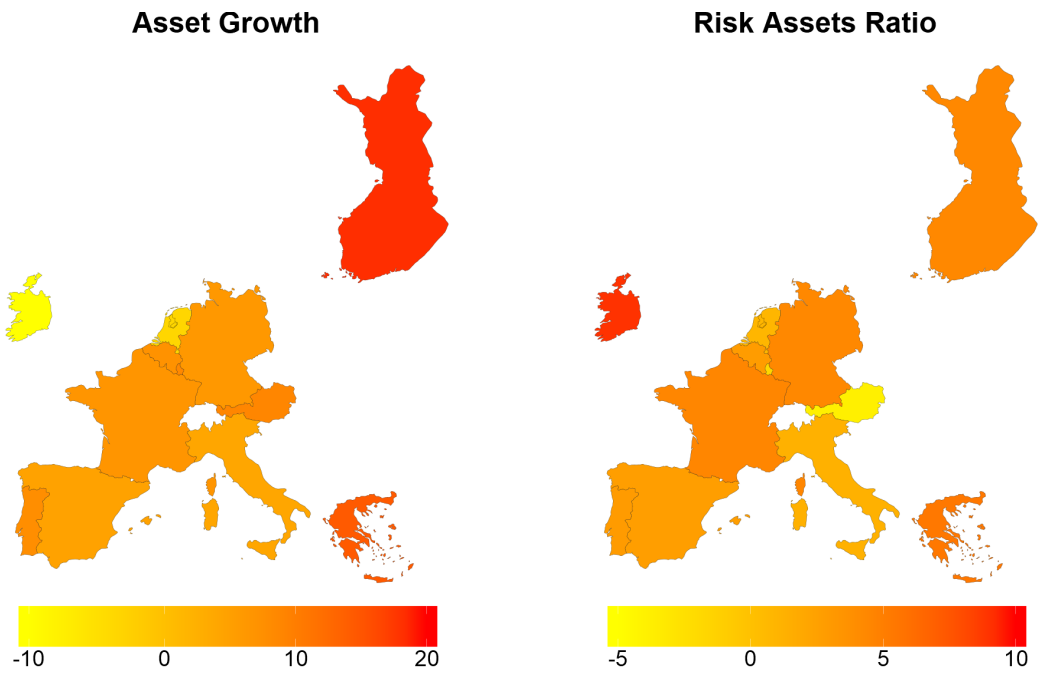
Figure A3: Euro Area-Wide Impulse Responses: Effective Monetary Stimulus



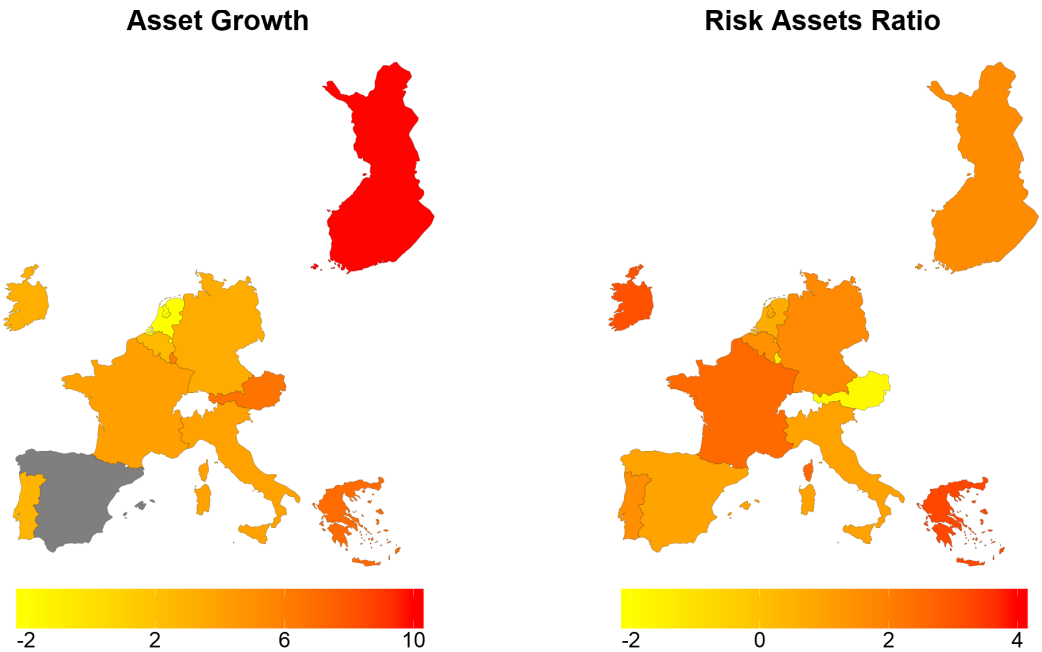
Notes: Solid lines represent mean impulse responses (in percentage points) to an expansionary monetary policy shock of 100 basis points. Dark gray shaded (light gray shaded) areas indicate 68% (95%) confidence bands derived by bootstrapping and 5,000 replications.

Figure A4: Peak Impulse Responses for Individual Countries

Panel A: Main Refinancing Rate



Panel B: Shadow Rate



Notes: Figure A4 visualizes the size of the peak impulse responses in the country-specific models in Table 2. Insignificant peak responses are in gray.