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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 2003Q1 - 2017Q3 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 for conventional monetary policy shocks that a portfolio reallocation effect towards riskier assets is more pronounced, whereas for unconventional monetary policy shocks we detect stronger evidence for a general expansion of assets. Country-specific estimations confirm these findings for most of the euro area countries, but also reveal some heterogeneity in the shadow banks' reaction.

JEL-Codes: E440, E520, E580, G110, G230, G280.

Keywords: European Central Bank, macroprudential policy, monetary policy transmission, risk-taking channel, shadow banks, vector autoregression.

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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 remains 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 shadow banks reached 41.37 trillion euros in the third quarter of 2017, which is more than half the size (53.5%; 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 2003Q1–2017Q3, with two indicators for the shadow banking sector, (i) total 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. Finally, we are able to establish the effects of conventional monetary policy shocks with the help of the main refinancing rate (MRR) and a mixture of conventional and un-

conventional monetary policy shocks with the help of the effective monetary stimulus (EMS; Krippner 2014). We identify the VAR with the help of two different recursive schemes.

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 for conventional monetary policy shocks that a portfolio reallocation effect towards riskier assets is more pronounced, whereas for unconventional monetary policy shocks we detect stronger evidence for a general expansion of assets. Country-specific estimations confirm these findings for most of the euro area countries, 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. 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.

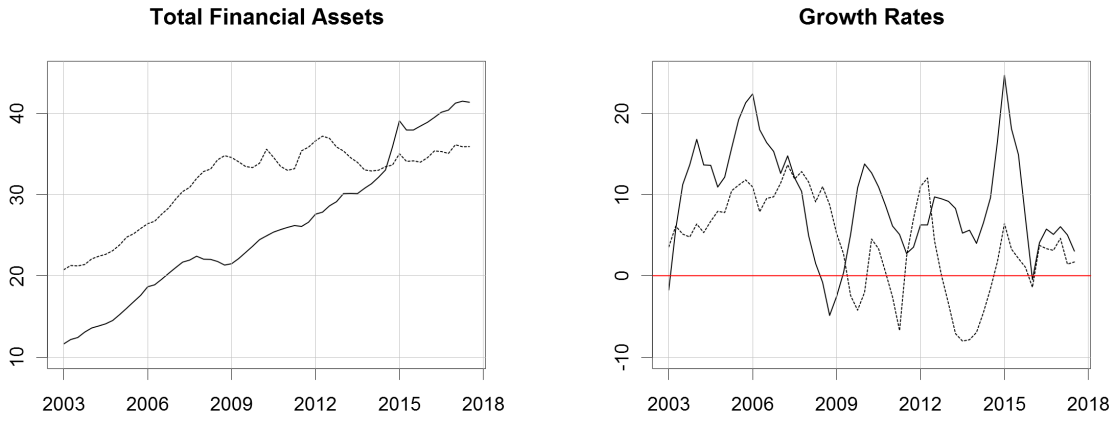
Securitization is pooling together small and otherwise illiquid financial assets into marketable securities. On the one hand, it provides several advantages, such as the provision of liquidity, risk sharing (Rajan 2006), triggering economic growth in advanced economies, and decreasing the indebtedness 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, the hidden leverage, 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 shadow banks based on the European Commission's categorization of non-MFIs, which include non-money market investment funds, insurance companies and pension funds, and other financial corporations (including other financial intermediaries except insurance companies and pension funds, financial auxiliaries, captive financial institutions, and money lenders). 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.

Figure 1 shows the total financial assets of MFIs and non-MFIs (left panel) and the corresponding growth rates to the previous year's quarter (right panel) over time. In 2003, the shadow banking sector was roughly half the size of the conventional banking sector (56%). However, due to more than twice as large average growth rates (9.2% for non-MFIs; 4.1% for MFIs) the shadow banking sector has become relatively more important over time. 2014Q4 marks the first time when total assets in the shadow banking sector exceeded those of the conventional banking sector. At the end of our sample period in 2017Q3, the volume of assets of non-MFIs (41.4 tn euros) is 15.1% larger than for MFIs (35.9 tn euros).

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



Notes: Dashed 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-12). Solid lines show the corresponding values for non-MFIs. *Source*: Eurostat.

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-12) for the period 2003Q1–2017Q3, 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 EMS. The MRR is utilized to test for the influence of conventional monetary policy, whereas the EMS allows for an assessment of conventional and unconventional monetary policy. Indeed, with short-term interest rates stuck at the zero lower bound, the EMS should be helpful as it quantifies all unconventional monetary policy measures in a single interest rate and can take negative values.

In addition to these three standard variables, our fourth and fifth variables are two indicators for the shadow banking sector. The European Commission recommends making inferences about the risk appetite of non-bank financial institutions in the euro area by looking at the growth rates (percentage change over the previous year's quarter) of: (i) their balance sheets and (ii) their risky asset holdings (see also, Delis and Kouretas 2011). Risky asset holdings are defined as equities 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 better 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

would be indicative of a risk-taking channel for shadow banks with non-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 solid lines show the actual series, the dashed 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

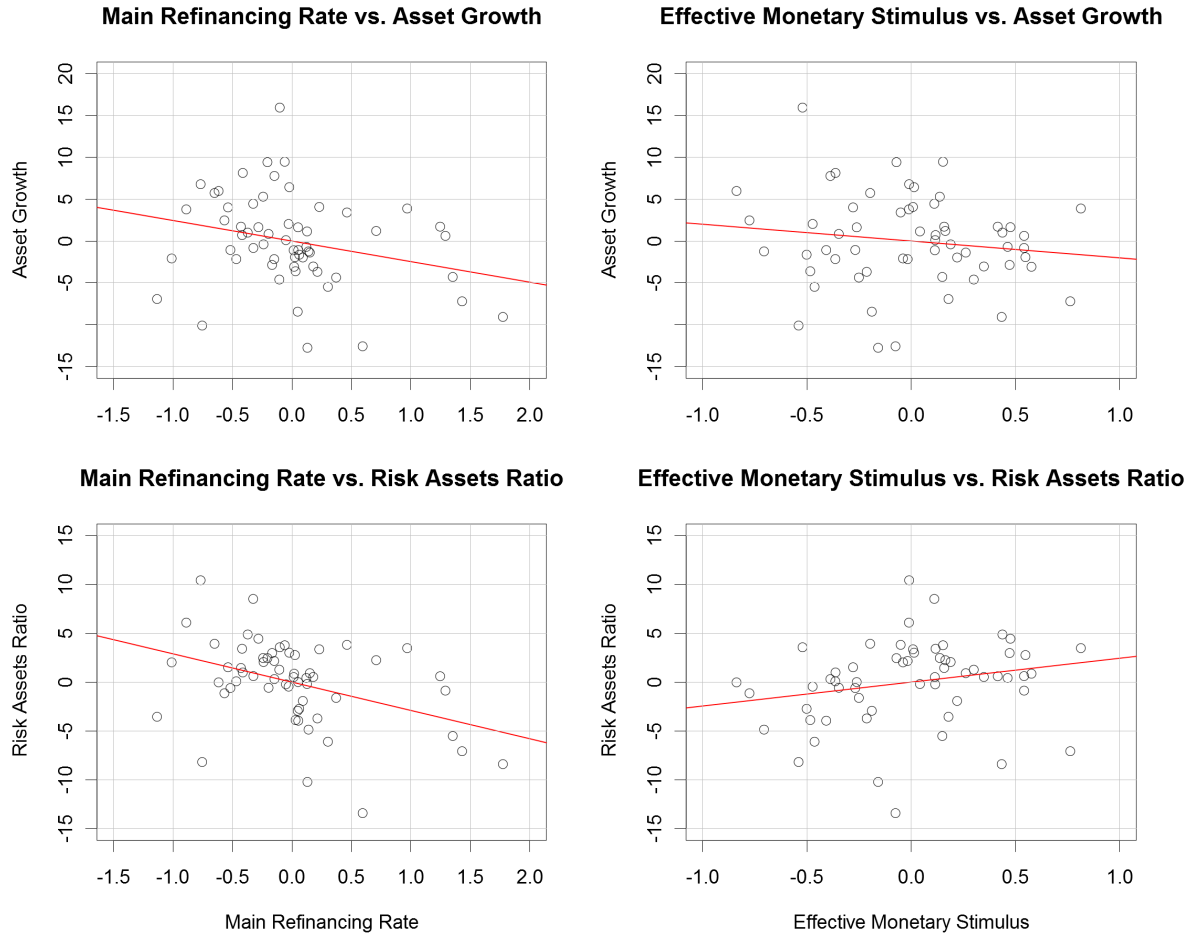
Notes: Solid lines show the actual series and dashed lines the HP-filtered ($\lambda = 1,600$) series. *Source*: Eurostat.

After an increase at the beginning of the sample period, total asset growth and the risk assets ratio tend to decrease up to the point of 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 risk assets ratio remain more or less stable with the exception of a strong peak in asset growth in 2015.

The left panel of Figure 3 shows scatter plots comparing both shadow banking sector variables and the indicator for conventional monetary policy, the MRR. The right panel repeats this exercise with the combined indicator for conventional and unconventional monetary policy, the EMS. All variables are HP-filtered with $\lambda = 1,600$.

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

Panel A: Main Refinancing Rate Panel B: Effective Monetary Stimulus



Notes: Left panel shows scatter plots comparing the MRR and (i) asset growth ($\rho = -0.27$) and (ii) the risk assets ratio ($\rho = -0.40$). Right panel shows scatter plots between the EMS and (i) asset growth ($\rho = -0.14$) and (ii) the risk assets ratio ($\rho = 0.22$). 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 (see the top panel). However, the correlation is less pronounced when employing the EMS ($\rho = -0.14$) as compared to the MRR ($\rho = -0.27$). The relationship between the risk assets ratio and the monetary policy stance depends on the choice of the interest rate indicator. When utilizing the indicator for conventional monetary policy, the MRR, the relationship is negative, that is, lower interest rate levels are associated with a higher ratio of risky assets in the balance sheet ($\rho = -0.40$). However, when also considering unconventional monetary policy, that

is, when utilizing the EMS, the relationship becomes positive ($\rho = 0.22$). Hence, the opposing relationships in the bottom part of Figure 3 indicate that it is also important to consider a variable for unconventional monetary policy. In the end, 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 two different identification schemes. Both methods are based 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 EMS), asset growth, and the risk assets ratio. All series are HP-filtered to remove deterministic trends. 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 5% 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 1 for our five-variable VAR model in the case of both monetary policy indicators. However, in both cases, the residuals of three equations of a VAR(1) model exhibit significant autocorrelation at the 5% level. Hence, a VAR(1) is not able to sufficiently capture the dynamics in the system. In contrast, the use of two lags, which is also recommended by the Hannan-Quinn criterion in case of the MRR, eliminates serial correlation in the error terms of all equations at the 5% 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. We impose

two different recursive identification schemes. In the baseline scheme (ordering 1), 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 risk assets ratio is ordered last, reflecting that the latter variable, by definition, immediately adjusts to changes in total financial assets.

As part of our robustness tests, we 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). Hence, the alternative ordering (ordering 2) is as follows: real GDP growth, core inflation, asset growth, risk assets ratio, and the monetary policy indicator.[1]

4 Results

4.1 Euro Area

Figures 4 (ordering 1) and 5 (ordering 2) show impulse response functions (IRFs) based on recursive identification for a 100 basis points (bps) expansionary shock in the MRR

[1] We also employed a Bayesian estimation method with a pure sign restriction approach and assumed that an expansionary monetary policy shock leads to: (i) a decrease in the MRR/EMS, (ii) an increase in core inflation, and (iii) an increase in real GDP growth on impact and for four quarters thereafter (Uhlig 2005). However, the impulse responses are, despite being qualitatively in line with those presented in Section 4, only significant, if at all, when considering 68% credible sets. One reason for this 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 two different recursive schemes. To conserve space, we only show the impulse responses based on the recursive schemes. All omitted results are available on request.

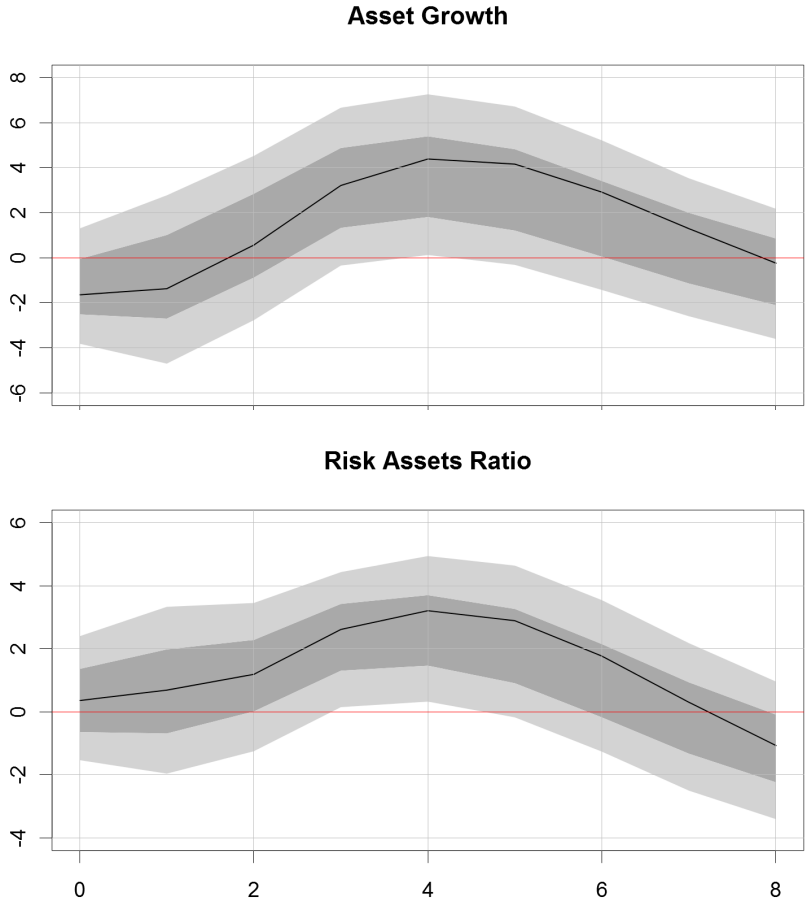
and the EMS, respectively. The IRFs based on either monetary policy indicator and either identification scheme are qualitatively very similar, despite the fact that ordering 1 allows for an instantaneous reaction of the financial variables to monetary policy shocks and ordering 2 precludes such a reaction. We find significant increases in asset growth and the risk assets ratio after an expansionary monetary policy shock. The peak effects are found three to four 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 the risk assets ratio is significant when considering the 95% confidence bands in the case of the MRR. In the case of the EMS, we only find a significant reaction for the less conservative 68% confidence bands. This is also reflected in a smaller peak reaction of the risk assets ratio in the case of the EMS (1.95 pp for ordering 1; 2.07 pp for ordering 2) as compared to the MRR (3.21 pp for ordering 1; 3.32 pp for ordering 2). The pattern of the reaction of asset growth is exactly the opposite. Here, shocks in the EMS cause a more significant and stronger reaction than shocks in the MRR. The peak effects are 4.96 pp (ordering 1) and 5.94 pp (ordering 2) for the EMS as compared to 4.39 pp (ordering 1) and 4.21 pp (ordering 2) for the MRR.

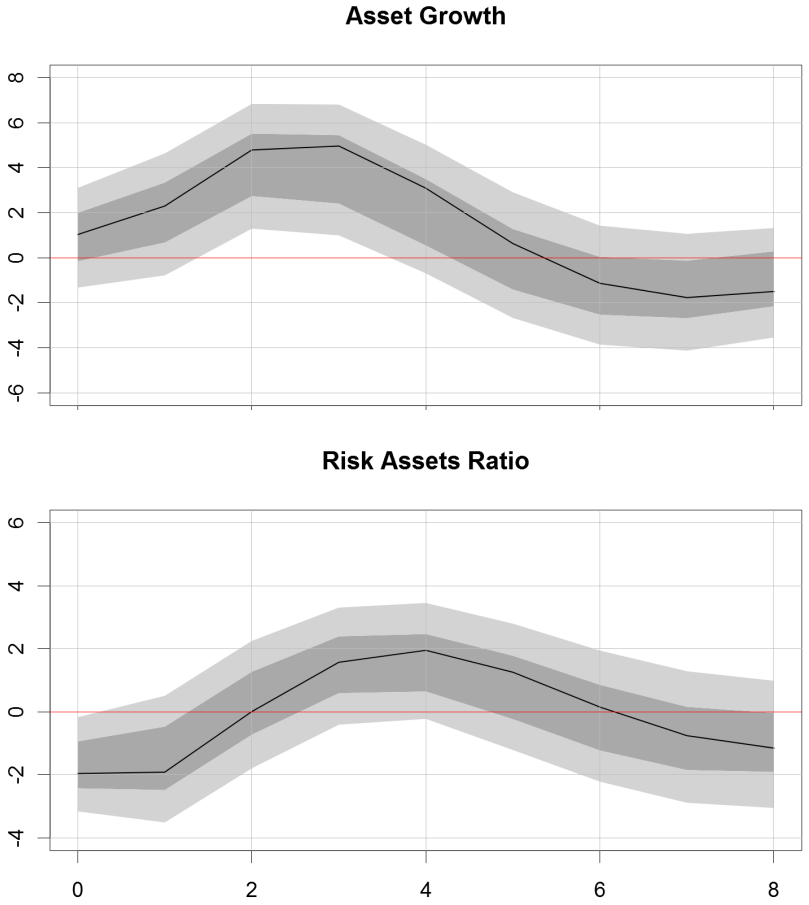
To summarize, we find evidence for both a general expansion of assets (see also, Adrian and Shin 2011; Cecchetti et al 2017) and a portfolio reallocation effect (see also, Delis and Kouretas 2011; Beck et al 2016; Hau and Lai 2016; IMF 2016) taking place after an expansionary monetary policy shock. When considering conventional monetary policy (i.e., shocks to the MRR), the portfolio reallocation effect is more pronounced, whereas for the combination of conventional and unconventional monetary policy (i.e., shocks to 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 that: (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."

Figure 4: Euro Area-Wide Impulse Responses for Cholesky Ordering 1

Panel A: Main Refinancing Rate



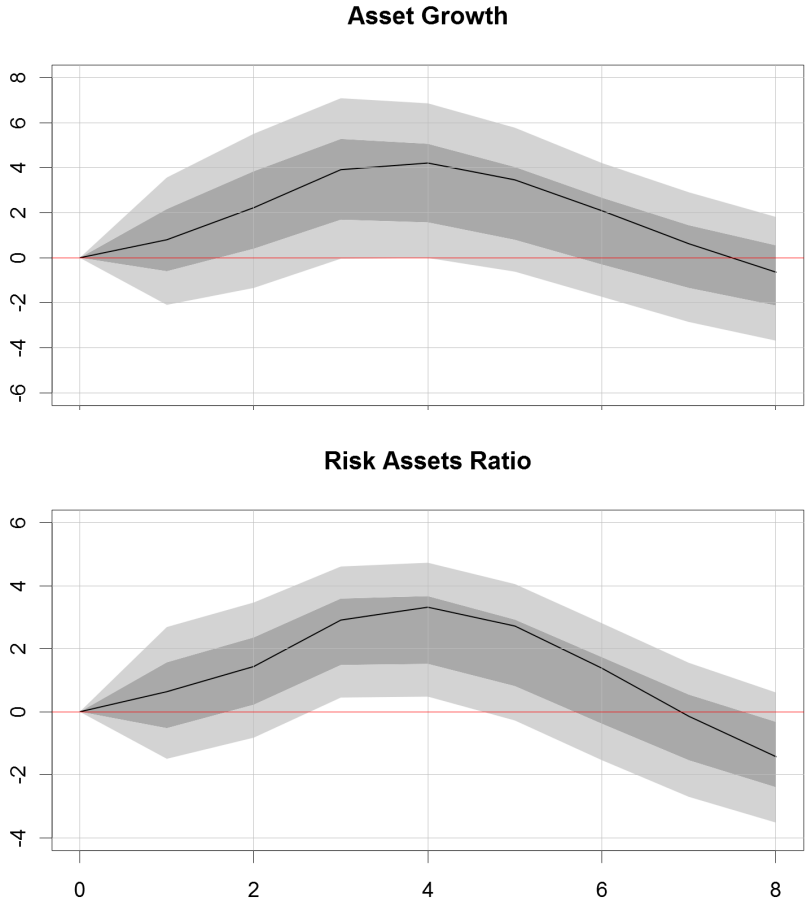
Panel B: Effective Monetary Stimulus



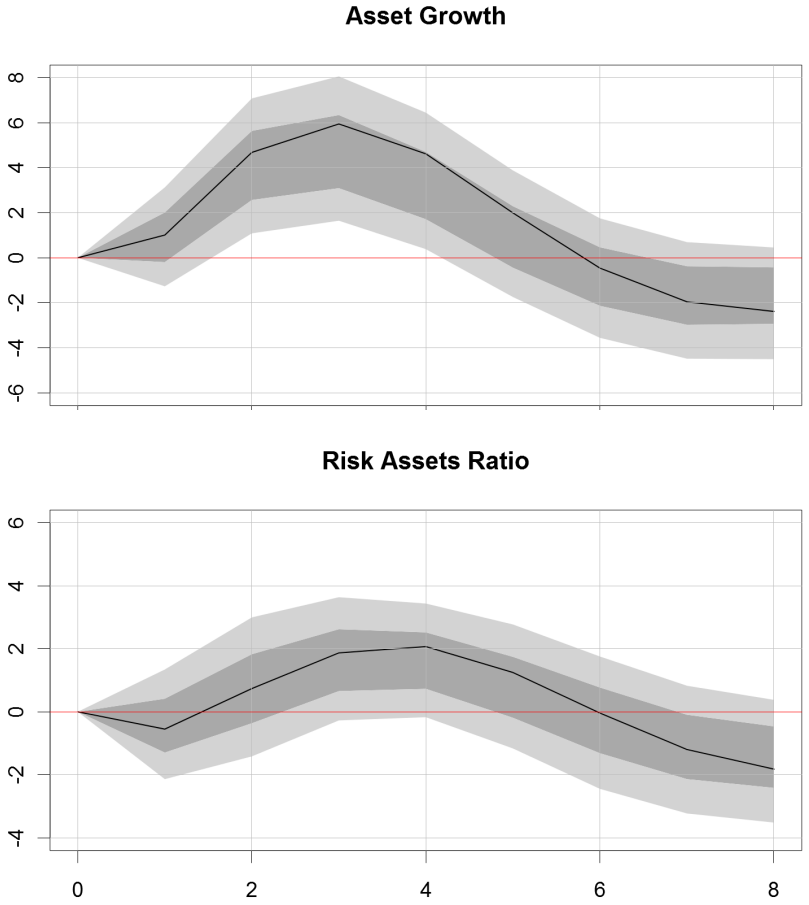
Notes: Solid lines represent mean impulse responses (in percentage points) to an expansionary monetary policy shock of 100 basis points based on recursive identification with the following ordering: (i) Real GDP growth, (ii) core inflation, (iii) MRR/EMS, (iv) asset growth, and (v) risk assets ratio. Dark gray shaded (light gray shaded) areas indicate 68% (95%) confidence bands derived by bootstrapping and 5,000 replications.

Figure 5: Euro Area-Wide Impulse Responses for Cholesky Ordering 2

Panel A: Main Refinancing Rate



Panel B: Effective Monetary Stimulus



Notes: Solid lines represent mean impulse responses (in percentage points) to an expansionary monetary policy shock of 100 basis points based on recursive identification with the following ordering: (i) Real GDP growth, (ii) core inflation, (iii) asset growth, (iv) risk assets ratio, and (v) MRR/EMS. Dark gray shaded (light gray shaded) areas indicate 68% (95%) confidence bands derived by bootstrapping and 5,000 replications.

To put these figures into perspective, one should consider the standard deviation of asset growth (5.44 pp) and the risk assets ratio (4.29 pp) in our sample. Hence, financial institutions increase the growth rate of their total assets by around one standard deviation after a 100 bps expansionary monetary policy shock. The increase in the risk assets ratio corresponds to roughly 0.5–0.75 standard deviations. Hence, the increase in risk-taking of non-bank financial institutions 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 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.[2] Tables 1 and 2 summarize the country-specific impulse responses, which are also visualized in Figures A2 and A3 in the Appendix.

Table 1 reveals that shadow banks in all twelve euro area countries under consideration increased their asset growth rate after conventional monetary policy shocks (i.e., when employing the MRR; left panel). This finding is replicated when considering the combination of conventional and unconventional monetary policy shocks (i.e., when employing the EMS; right panel) for all countries except Belgium and Greece.

[2]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.

Table 1: Summary of Impulse Responses for Individual Countries: Asset Growth

	Main Refinancing Rate								Effective Monetary Stimulus							
	Ordering 1				Ordering 2				Ordering 1				Ordering 2			
	Peak		Diff	Rk	Peak		Diff	Rk	Peak		Diff	Rk	Peak		Diff	Rk
Austria	**7.93**	4q	+	3	**7.55**	4q	+	4	**7.58**	2q	+	4	**7.47**	2q	+	4
Belgium	**2.74**	4q		9	**2.76**	4q		10	1.18	3q	−	12	1.42	3q	−	11
Germany	**2.44**	4q		10	**2.36**	3q		11	**3.84**	2q		7	**4.31**	3q		7
Greece	**9.23**	3q	+	1	**8.44**	3q	+	2	3.31	1q		9	1.37	2q	−	12
Finland	**9.09**	4q	+	2	**9.20**	4q	+	1	**8.74**	3q	+	2	**8.54**	3q	+	3
France	**4.66**	4q		7	**5.30**	3q	+	5	**4.86**	3q		5	**4.44**	3q		5
Ireland	**4.72**	4q		6	**4.95**	4q		7	**8.41**	2q	+	3	**9.02**	2q	+	2
Italy	**5.38**	2q		5	**5.10**	3q		6	**4.46**	3q		6	**4.37**	3q		6
Luxembourg	**7.88**	4q	+	4	**7.72**	3q	+	3	**12.97**	2q	+	1	**14.00**	2q	+	1
Netherlands	**1.55**	5q	−	12	**1.48**	5q	−	12	**3.32**	2q		8	**2.45**	3q	−	8
Portugal	**1.97**	3q		11	**3.34**	3q		9	**2.11**	4q	−	11	**2.10**	3q	−	10
Spain	**3.10**	2q		8	**3.42**	2q		8	**2.14**	3q	−	10	**2.19**	3q	−	9
Euro Area	**4.39**	4q			**4.21**	4q			**4.96**	3q			**5.94**	3q		

Notes: Table 1 summarizes the impulse responses of asset growth in the country-specific models. Column "Peak" shows the respective peak positive reaction alongside the number of quarters after which it is found. All responses are measured in pp. Peak responses in bold are significantly different from zero. +/− 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.

Table 2: Summary of Impulse Responses for Individual Countries: Risk Assets Ratio

	Main Refinancing Rate								Effective Monetary Stimulus							
	Ordering 1				Ordering 2				Ordering 1				Ordering 2			
	Peak		Diff	Rk	Peak		Diff	Rk	Peak		Diff	Rk	Peak		Diff	Rk
Austria	**4.64**	4q	+	7	**4.92**	1q	+	7	**3.85**	2q	+	3	**3.72**	2q	+	5
Belgium	**8.11**	4q	+	2	**7.89**	4q	+	1	**4.10**	4q	+	2	**4.73**	4q	+	2
Germany	**4.93**	4q	+	6	**4.93**	4q	+	6	**3.24**	4q	+	6	**3.91**	4q	+	3
Greece	5.55	3q	+	4	**7.02**	2q	+	4	**7.61**	3q	+	1	**7.74**	3q	+	1
Finland	**8.11**	3q	+	1	**7.50**	3q	+	2	**3.05**	4q	+	7	**3.11**	4q	+	7
France	**5.21**	4q	+	5	**5.82**	4q	+	5	**3.34**	3q	+	5	**2.90**	4q	+	8
Ireland	**7.46**	3q	+	3	**7.45**	3q	+	3	**2.89**	3q	+	8	**3.85**	3q	+	4
Italy	**4.33**	4q	+	8	**4.89**	4q	+	8	1.39	5q		9	1.41	4q		9
Luxembourg	**3.73**	0q	+	10	0.00	0q	-	12	-0.31	8q	-	12	0.81	3q		11
Netherlands	**2.49**	3q		12	**2.46**	3q		11	0.23	5q	-	11	0.66	5q	-	12
Portugal	**3.28**	5q		11	**3.13**	4q		10	**3.73**	4q	+	4	**3.56**	4q	+	6
Spain	**3.85**	4q	+	9	**3.79**	4q	+	9	1.06	5q		10	0.90	5q		10
Euro Area	**3.21**	4q			**3.32**	4q			**1.95**	4q			**2.07**	4q		

Notes: Table 2 summarizes the impulse responses of the risk assets ratio in the country-specific models. Column "Peak" shows the respective peak positive reaction alongside the number of quarters after which it is found. All responses are measured in pp. Peak responses in bold are significantly different from zero. +/− 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.

In the case of conventional monetary policy, the strongest peak reactions can be found in Finland and Greece, followed by Austria and Luxembourg. The maximum of around 9 pp is more than twice of the size of the euro area's peak reaction of 4.2–4.4 pp. When considering conventional and unconventional monetary policy measures, Greece moves out of that top group and falls closer to the bottom, reflecting the deep crisis of the country's financial system 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). Here, Luxembourg takes the top spot with a peak reaction of up to 14 pp, followed by Finland, Ireland, and Austria.

The only country with a peak reaction to conventional monetary policy shocks that is significantly below the euro area aggregate is the Netherlands where financial institutions expand their asset growth only by around 1.5 pp. When employing the EMS, Belgium, Portugal, and Spain show the smallest responses to monetary policy shocks. Similar to the case of Greece, the small reaction of Portuguese and Spanish non-bank financial institutions is reflective of the deep economic and financial crisis in these countries.

Turning to the response of the risk assets ratio (see Table 2), we again find evidence that shadow banks in all twelve euro area countries under consideration increased their risk assets ratio after conventional monetary policy shocks (left panel). This finding is replicated for eight countries (all countries except Italy, the Netherlands, Portugal, and Spain) when considering the combination of conventional and unconventional monetary policy shocks (right panel).

We find the strongest reaction to conventional monetary policy shocks for Belgium, Finland, Greece, and Ireland. Here the peak responses are also more than twice as large as for the euro area aggregate. When considering both, conventional and unconventional monetary policy shocks, Greek financial institutions take the top spot, followed by their counterparts in Belgium. Hence, we find particularly strong evidence of portfolio restructuring in favor of risky assets in Greece during the financial

crisis, a finding that should be considered as alarming given the overall state of the Greek financial sector.

Two countries that consistently show the smallest responses of the risk assets ratio to either indicator are Luxembourg and the Netherlands. The finding for the Netherlands is somewhat surprising as the conventional banking sector is found to show the strongest risk-taking behavior among the ten euro area countries analyzed in Neuenkirch and Nöckel (2018). The case of Luxembourg reveals an interesting topic for further research. 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 barely rises (if at all). This could imply that risk is hiding in securities other than equities and that the search for yield effect possibly operates through other more complex financial instruments that 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 2003Q1–2017Q3 by augmenting a standard monetary policy transmission model, with two indicators for the shadow banking sector: (i) total 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.

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 that: (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).

Country-specific estimations reveal that shadow banks in all twelve euro area countries increased their asset growth rate after conventional monetary policy shocks. This finding is replicated when considering the combination of conventional and unconventional monetary policy shocks for all countries except Belgium and Greece. The strongest reactions are found in Luxembourg, Finland, and Austria, whereas the weakest can be found in Belgium, the Netherlands, Portugal, and Spain.

We also find evidence that shadow banks in all twelve euro area countries increased their risk assets ratio after conventional monetary policy shocks. This finding is replicated for all countries except Italy, the Netherlands, Portugal, and Spain, when considering the combination of conventional and unconventional monetary policy shocks. The strongest portfolio restructuring effects are found in Belgium, Finland, Greece, and Ireland and the weakest in 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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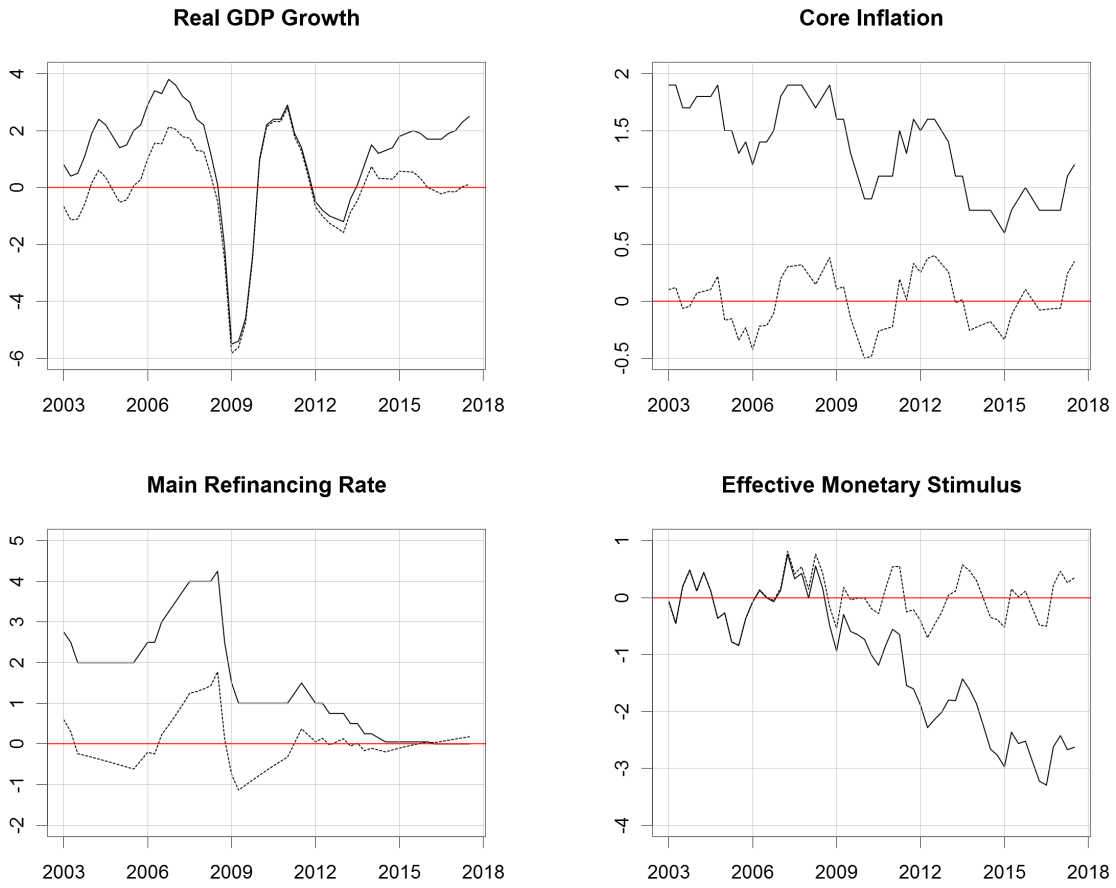
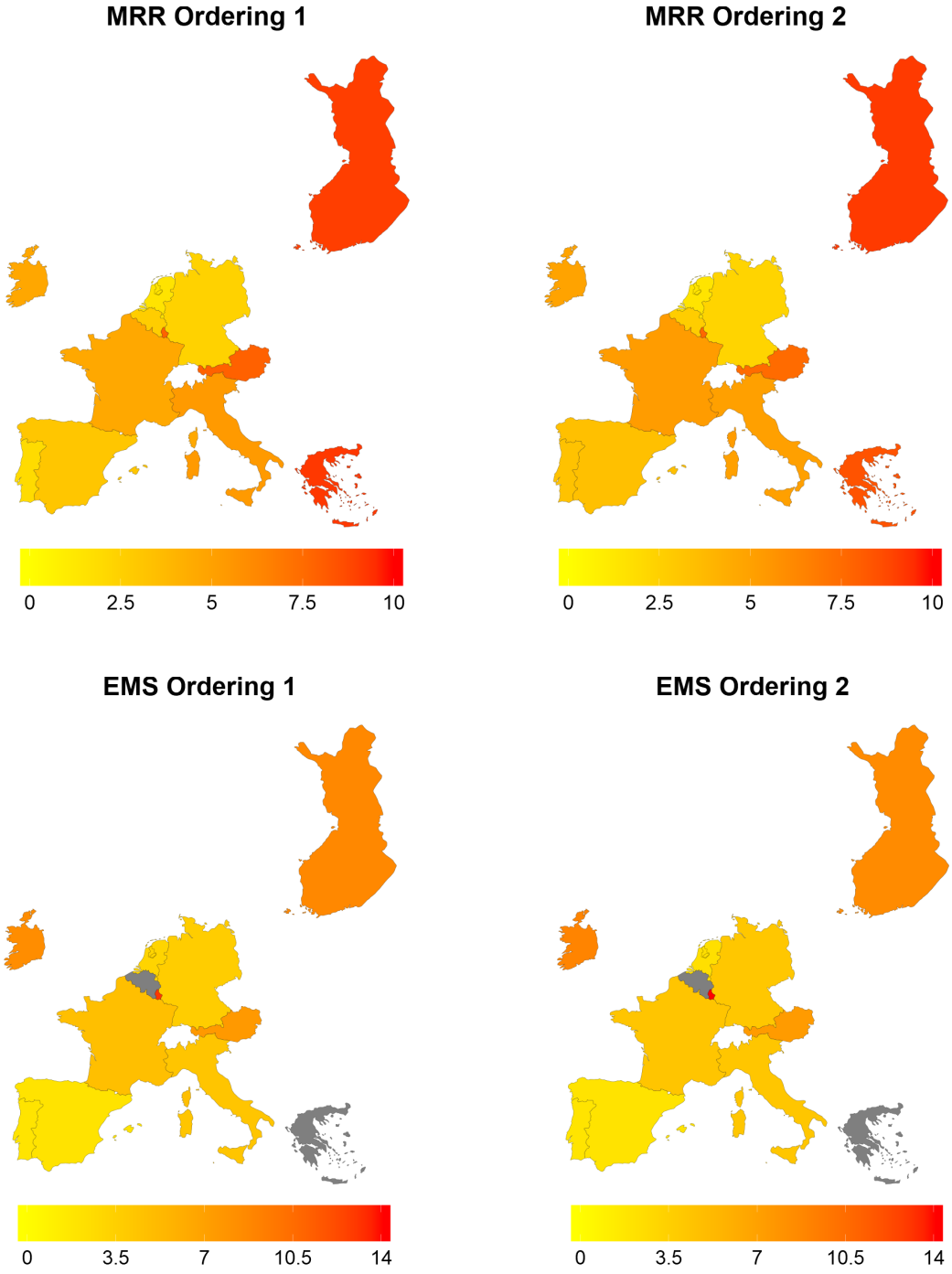
Appendix

Figure A1: Macroeconomic Variables for the Euro Area



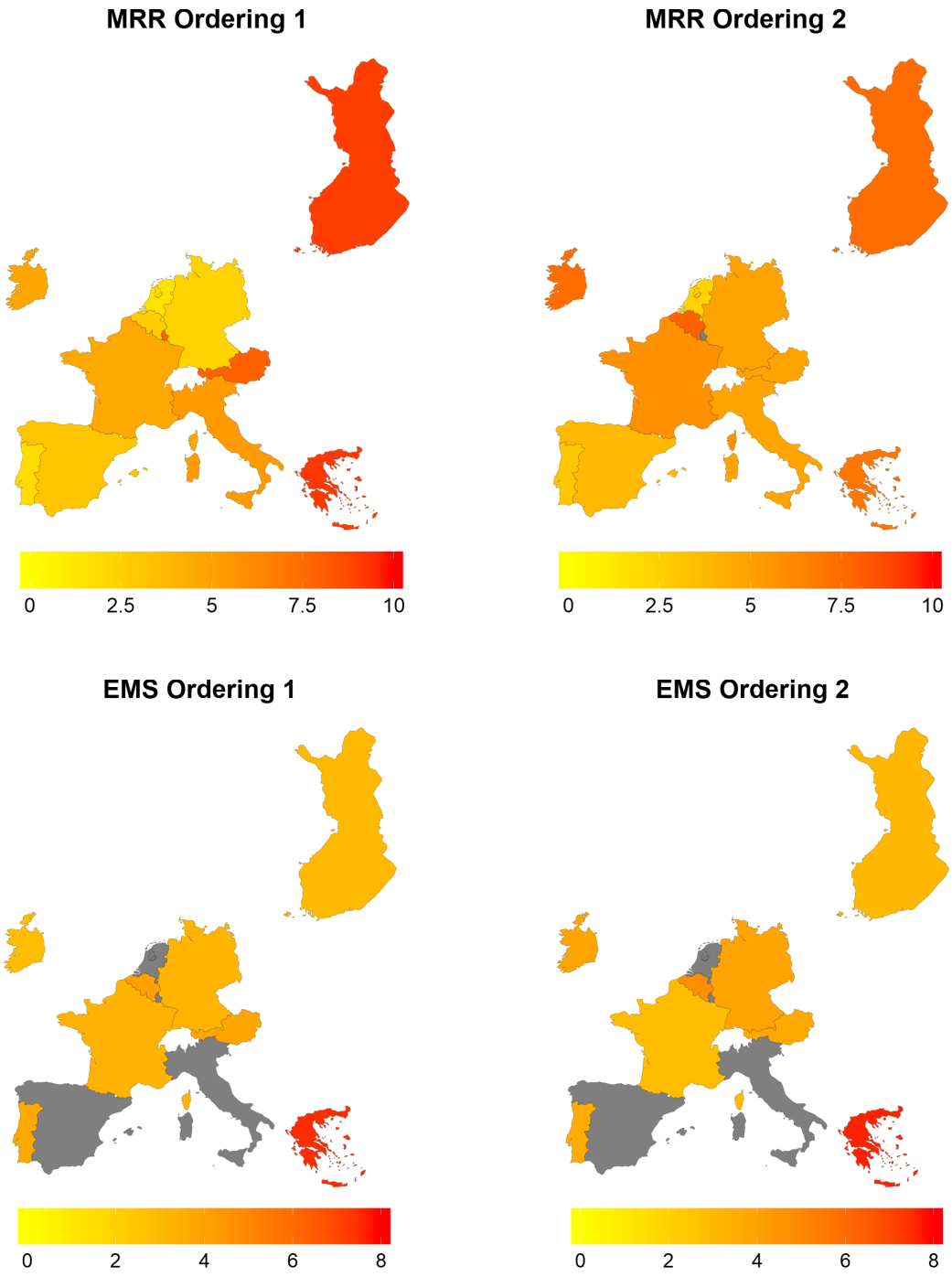
Notes: Solid lines show the actual series and dashed lines the HP-filtered ($\lambda = 1{,}600$) series.
Source: Eurostat and Krippner (2014; EMS).

Figure A2: Peak Impulse Responses for Individual Countries: Asset Growth



Notes: Figure A2 visualizes the size of the peak impulse responses of asset growth in the country-specific models in Table 1. Insignificant peak responses are in gray.

Figure A3: Peak Impulse Responses for Individual Countries: Risk Assets Ratio



Notes: Figure A3 visualizes the size of the peak impulse responses of the risk assets ratio in the country-specific models in Table 2. Insignificant peak responses are in gray.