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Abstract

It is now widely accepted that monetary authorities should have a mandate to safeguard financial stability and that macroprudential policies should be an integral part of such a mandate. However, our understanding of the effectiveness of macroprudential policies and their impact on monetary policy target variables and, more broadly, on macroeconomic outcomes, is still limited. This paper addresses that gap and examines the development and impact of macroprudential policies in the euro area. The contribution of the paper is twofold. First, we construct a novel index that captures the stance of the macroprudential policy and we highlight its main stylised facts since the inception of the euro in 1999. Second, we employ a combination of a narrative approach and a structural VAR method to identify both unanticipated and anticipated exogenous variations in macroprudential policies. Our results show that unanticipated or surprise shocks and anticipated or news macroprudential policy shocks exhibit differentiated effects on macroeconomic variables and that they both contribute over the medium term to safeguard financial stability. We also find significant linkages between monetary and macroprudential policies over a sample period that includes events such as the great financial crisis and the sovereign debt crisis.

Keywords: macroprudential policy, financial stability, euro area, monetary policy

JEL codes: E58, E61

"[Macroprudential policy] has the potential to bring about the biggest change in the policymaking environment for a generation." (Paul Tucker, Bank of England, at the colloquium 'the great financial crisis' held at the ECB, 2010)

1 Introduction

There is now a consensus that price stability is not a sufficient condition to achieve economic prosperity. Financial stability matters. The financial system can be a source of risks as well as a propagation mechanism for shocks. In addition, it is now evident that systemic stability of the financial system cannot be secured by exclusively focusing on the soundness of individual institutions, that is, with microprudential supervision (see Kahou and Lehar, 2017). A macro, i.e. system-wide, approach is also needed to enhance and secure financial stability.

Although the issue of prudential supervision has been receiving increasing attention, it is important to note that macroprudential policies are not new, they have been employed by policymakers for a long time (see Elliott *et al.*, 2013 for a historical review of macroprudential policies in the US, and Kelber *et al.*, 2014 for a European historical perspective). The emphasis on having a macroprudential framework that includes a defined and specific target about financial stability, the prevention and mitigation of systemic risk is, however, relatively new. One of the consequences of this relatively novel policy framework is the lack of a consolidated body of academic work informing about the effectiveness of these policies from a macro perspective (see Galati and Moessner, 2018). Furthermore, we note that there is no consensus yet about the interaction between macroprudential and monetary policies, neither from a positive nor a normative perspective (Gelain and Ilbas, 2017). Consequently, our understanding of the efficacy of macroprudential policies as well as their impact on monetary policy target variables and, more broadly, on macroeconomic outcomes, is still limited. We address this gap and we focus on the euro area. Since it was established, the euro area has been pro-active in the development and implementation of macroprudential policies. Moreover, there have been continued efforts, such as the establishment of the European Systemic Risk Board (ESRB), to coordinate monitoring of the financial system and to improve macroprudential supervision. However, policymakers, macroeconomic analysts and academics acknowledge the need for empirical insights about the evolution of aggregate macroprudential policies and their transmission mechanism through other macroeconomic variables. These are the two issues this paper contributes to shed light on.

First, we provide an overview of the stance of the macroprudential policy in the euro area since its inception in 1999. We employ MaPPED, a database constructed by the ECB in conjunction with national monetary authorities, to create EAMPP (Euro-Area MacroPrudential Policy), a novel index representing the aggregate level of macroprudential policies in the euro area.[1] The construction of the time series of EAMPP allows us to highlight the main stylised facts of the aggregate macroprudential policy. One of those stylised facts worth noting is that macroprudential policy has progressively tightened over the sample period, and therefore its evolution contrasts with that of monetary policy. These policy dynamics are the result of periods of severe financial instability and deflationary pressures in the euro area such as the aftermath of the great financial crisis (GFC) and the European sovereign debt crisis.

Second, we are the first to provide evidence about the effects of exogenous variations in macroprudential policies in the euro area within a structural econometric approach. Our methodology addresses the issue of foresight in econometric models and the presence of 'news' shocks influencing macroeconomic outcomes, which is particularly relevant in the case of macroprudential policies as there may be changes in the macroprudential stance that are anticipated by agents. We identify two types of shocks driving non-systematic fluctuations of macroprudential policies: an unanticipated or surprise shock, and an anticipated or news shock.

We examine the impact of those two shocks on the economic variables that are objectives of both macroprudential and monetary policies such as systemic risk, prices and output. Our results show that there are differences in the dynamics following each type of shock, and that they both contribute over the medium term to safeguard financial stability by moderating systemic risk, and, importantly enough, by lowering the pro-cyclicality of credit growth. Regarding the interaction with monetary policy, we find that macroprudential policy shocks have an insignificant effect on inflation stability, the primary monetary policy target for the ECB, and that monetary policy reacts such that the macroeconomic

[1] The use of MaPPED to construct this index presents several advantages relative to other databases previously used in the literature. See Section 2 below and Section 10.1 of Budnik and Kleibl (2018) for discussions about the differences between MaPPED and other macroprudential databases.

policy mix is effective to achieve its goals.

Our paper relates to two strands of the economics literature. One strand is the empirical research about the effects of macroprudential policies on macroeconomic outcomes and their interaction with monetary policy. Most of the studies in this literature capture variations in macroprudential policies by constructing an index that aggregates actions taken over a number of macroprudential policy instruments.[2] The construction of those indices has typically been done by using one or more than one of the databases from the International Monetary Fund (IMF), Bank for International Settlements (BIS), central banks, bank regulators or other national sources (see Alam *et al.*, 2019, Appendix I Table 4, for a detailed summary of 17 databases employed in this literature). Some of those studies include both advanced and emerging market economies (e.g. Kuttner and Shim, 2016; Cerutti *et al.*, 2017; Akinci and Olmstead-Rumsey, 2018; Alam *et al.*, 2019; Richter *et al.*, 2019) while others examine a particular group of countries (e.g. Vandenbussche *et al.*, 2015 analyse Central Eastern and South Eastern European (CESEE) countries; Bruno *et al.*, 2017, Kim and Mehrotra, 2017 and Kim and Mehrotra, 2018 Asia-Pacific countries; Budnik and Kleibl, 2018 and Budnik, 2020 European Union member states; Rojas *et al.* (2020) Latin American countries; and Klingelhöfer and Sun, 2019 study the case of China).

Those studies cited above employ different econometric methods to assess the effectiveness of macroprudential policies. Cerutti *et al.* (2016) and Budnik and Kleibl (2018) examine the correlation between changes in prudential instruments and the evolution of financial stability measures such as credit growth and house prices. Although the results of those studies are illustrative about the effects of prudential policies, analyses that use dynamic panel regression methods address some of the limitations of correlation analysis. For example, Alam *et al.* (2019) find that an average effect across 63 countries is that all macroprudential policies impact on household credit growth. Their impact on house prices is, on the other hand, weaker. Only the tightening of certain tax-related macroprudential policies can significantly moderate house price growth. This empirical evidence based on a large set of countries is in line with Akinci and Olmstead-Rumsey (2018) and also consistent with the findings of Kuttner and Shim (2016) and Vandenbussche *et al.*

[2] A stylised feature of macroprudential policies is that the number of policy actions per country per unit of time, typically a quarter, is low. This is the reason these studies are typically undertaken within an international context to exploit the cross section nature of the panel structure to have enough variation to yield statistical meaningful results.

(2015).

The studies cited above typically control for endogeneity using GMM methods, however, caution should be taken when making causal claims due to issues such as reverse causality and contemporaneous effects.[3] Few papers in the literature use a structural VAR (SVAR) approach that does not hinge on the timing assumption and therefore are able to claim causal effects of exogenous variations in macroprudential policy actions and to provide economically interpretable impulse responses.[4] Kim and Mehrotra (2017) and Klingelhöfer and Sun (2019) address this issue using a recursive ordering identification strategy by means of a Cholesky decomposition. The latter study finds that a macroprudential policy shock lowers credit and that there is not an explicit trade-off between macroprudential and monetary policies. This finding lends support to the view that the two policies can act independently of each other. This is the thesis proposed by Svensson (2018) and Beau *et al.* (2012). However, the evidence in Kim and Mehrotra (2017) suggests that the qualitative impact of monetary policy rates is similar to the macroprudential policy instrument, and therefore a trade-off arises between the two policies. Theoretical studies by Angelini *et al.* (2011), Rubio and Carrasco-Gallego (2014) and Gelain and Ilbas (2017) show that there is scope for welfare gains derived from coordination between the two policies. The empirical evidence about the impact of macroprudential policies on monetary policy target variables is therefore still inconclusive.[5]

The use of recursive ordering as an identification strategy presents certain limitations, especially so in the presence of foresight in economic models (see Ramey, 2016).[6] Identification strategies in SVAR analyses that are robust to the presence of foresight and that allow the identification of both surprise and news shocks is the second strand of the literature our paper is related to. In particular, our study employs a combination of a nar-

[3]See Galati and Moessner (2018) for a detailed discussion about disadvantages of panel regression and other methods employed to examine the effectiveness of macroprudential policies.

[4]An alternative method to infer the causal effect of one particular macroprudential instrument, LTV caps, on credit and house prices has been employed by Alam *et al.* (2019) and Richter *et al.* (2019). They use an inverse propensity-score weighted estimator and conclude that changes in the maximum LTV likely cause credit and house price changes.

[5]Alternative empirical evidence based on correlation analysis between macroprudential and monetary policy actions also provide an ambiguous picture. Cerutti *et al.* (2017) show that there is not a clear pattern across countries and Akinci and Olmstead-Rumsey (2018) find a lack of pattern across macroprudential instruments.

[6]An alternative identification method applied to proxy VARs in the context of macroprudential policies in the US is developed by Budnik and Rünstler (2020). The identification of policy shocks is done using as an instrument a constructed macroprudential policy narrative indicator based on capital requirements and mortgage underwriting standards. One of the implications of their study is that static panel regression methods may significantly underestimate the impact of policies.

rative approach and the econometric methodology developed by Barsky and Sims (2011) to identify both an unanticipated or surprise shock and an anticipated or news shock that drive exogenous variations of the variable of interest. We note that, until recently, most of the literature on identification of structural shocks has focused on the effects of unanticipated or surprise shocks. However, agents may receive signals about future changes before those changes actually take place and the empirical strategy needs to address the non-uniqueness problem generated by foresight in econometric models (see Leeper *et al.*, 2013). Kurmann and Otrok (2013) follow Barsky and Sims (2011) to examine the impact of news shocks about future total factor productivity (TFP) in the term structure of interest rates.[7] The identification of news shocks has also been used to assess the impact of unanticipated and anticipated fiscal and monetary policy shocks. For the case of the US, Mertens and Ravn (2012) provide evidence of the differential effect of both types of shocks on macroeconomic aggregates while Forni and Gambetti (2016) document their impact on the exchange rate and the trade balance. Anticipated shocks in monetary policy in the US have been identified by Ben Zeev *et al.* (2019) using the Barsky and Sims (2011) methodology. In this case, news shocks that may cause agents to anticipate policy rate decisions can arise as a consequence of forward guidance, or more generally, commitments to future actions, changes in the membership of committees, or even public commentary by market participants. Our paper will relate to this literature because it will be the first to examine the impact of both unanticipated and anticipated shocks within a macroprudential policy context.

The reminder of the paper proceeds as follows. In Section 2, we describe the construction of the Euro Area Macroprudential Policy index (EAMPP) and we present its main stylised facts over the last two decades. Section 3 describes the empirical methodology that we employ to obtain both unanticipated and anticipated prudential policy shocks and to examine their impact on macroeconomic outcomes. In Section 4, we discuss the main empirical findings. Finally, Section 5 presents some concluding remarks.

[7]This method has also been used within the business cycle literature by, among others, Beaudry and Portier (2014) and Ben Zeev and Khan (2015).

2 Euro Area Macroprudential Policy Index (EAMPP)

To construct the Euro Area Macroprudential Policy index (EAMPP) we employ the Macro-Prudential Policies Evaluation Database (MaPPED). This database is the product of a collective effort by ECB staff and experts from national central banks and supervisory authorities from the 28 EU member states.[8] For the euro area countries, MaPPED provides information about 1205 policy actions between 1995 and 2019.[9] These policy actions relate to the following 11 different macroprudential policy tools (or instruments): capital buffers, lending standards, maturity mismatch tools, limits on credit growth, exposure limits, liquidity rules, loan loss provisions, minimum capital requirements and risk weights, leverage ratio, and the final one labelled as 'other measures'.

We now highlight some of the key characteristics of MaPPED and how it compares with other existing macroprudential policy databases.[10] The first characteristic is that MaPPED provides details about the life-cycle implementation of each policy instrument in each country, that is, the activation date, subsequent changes in the scope or the level of the policy, and the deactivation date. Policy actions are therefore the unit of observation. For instance, an activation, a subsequent change in the level, and a posterior deactivation of a policy that limits credit growth and volume are three different policy actions that belong to the same policy instrument. This allows to measure the impact of each policy not only when it is first activated, but also when it is recalibrated or deactivated. This analysis would not be possible with other databases because the only information provided is the date the policy instrument was first implemented. A second characteristic is that the survey designed for MaPPED is such that policy tools and actions reported are perfectly comparable across countries. This overcomes potential biases that may arise employing other databases due to their lack of harmonisation in open-text questionnaires (Budnik and Kleibl, 2018).[11] The third and final characteristic we note is that the information set about

[8] In particular, 90 experts from the EU national central banks and supervisory authorities that belong to the Financial Stability Committee (FSC) were involved in the creation of MaPPED.

[9] We note that we only employ a subset of countries included in the database, those of the euro area. However, MaPPED originally provided details on almost 1700 macroprudential policy actions in the 28 member states of the EU between 1995 and 2014. Since the database is regularly updated (twice a year), we expand the sample period using information up to the second quarter of 2019.

[10] The other main databases are (i) the one from the IMF used in Lim *et al.* (2011), (ii) databases from BIS employed by Shim *et al.* (2013), (iii) the IMF Global Macroprudential Policy Instruments Database (GMPI) used in Cerutti *et al.* (2017), and (iv) the iMaPP by Alam *et al.* (2019).

[11] MaPPED has been carefully designed with that concern in mind and respondents can only choose from a closed list of policy tools. Thus, both the questionnaire design and subsequent revisions are consistent and aiming at ensuring comparability across countries and across measures (Budnik and Kleibl, 2018). This is particularly relevant for the case of the EU because other datasets may include policies in some EU

each policy provided by MaPPED is broader than the one given by other macroprudential policy databases. In particular, it specifies, among other things, the announcement date of the policy,[12] the stance (loosening, tightening, or ambiguous), the main character of the policy (macroprudential or microprudential), and whether it has a countercyclical design or not.[13] We will therefore use the announcement date of the policy to assign a particular value to a policy action as it will be described below.[14] This will be important later on in the empirical analysis to time the identified policy shocks. We will assume that agents can react to policies from the moment they are announced. This issue relates to the arguments in Leeper *et al.* (2013) who note that foresight problems arise as a consequence of inside as well as outside lags.[15] The latter arise whenever there is a delay between the legislation's passage and its implementation. This happens in many of the macroprudential regulations that are introduced around the world.[16] In such a framework, the use of the enforcement date rather than the announcement date could contaminate the identification of an "unanticipated" shock since, by definition, agents would have already known about the policy action, implying the shock would no longer be exogenous.

We have highlighted some of the main features of the database we employ to construct the index and we now proceed to describe how the index has been constructed. First, we only include policies that are 'binding'. Therefore, we do not include policies that are just recommendations. Otherwise, recommendations that do not end up being implemented would bias the results. Second, policy actions will be signed and weighted following the scheme proposed by Meuleman and Vander Vennet (2020). We assign a positive value

states and not in others, even though these instruments have been harmonised across the whole of the EU. Moreover, there is not always an harmonised perception of what should be reported as a macroprudential measure when responding to open-text questionnaires in alternative databases.

[12] While MaPPED provides the enforcement date as well as the announcement date for almost all policy actions, most of the previous databases only contain information about the former.

[13] In the questionnaire, an instrument is said to have a countercyclical design if: (i) its level automatically tightens when systemic risks intensify and loosens when they fade, or (ii) it is regularly (e.g. quarterly) revised and calibrated along with the intensity of cyclical systemic risk by, for example, linking the revisions of an instrument to the evolution of indicators of systemic risk (Budnik and Kleibl, 2018).

[14] MaPPED does not provide the announcement date for 182 out of the 1205 policy actions originally reported in the database. Even though those policy actions with a missing announcement date will be removed from the index to carry out the empirical analysis in subsequent sections, we keep them here in the construction of the EAMPP because in this section the index will only be used to show the stance of the macroprudencial policy in the euro area. Therefore, in this section, we assume that the announcement date for those policies coincides with the enforcement date. In any case, we have run a robustness exercise of the empirical analysis where we include those policies for which the announcement date is not provided and the results barely change.

[15] These labels were introduced by Friedman (1948). In line with Leeper *et al.* (2013) we use that terminology to refer to the "recognition" and "decision" lags (inside lag), and to how long it takes between the enaction and effectiveness of a policy (outside lag).

[16] For instance, around 54% of the total policy tools covered by MaPPED for euro area countries experience a delay between announcement and implementation dates.

Table 1: Weighting scheme of a macroprudential policy tool

Type of Policy Action	Weight	Strengthening / Loosening	Sign	Final Weight
Activation	1	Tightening	+	1
		Other/ambigous impact		0
		Loosening	-	-1
Change in the Level	0.25	Tightening	+	0.25
		Other/ambigous impact		0
		Loosening	-	-0.25
Change in the Scope	0.10	Tightening	+	0.10
		Other/ambigous impact		0
		Loosening	-	-0.10
Maintaning the existing level and scope	0.05	Tightening	+	0.05
		Other/ambigous impact		0
		Loosening	-	-0.05
Deactivation	Dependent on the life-cycle of the tool (cumulative index drops to zero)			

Notes: Description of the weights used to construct the cumulative index for each policy instrument based on Meuleman and Vander Vennet (2020).

to tightening actions, a negative value to loosening actions, and a value of zero to policy actions that have an ambiguous impact or if no macroprudential policy action was announced in that month. Policy actions are given different weights according to the following criteria. First time policy activations receive the highest weight, a lower value is assigned to changes in the level, an even lower value to changes in the scope, and the lowest weight is given to maintaining the existing level and scope of a policy tool. Once the tool is deactivated, the cumulative index drops to zero. A description of this weighting scheme applied to each macroprudential policy instrument can be found in Table 1.

We have already mentioned above that the information provided by MaPPED allows us to link all the policy actions of each policy instrument. We therefore construct for each policy instrument an index that is a cumulative sum of the measures taken during the period from which the specific policy is activated until it is deactivated, using the weighting scheme we just described above. Therefore, the index reflects the macroprudential policy stance of a given policy instrument for a given country, where a higher value of the index reflects a tightening stance of the macroprudential policy. This exercise results in around 470 indices representing the life-cycle of policy instruments or tools across euro area countries over our sample period. We then use those indices to construct a macroprudential policy index for each country by simply adding up the indices of all the policy instruments implemented within a particular country.[17] Finally, we add up the country indices weighted by GDP shares to obtain a single index for the euro area that we call

[17] All instruments carry equal weight. This is the method employed in the literature on macroprudential policy instruments because of the difficulty to predict the type of policies that are more effective in safeguarding the stability of the financial system. Some examples are Akinci and Olmstead-Rumsey (2018), Cerutti *et al.* (2017), and Kim and Mehrotra (2018).

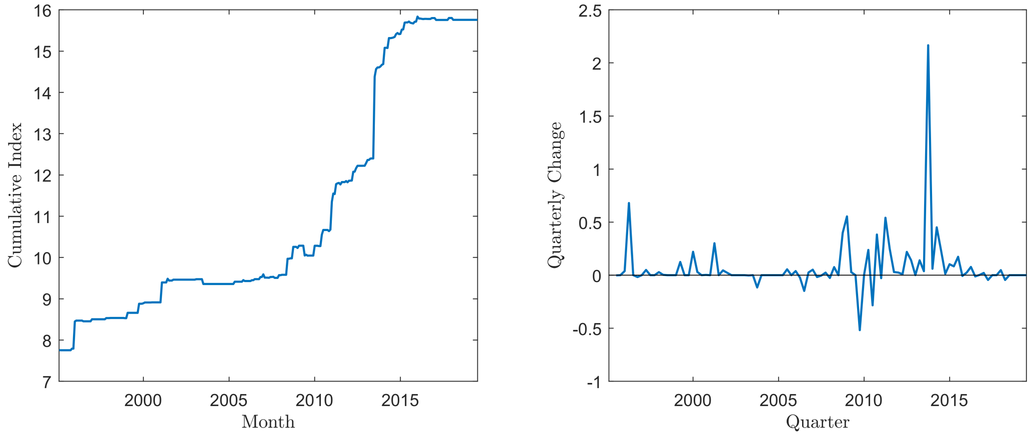

Figure 1: Euro Area Macroprudential Policy Index (EAMPP). Changing composition: EA-11 (1999), EA-12 (2001), EA-13 (2007), EA-15 (2008), EA-16 (2009), EA-17 (2011), EA-18 (2014), EA-19 (2015).

Euro-Area MacroPrudential Policy index (EAMPP).[18]

2.1 Macroprudential Policy Stance in the Euro Area

We use EAMPP, the aggregate index constructed following the procedure described in the previous section, as an indicator of the stance of the macroprudential policy in the euro area. Figure 1 plots the monthly time series of this index as well as its quarterly changes from 1995 until June 2019.[19] We now describe some of the main stylised facts of this policy stance over the last 25 years. First, the fact that the index displays a positive value at the beginning of the sample implies that there were macroprudential policies already at work at the start of the sample and that they had been implemented prior to the creation of the euro with, on average, a tightening stance. Second, there is a small positive trend of the index up until the GFC. Third, despite the fact that at the beginning of the GFC in 2009 there is, on average, a loosening in the stance of the macroprudential policy, continued concerns by the monetary authorities about financial stability in the euro area, later fuelled by the sovereign debt crisis, are reflected in a clear upward trend in the EAMPP index during the following seven years. The tightening stance following the GFC came as a result of a consensus about the need to ensure financial stability by moderating the build up of systemic risk and increasing the resilience of the financial system. This consensus

[18] We use the average GDP share over the period 2008-2015. In any case we note that, since GDP shares are stable over time, assigning time-varying-GDP-share weights has very limited impact on the level of the index. A detailed description of the weights used for each country is provided in the Appendix.

[19] We decided to use quarterly rather than monthly changes to illustrate in a clearer, less noisy, way variations in the macroprudential policy stance. We also note that the first value of EAMPP is not zero. This is due to the fact that 185 out of the 1205 policy actions included in MaPPED had been implemented before 1995. Therefore, EAMPP does take into account the effects of those policies that were part of the macroprudential policy stance at the time.

is illustrated with the arrival of Basel III, an international agreement to implement a set of measures with the aim to strengthen regulation, supervision and risk management of banks. Numerous policies were then implemented and many others were recalibrated from 2012 onwards. For example, the largest quarterly change in EAMPP took place in the third quarter of 2013 when many macroprudential policies were announced in most euro area countries as a result of the introduction of the CRR/CRDIV package at the beginning of 2014.[20] Fourth, we note that the level of EAMPP is almost twice as tightening in 2016 as it was in the years prior to the outbreak of the financial crisis. Finally, macroprudential policy appears to have taken a more neutral stance towards the end of the sample period coinciding with a significant decline in the number of prudential policies implemented in the euro area.[21]

We now complement the discussion about the stylised facts of the macroprudential policy in the euro area with an overview of the evolution of the EAMPP index in tandem with the monetary policy instrument as shown in Figure 2. The monetary policy index is constructed with a combination of the EONIA rate and the shadow policy rate obtained following the methodology developed by Wu and Xia (2016). In particular, we use the EONIA rate from 1999 until 2009, and the shadow rate for the remaining of the sample.[22] The use of the shadow rate overcomes the problem of the zero lower bound of the interest rate and captures the implementation of unconventional monetary policies by the ECB.[23] Looking at this policy rate we note that, prior to the GFC, monetary policy was relatively tightening due to inflationary pressures existing at the time (see Micossi, 2015 for a comprehensive analysis of the monetary policy of the ECB from 2002 until 2015). However, with the onset of the Great Recession, deflationary pressures began to emerge. This fact, coupled with a substantial drop in overall output, led to a change in the policy stance to a significantly more lax monetary policy. This was especially evident after the

[20] The CRR/CRDIV package replaced the Capital Requirements Directives 2006/48 and 2006/49 and it was adopted in the EU to strengthen the regulation of the banking sector and to implement the Basel III agreement within the EU legal framework. A description of policies announced in 2013 and subsequently implemented in 2014 as a consequence of the CRR/CRDIV package can be found here: https://www.esrb.europa.eu/pub/pdf/other/150625_review_macroprudential_policy_one_year_after_intro_crdcrr.en.pdf

[21] For instance, the average number of policies announced in the period 2016-2019 was approximately 2 per quarter. This contrasts with an average of around 13 policies per quarter announced during 1999-2015.

[22] The period with a common monetary policy for the euro area countries, from 1999Q1 until 2019Q2, will therefore constitute our sample for the empirical analysis later in the paper.

[23] We note that the correlation between the EONIA rate and the shadow rate between 2004Q4 and 2008Q4 is 0.98. 2004Q4 is the first period for which data on the shadow rate is available, while 2008Q4 is the last period in which we use the EONIA rate as the monetary policy instrument.

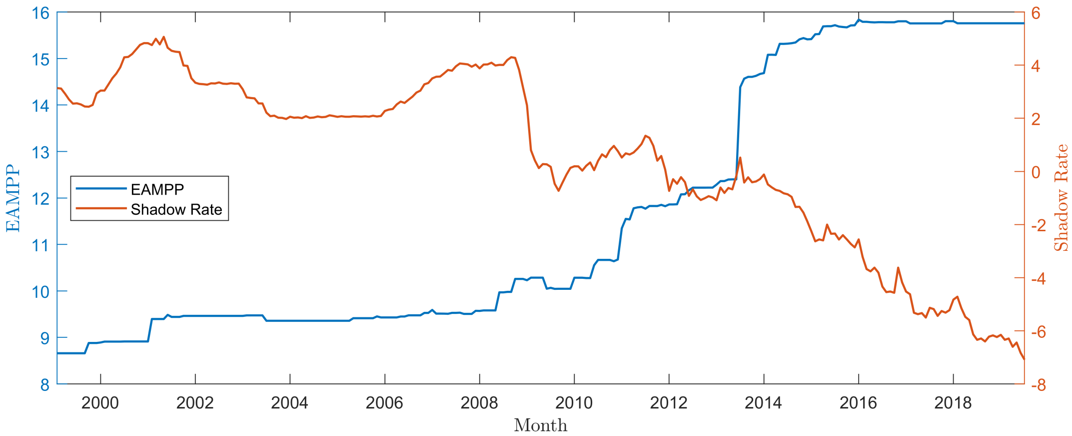

Figure 2: Macroprudential Policy and Monetary Policy in the Euro Area (1999-2019). Changing composition: EA-11 (1999), EA-12 (2001), EA-13 (2007), EA-15 (2008), EA-16 (2009), EA-17 (2011), EA-18 (2014), EA-19 (2015).

sovereign debt crisis. The shadow rate began to take negative values, reflecting unconventional policies such as Quantitative Easing (QE) and Forward Guidance introduced by the ECB within a context of low inflation and growth in the euro area. It is therefore evident that, in a context where deflationary pressures and financial instability co-existed, monetary and macroprudential policies took an opposite stance. The character of both policies also differed towards the end of the sample where monetary policy continued to react to downside risks in inflation.

3 Empirical Strategy

Nonsystematic variations in macroprudential policy need to be identified in order to examine the causal effect of those policies on economic aggregates such as output, prices and financial stability. Since the introduction of Structural VAR (SVAR) models by Blanchard and Watson (1986) and Bernanke (1986), the econometric methods to recover structural shocks from the residuals of the reduced-form VAR have been continuously evolving.[24] These methods include, among others, contemporaneous restrictions (such as recursive identification), sign restrictions, medium horizon restrictions, long-run restrictions, and narrative methods. A recent strand of the literature argues that foresight, or news, about future economic fundamentals or policies do have an affect on macroeconomic outcomes. This research points to the importance of quantifying not only unanticipated but also

[24] We refer the reader to Ramey (2016) for a comprehensive review of methods employed to identify shocks within the SVAR methodology.

anticipated shocks. Lack of identification of the latter type of shocks leads to incorrect identification of the former shocks (see Ramey, 2016). The reason is that foresight generates a second type of non-uniqueness as highlighted by Leeper *et al.* (2013). Failure to correctly identify shocks as a consequence of foresight problems implies that not only impulse response functions, but all conditional statistics, such as forecast error variance decomposition (FEVD) or Granger causality test, will be misspecified.

The literature has so far employed three alternative methods to overcome this issue. First, a narrative approach that introduces new information to aid identification (e.g. Romer and Romer, 2010 or Ramey, 2011). Second, a high-frequency data identification approach that exploits timing to identify news (e.g. Altavilla *et al.*, 2019). Third, the estimation of VAR models in such a way that anticipated effects can be isolated (see for instance Blanchard and Perotti, 2002, Beaudry and Portier, 2006, or Uhlig, 2005). Within this third type of methodology, we now focus on the one we use, the medium horizon identification strategy of Barsky and Sims (2011). This methodology, which was first applied to the RBC empirical literature (e.g. Barsky and Sims, 2011, Ben Zeev and Khan, 2015), has been implemented in different contexts when trying to capture anticipated effects. For instance, it has been implemented to identify fundamental sources driving movements in the term structure of interest rates (Kurmann and Otrok, 2013), news shocks to defense spending (Ben Zeev and Pappa, 2017), and anticipated monetary policy shocks (Ben Zeev *et al.*, 2019).

We argue that, in our context, similarly to what it has been pointed out above with fiscal and monetary policy, there may be changes in the stance of the macroprudential policy that are anticipated by agents. News can, in this regard, include statements that imply high degree of commitment to future policy implementations, informal comments made by policymakers to the media, or implicit communication derived from other actions (e.g. policy committees membership). Therefore, those news shocks need to be identified as part of the exogenous variations in policy to establish causal relationships. We now describe the way the information provided by MaPPED about policies that are systematic responses to the financial cycle and the methodology developed by Barsky and Sims (2011) will be part of our empirical strategy.

Let us assume that the macroprudential policy indicator, EAMPP, evolves according to the following process:

$$EAMPP_t = \gamma(L)\varepsilon_t^{surprise} + \delta(L)\varepsilon_t^{news} + \psi(L)\xi_t \tag{1}$$

where $\varepsilon_t^{surprise}$ is the unanticipated shock, ε_t^{news} is the anticipated shock, and ξ_t is a shock reflecting the non-discretionary part or the systematic component of macroprudencial policies, i.e. macroprudencial policies that react to the financial cycle. Potentially, ξ_t could be a vector, in which case ψ would be a row vector. Lag polynomials are expressed as: $\gamma(L) = \sum_{q=0}^{\infty} \gamma_q L^q$, $\delta(L) = \sum_{q=0}^{\infty} \delta_q L^q$, and $\psi(L) = \sum_{q=0}^{\infty} \psi_q L^q$.

The restrictions of the model are such that $\gamma(0) \neq 0$, i.e., $\varepsilon_t^{surprise}$ can affect EAMPP contemporaneously, and $\delta(0) = 0$, implying that ε_t^{news} is materialized at time t but affects the macroprudential policy stance with at least a lag. It is worth noting at this point that we minimize the effect of ξ_t on EAMPP by re-computing the EAMPP index dropping all the policies that are specific reactions to the financial cycle.[25] Therefore, by excluding those reactive policies that have a countercyclical design we obtain an index that is exogenous to the financial cycle. This is because the remaining policies included in EAMPP can be regarded as exogenous in the Romer and Romer (2010)'s sense.[26] In particular, we can think of this new narrative measure of the EAMPP index as being exogenous as long as the policies included in the index were implemented pursuing goals such as long-run financial stability.[27] Therefore, we assume that the only structural shocks driving the adjusted EAMPP index are the macroprudential policy surprise shock and the macroprudential policy news shock.

Finally, we note a few additional advantages of using the Barsky and Sims (2011) methodology within our framework. First, a multivariate structure, unlike a univariate

[25] We explained in section 2 that MaPEED provides a classification of the policy actions that includes the ones that explicitly target the financial cycle, i.e., those with a counter-cyclical design. In that sense, our methodology is in line with the narrative identification approach followed by Richter *et al.* (2019). These authors drop the policies targeting real as opposed to financial objectives to extract causal relationships from the remaining prudential policies.

[26] The spirit of Romer and Romer (2010) has also been used by Fieldhouse *et al.* (2018) and Rojas *et al.* (2020). Fieldhouse *et al.* (2018) within their narrative approach to examine the impact of anticipated agency mortgage holdings, exclude those policy interventions that have short-run stabilisation objectives. Rojas *et al.* (2020) adopt a narrative approach to identify exogenous changes in reserve requirements in three Latin American countries (Argentina, Brazil, and Uruguay) and show that the inclusion of cyclically-policy motivated changes can lead to a bias in the results obtained.

[27] This is because, as mentioned above, the narrative measure of the EAMPP index only contains those policies that are proactive, that is, that have as ultimate goal financial stability, which is a long-run goal. For instance, we note the following remark: "At the same time it should be emphasised that the ultimate objective of macro-prudential policy is financial stability and not stimulating credit and economic growth *per se*" (ESRB, 2016). Our approach therefore follows from Romer and Romer (2010) who identify as exogenous, in the fiscal policy context, those tax changes that were a response to concerns about long-run economic growth or about the state of government debt.

one, allows the identification of the impact of the news shock on the macroprudential policy index because the other variables in the system will react contemporaneously to the anticipated shock. Therefore, once $\varepsilon_t^{surprise}$ is identified and controlled for, the news shock ε_t^{news} is identified as the shock that is orthogonal to the surprise shock and best explains all the remaining variations in EAMPP over a given horizon. Second, it does not rely on other auxiliary assumptions about other shocks. This allows the implementation of this method to a system with any number of variables without having to impose additional restrictions. Third, medium-run identification strategies, as in our case, outperforms standard long-run restrictions in finite samples (Francis *et al.*, 2014). Fourth, it is not necessary to make any assumption about the order of integration or about a cointegration relationship among the variables included in the system.

3.1 Macroprudential policy surprise shock

We have reviewed above the main assumptions and advantages of our empirical strategy, and we now proceed to the description of the econometric method we employ. Let us consider the following SVAR(p) model:

$$B_0 Y_t = B_1 Y_{t-1} + ... + B_p Y_{t-p} + \varepsilon_t, \tag{2}$$

where deterministic components are not included, Y_t is a $Kx1$ vector of zero mean endogenous variables, B_i, $i = 0, ..., p$ is a KxK matrix, and ε_t is a $Kx1$ vector of structural disturbances. The structural elements of ε_t are mutually uncorrelated such that the variance-covariance matriz Σ_ε is a diagonal matrix containing the variance of the structural shocks. Error variances are normalised to unity, therefore $\Sigma_\varepsilon = I_k$.

This model can be expressed in the following reduced form:

$$Y_t = A_1 Y_{t-1} + ... + A_p Y_{t-p} + u_t, \tag{3}$$

where $A_i = B_0^{-1} B_i$, $i = 1, ..., p$, $u_t = B_0^{-1} \varepsilon_t$, and the reduced-form error covariance matrix is given by $E(u_t u_t') = \Sigma$. Under stationarity, the above process has a moving average representation:

$$Y_t = C(L) u_t, \tag{4}$$

where Y_t is a $Kx1$ vector of variables observed at time t; $C(L) = \sum_{i=0}^{\infty} C_i L^i$ is a lag polynomial; and u_t is a $Kx1$ vector of one step ahead forecast errors with variance-covariance matrix $E(u_t u_t') = \Sigma$.

Identification of the structural shocks amounts to finding a mapping B_0^{-1} between the residuals u_t and a vector of mutually orthogonal shocks ε_t ; i.e., $u_t = B_0^{-1}\varepsilon_t$. The key restriction on the impact matrix B_0 is that it needs to satisfy $\Sigma = E[B_0^{-1}\varepsilon_t\varepsilon_t' B_0^{-1\prime}] = B_0^{-1}B_0^{-1\prime}$. This restriction is, however, not sufficient to identify B_0^{-1} because for any matrix B_0^{-1}, there exists some alternative matrix $\tilde{B_0}^{-1}$ such that $\tilde{B_0}^{-1}Q = B_0^{-1}$, where Q is an orthonormal matrix that also satisfies $\Sigma = \tilde{B_0}^{-1}\tilde{B_0}^{-1\prime}$ (note that: $\Sigma = \tilde{B_0}^{-1}QQ'\tilde{B_0}^{-1\prime} = \tilde{B_0}^{-1}\tilde{B_0}^{-1\prime}$). This alternative impact matrix maps u_t into another vector of mutually orthogonal shocks $\tilde{\varepsilon}_t$; i.e., $u_t = \tilde{B_0}^{-1}\tilde{\varepsilon}_t$. Therefore, for some arbitrary matrix $\tilde{B_0}^{-1}$ satisfying $\Sigma = \tilde{B_0}^{-1}\tilde{B_0}^{-1\prime}$ (e.g., a Cholesky decomposition of Σ), identification reduces to choosing an orthonormal matrix Q such that $\tilde{B_0}^{-1}Q = B_0^{-1}$. Hence, in a VAR in which the EAMPP is ordered first, we identify $\varepsilon_t^{surprise}$ as the shock associated with the first column of the matrix $\tilde{B_0}^{-1}$ obtained from a Cholesky decomposition.

3.2 Macroprudential policy news shock

The second shock driving macroprudential policy is identified using the forecast error variance (FEV) maximization approach of Barsky and Sims (2011). Let denote the h-step-ahead forecast error of the i-th variable $y_{i,t}$ in Y_t by

$$y_{i,t+h} - y_{i,t+h|T} = e_i' \left[\sum_{l=0}^{h-1} C_l \tilde{B_0}^{-1} Q \varepsilon_{t+h-l} \right], \tag{5}$$

where e_i is a column vector with 1 in the i-th position and zeros elsewhere. Therefore, based on a VAR with the variable EAMPP ordered first and Cholesky decomposition $\tilde{B_0}^{-1}$, we solve for the following

$$q^* = \text{argmax } e_1 \left[\sum_{k=\underline{k}}^{\overline{k}} \sum_{l=0}^{h-1} C_l \tilde{B_0}^{-1} q q' \tilde{B_0}^{-1\prime} C_l' \right] e_1 \quad s.t \quad q(1) = 0, q'q = 1. \tag{6}$$

We therefore proceed to identify the news shock as the column q of Q that maximizes the sum of the forecast error variance of the macroprudential policy index over some horizon from $\underline{k}$ to $\overline{k}$, imposing two restrictions: first, that it does not contemporaneously affect EAMPP, and second, that it belongs to an orthonormal matrix Q.

4 Empirical Evidence

4.1 Data and VAR Specification

We employ a seven-variable VAR model with quarterly frequency. The first variable is the narrative measure of the EAMPP index described in Section 3. This index captures the stance of the macroprudential policy in the euro area. To convert the index from monthly to quarterly frequency, we take the observation of the last month of each quarter. We later standardize the EAMPP index to ease interpretation of results. In order to assess the effect of macroprudential policies and its relationship with monetary policy, we include a number of variables that may be considered as targets for any of those two policies. In particular, we include total credit to private non-financial sector, real gross domestic product (RGDP), and core consumer prices. We note that excessive credit growth is one of the intermediate objectives of macroprudential policy.[28] Furthermore, empirical evidence suggests that domestic credit expansion is among the most robust and significant predictors of financial crises (see e.g. Gourinchas and Obstfeld, 2012; Jordà *et al.*, 2015), and that total credit to the private non-financial sector rather than just bank credit better predicts the risk of systemic crises (Drehmann, 2013; and Alessi and Detken, 2018).[29] In addition to this, high procyclicality of credit is a source of a weakening financial system and less resilient banking institutions, making it undesirable from a financial stability perspective. This is the reason the inclusion of RGDP in the system will allow us to examine its evolution in conjunction with credit. Finally, the prime monetary policy target is captured by core CPI price series as it is customary in the literature.

In order to ensure the model incorporates forward looking variables, we include inflation expectations and the index VSTOXX. Inflation expectations are measured by the ZEW Financial Market Survey. This is a survey completed by financial experts who are asked to express their medium-term expectations (6-month ahead) about the development of a number of variables, including the inflation rate (and employed in other studies such as

[28] For instance, see ESRB (2013) for a review of recommendations, objectives and instruments of macroprudential policies.

[29] Notwithstanding this, we carry out robustness analyses with other measures of financial stability such as a systemic risk index (CISS), bank credit, and household credit, as shown further below in Section 4.3.

Hachula *et al.*, 2020).[30] VSTOXX is the European counterpart of VIX, and it is supposed to capture future financial market volatility (e.g. Csonto and Ivaschenko, 2013; Ghysels and Marcellino, 2018), global risk conditions (e.g. Akinci and Olmstead-Rumsey, 2018 or Alam *et al.*, 2019), and the global financial cycle (e.g. Passari and Rey, 2015, Cerutti *et al.*, 2019).[31] Finally, we include as monetary policy instrument the combination of the EONIA rate, from 1999 to 2009, and the shadow rate as developed by Wu and Xia (2016), from 2009 until the end of the sample. We use this variable for the reasons explained in subsection 2.1.

The sample period is from 1999:Q1 until 2019:Q2. The beginning of the sample coincides with the date of the introduction of the euro currency. The VAR model is estimated in levels with 4 lags of each variable.[32] We estimate the model employing Bayesian techniques and impose a Minnesota prior with the same values for the hyperparameters as in Kurmann and Otrok (2013).[33] For the FEV maximization problem we choose $\underline{k} = 0$ and $\overline{k} = 24$.[34]

4.2 Empirical Results

4.2.1 Unanticipated Shocks

Figure 3 presents the impulse responses of the SVAR variables to a one standard deviation macroprudential policy surprise shock. The top-left figure shows that the unanticipated shock generates a persistent effect on the policy index and therefore has a long-lasting impact on the stance of macroprudential policy. Regarding the other variables in the VAR system, we first discuss the ones that are more closely related to the ultimate prudential policy objective of safeguarding financial stability. We start with the response of total credit to the private non-financial sector. A tightening macroprudential surprise shock generates on impact a drop in credit that later accentuates and persists over the medium

[30] Castelnuovo and Surico (2010) show that the omission of a variable capturing expected inflation could give rise to the price puzzle in the monetary policy context within a VAR framework.

[31] As a robustness exercise, we have replaced the index VSTOXX with the VDAX index. VDAX is the German analogue of VIX. We run our analysis with this index given the influence that this country has on the financial cycle of the euro area as a whole. Results available upon request are found to be qualitative the same.

[32] A logarithm transformation is applied to all variables except for the two policy instruments and inflation expectations. A complete description of data, sources, and seasonal adjustments is provided in the Appendix.

[33] We are grateful to Andree Kurmann and Christopher Otrok for making their code available online at OpenICPSR.

[34] For robustness purposes, we have also performed the analysis with longer truncation horizons. Specifically we set $\overline{k} = 30$ and $\overline{k} = 40$. We find quantitative and qualitative similar results.

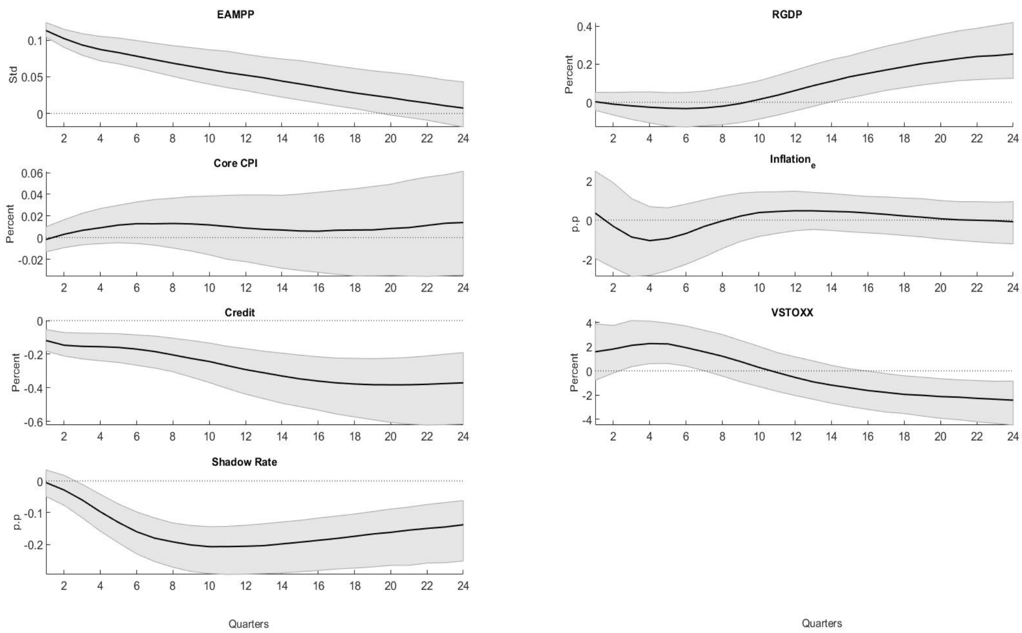

Figure 3: Impulse Responses to a Macroprudential Surprise Shock. This figure shows the median and 16th and 84th posterior percentiles of the impulse responses to the macroprudential surprise shock from the SVAR

term. The finding that a prudential tightening reduces credit is in line with theoretical arguments, and is also in line with work previously done in the literature employing alternative methods as noted in the introductory section.

We now examine another central issue about macroprudential policy: whether it is able or not to reduce the pro-cyclicality of credit. This is important because, if the policy is effective, prudential authorities could avoid excess credit from building up in the system during boom years that would later become a source of risk to financial stability. In this regard, we observe that the response of aggregate output is clearly negatively correlated to that of credit, therefore implying that a surprise macroprudential shock lowers the pro-cyclicality of credit.

In addition, we note that VSTOXX, a variable that captures the global financial cycle and risk conditions, is also reduced over the medium term. However, this decline is preceded by an initial increase following the surprise shock. Expected future market uncertainty and global risk conditions do not respond positively to the shock on impact. It takes a few quarters before the rise in risk perception dissipates, but it ultimately declines and falls below base line over the medium term.

The impulse responses of the variables that we have so far discussed indicate that, overall, a macroprudential surprise shock produces the desired effects: it curbs credit, reduces expected market volatility over the medium term and it moderates the pro-cyclicality of credit.

We now turn to one of the topics that is still at the early stages of research but that is essential to the design of macroeconomic policies: the relationship between macroprudential and monetary policies. We already highlighted in the introduction that this literature has not yet reach a consensus about neither the empirical evidence of such relationship nor the normative aspects of it. To shed light on the former issue we first analyse the impact of the macroprudential shock on the ECB's primary monetary policy target, i.e., price stability. We observe that the effect of an unanticipated tightening macroprudential shock on inflation expectations is initially negative although the uncertainty about the estimates is large, hence the effect is not significant. Furthermore, the shock barely affects core CPI prices. Therefore, the surprise macroprudential policy shock has no overall effect on price stability.[35]

Regarding the response of the monetary policy rate, we find that the macroprudential innovation causes the rate to move in the opposite direction, i.e., experiences a gradual decline. This response suggests that monetary policy is able, through an accommodative stance, to stop economic growth, a secondary monetary policy objective, from deteriorating due to the decline in credit. This way, monetary policy can in this case be considered to complement the tightening macroprudential policy shock such that policy objectives are achieved.[36] The consensus is that more than one policy objective, such as financial stability and price stability, cannot be achieved with only one policy. Our empirical evidence suggests that, within the euro area, macroprudential policies have not generated a policy trade-off with regard to prices,[37] and that monetary policy has therefore been able to complement macroprudential policies.[38]

[35] This result reinforces the view that a macroprudential surprise shock is qualitatively different from a monetary policy shock and that a lack of an explicit trade-off between those policies regarding prices facilitates their complementarity as highlighted in previous literature (see Kim and Mehrotra, 2017).

[36] Budnik (2020) finds evidence that the coordination of macroprudential and monetary policy in EU member states has been effective and that such coordination can enhance the policy mix. Additional empirical evidence in Maddaloni and Peydró (2013) suggests that both policies tend to reinforce each other in the euro area.

[37] This is in line with Svensson (2018) who argue that macroprudential policy has a small and unsystematic effect on inflation. Moreover, this result is similar to Richter *et al.* (2019). They find that a tightening macroprudential policy (note that they only focus on LTV tools) has a small positive effect, although in their case it is significant, on the price level at very short horizons, becoming not significant at longer horizons.

[38] This has previously been noted by IMF (2012): *"If macroprudential policies have strong effects on output, more accommodative monetary policy can offset these effects as necessary"*.

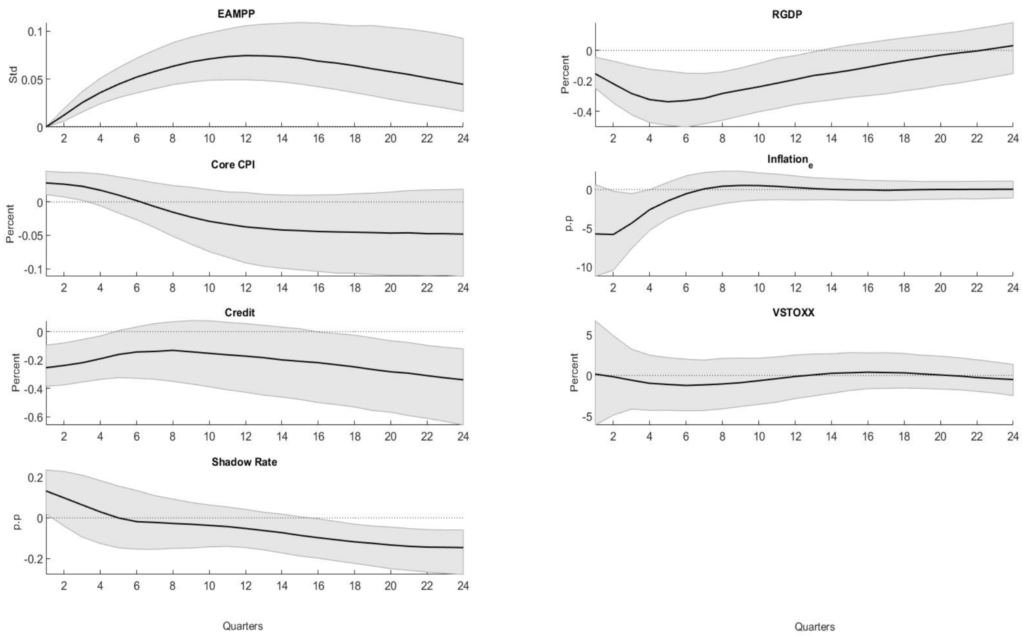

Figure 4: Impulse Responses to a Macroprudential News Shock. This figure shows the median and 16th and 84th posterior percentiles of the impulse responses to the macroprudential news shock from the SVAR.

4.2.2 Anticipated Shocks

Figure 4 presents the impulse responses of the system variables to the news shock described in subsection 3.2. We start by noting that an anticipated macroprudential shock generates a gradual tightening in the policy itself that persists over time. Regarding financial stability, we find that a news shock of tightening nature reduces credit from the initial period, credit then moderates its decline before dropping again over the medium term. Aggregate output also falls initially but, more importantly, we note that total credit to the non-financial sector and real output dynamics are such that their growth rates negatively correlate, hence lowering the pro-cyclicality of credit. News shocks do, on the other hand, have a muted effect on expected financial market volatility or global risk conditions.

Having examined the impact on financial stability measures, we now discuss the impact of macroprudential news shocks on monetary policy and its targets, price stability and output. An anticipated tightening shock generates an initial small increase in core prices followed by a gradual and sustained decline. However, the estimate uncertainty is high after a few periods and the impact on prices becomes insignificant. An insignificant response is also observed for inflation expectations. The fact that the news shock barely impacts the primary monetary policy objective of the ECB facilitates the complementarity of monetary policy. We observe that the monetary policy rate reacts to the news shock with an increase in its level, complementing the tightening nature of the anticipated macroprudential shock and also driven by the small initial price increase. However, this is soon reversed, and the monetary policy rate turns negative over the medium term which helps to support growth conditions and avoid deflationary pressures. This response of the monetary policy rate also helps, as pointed out above, to reduce the pro-cyclicality of credit.

Our empirical evidence suggests that there are differences characterising the impact of an unanticipated and an anticipated macroprudential policy shock and that their effects appear to be effective from a policymaking perspective.

4.2.3 Forecast Error Variance Decomposition

The impulse responses have provided economic interpretation to the impact of macroprudential policy shocks. We now examine through the FEV decomposition a few additional features that characterise the two types of shocks. Table 2 displays the median FEV decompositions of the two policy instruments together with their respective primary policy objectives. We first note that, as we expect from the method employed here, the two shocks combine to explain the vast majority of the variation in macroprudential policy at all horizons. Second, there is a difference between the share of the rest of the variables' variation explained by each shock at the short term relative to the medium and long term. At short horizons, while surprise shocks explain very little of the variance decomposition, news shocks account for a relatively larger share of the forecast variance. This suggests that agents react quickly to new information about the stance of macroprudential policy. For instance, signals about future macroprudential policy strongly affect total credit to the non-financial sector, accounting for around 20% of the forecast variance already within the first quarter. A similar proportion is obtained by the surprise shock, although in this case this is attained at the medium to long horizon, following a gradual increase from a small percentage at short horizons. Overall, both macroprudential policy shocks combine to account for around half of credit variability after 24 quarters. Third, we find that macroprudential policy shocks do not explain much of the variation of prices. Neither shock exceeds 12% of the forecast variance of the primary ECB's monetary policy objective, and if both shocks are combined, they never account for more than 15% of prices' forecast error variance.

Table 2: Median Forecast Error Variance Decomposition

	Surprise Shock				News shock			
Horizons	% EAMPP	% Core CPI	% Credit	% Shadow Rate	% EAMPP	% Core CPI	% Credit	% Shadow Rate
h=1	100.00	0.70	4.35	0.61	0.00	8.64	20.38	13.78
h=4	92.28	1.28	7.24	2.81	4.93	6.98	18.70	10.20
h=8	79.26	1.90	10.52	12.34	17.46	6.75	17.34	11.34
h=16	58.69	2.67	20.11	27.96	38.39	10.17	16.28	13.01
h=24	48.82	3.59	27.19	31.80	45.63	12.15	19.44	17.95

Notes: This table displays the median forecast error variance decomposition at different horizons for the two policy instruments and the primary policy objectives.

We now compare these results with the ones in the other two studies that have extracted, via alternative methods, exogenous variations in macroprudential policies, namely, Kim and Mehrotra (2017) for the case of four Asia-Pacific countries, and Klingelhöfer and Sun (2019) for the case of China. We note that while both of those studies find that macroprudential policy surprise shocks do not explain much of the variability in prices, only Klingelhöfer and Sun (2019) find a more significant role in explaining credit fluctuations. While this latter result is in line with ours, we note that we obtain different findings regarding the interaction between macroprudential and monetary policy instruments. We find that macroprudential policy surprise shocks contribute more to the variance decomposition of the policy rate. This strong link between policies is perhaps not surprising given that (i) prudential policy shocks affect output, and (ii) the euro-area monetary authorities had to deal, over our sample period, with periods of major financial instability such as the effects of the GFC, which were more severe in Europe than in Asia, and the euro area sovereign debt crisis. This is also illustrated by the fact that the correlation between the macroprudential policy index EAMPP and the monetary policy rate is strong (around -0.90), negative and significant, while in the case of the Asia-Pacific countries, as shown by Bruno *et al.* (2017), is positive and weaker.[39]

4.3 Robustness Analyses

4.3.1 Alternative target variables for macroprudential policy

In the previous section we included total private credit to non-financial institutions as the variable capturing the intermediate target of macroprudential policy. We now consider three alternative model specifications where we replace the credit variable by three other variables that could potentially capture the objectives of macroprudential policy. In par-

[39] Specifically, they find a correlation of around 0.25 for a sample of 12 Asia-Pacific economies during 2004–2013. However, we note that their results are not directly comparable to ours because macroprudential and monetary instruments are defined differently.

ticular, we use a composite index named CISS, constructed by the ECB, that serves as an indicator of systemic risk. The other two alternative variables are two different measures of credit, bank credit and household credit. We briefly discuss here the main results and do not report the impulse responses for space consideration, even though they are available from the authors upon request.

First, the empirical results of the model with a measure of systemic risk, CISS, barely change relative to the baseline model. This result is reassuring given that the macroprudential target of financial stability is not as explicitly defined as the targets in other type of policies, such as monetary policy. Second, in the specification where we replace total credit by bank credit, we find that the impulse responses of all the variables are quantitatively and qualitatively similar to the baseline model. The only difference we note is the response of bank credit. In particular, our results show that the overall decline in bank credit as a response to both type of shocks is more pronounced. In the third alternative specification where we use household credit, we find that, in response to the news shock, (i) there is an initial rise in VSTOXX, although the initial response is not significant, and (ii) the decline in household credit is stronger than in the baseline model. Regarding the responses to a macroprudential policy surprise shock, we find that (i) the decline in credit becomes not significant, and (ii) output experiences an increase from the initial period.

4.3.2 Granger causality and autocorrelation

This robustness analysis aims to provide further evidence about the fact that the series identified as surprise and news shocks can be considered as shocks. Ramey (2016) shows that many of the structural shocks identified in the literature do not satisfy this property because some of them are serially correlated or Granger caused by some other forward-looking variables.[40] To address this issue, we carry out the following two analyses. First, we test for Granger causality using seven forward-looking survey series that contain information on expectations about whether credit standards applied to loan approvals will be tightened or eased within the following three months.[41] A description of these series can

[40] Forni and Gambetti (2014) proposed a formal test to verify whether the identified shocks suffers from the problem of informational insufficiency. However, this specific test cannot be easily implemented in the context of the euro area given the lack of availability of numerous time series capturing all of the relevant macroeconomic information at the aggregate level. Instead, we choose to capture expectations about future macroprudential policy to check if our shocks are anticipated by the economic agents.

[41] These series are survey responses of senior loan officers from a representative sample of euro area banks. The series focus on the "net percentage", that is, the difference between the share of banks reporting that credit standards applied to loan approvals will be tightened and the share of banks reporting that they

be found in the Appendix.

We proceed as follows:

1. We extract up to three principal components f_t^n, $n = 1, 2, 3$, from the seven survey series. We stop at $n = 3$ because the first three principal components already explain around 98,4% of the total variance.

2. We run the following regression:

$$\varepsilon_t^i = \alpha_0 + \sum_{n=1}^{N} \sum_{l=1}^{L} \beta_l^n f_{t-l}^n + \omega_t \tag{7}$$

where ε_t^i is the median of the identified shock, with $i = surprise, news$, and $L = 1, ..., 4$, $N = 1, 2, 3$.

3. We test whether the estimated principal components Granger-cause the identified shocks using a standard F-test.

Table 3 shows the p-values for the different specifications for which the Granger causality test has been implemented. The null hypothesis cannot be rejected in any of the cases at any reasonable significance level. This result provides evidence supporting the exogeneity of both type of shocks as none of them are predicted by the surveys.

Table 3: Granger Causility test

	Surprise Shock			News shock		
L\N	1	2	3	1	2	3
1	0.87	0.98	0.62	0.66	0.62	0.75
2	0.97	0.99	0.70	0.37	0.57	0.78
3	0.40	0.75	0.80	0.63	0.69	0.77
4	0.57	0.78	0.88	0.76	0.44	0.50

Notes: This table displays the p-value from a Granger-causility test. L and N are the number of lags and factors included in each specification, respectively. The tests for Granger causality are conducted by regressing each type of shock on the principal components extracted using the seven forward-looking survey series.

The second analysis is a test for serial correlation of the estimated structural shocks. This is done by regressing the shocks on their own two lags and testing their joint significance. The p-values are 0.47 for the surprise shock and 0.77 for the news shock, and

will be eased. Since these series are only available from 2003 onwards. We test for Granger causility using the sample period 2003:Q1 until 2019:Q2.

therefore, in neither of the two cases can the null of no serial correlation be rejected at any reasonable significance level.

5 Conclusions

There is international consensus that economic authorities should have, as part of their policy objectives, a mandate over financial stability. Complex and interconnected financial systems across countries require a macro or system-wide approach to safeguard the stability of the system. Monetary authorities develop and implement macroprudential policies to achieve this goal with the aim to avoid economic crises driven by financial distress and to experience long-term sustainable growth. Despite their importance, there is limited knowledge about the overall stance of macroprudential policies, the effectiveness of those policies and the way they interact with monetary policies. This paper addresses that gap for the case of the euro area. The euro area presents a particularly interesting case of study because of its inherently international structure and because, within the relatively short life span of the euro, their countries have experienced historical episodes of significant financial instability and economic crises.

We employ MaPPED, a comprehensive database about macroprudential policies constructed by the ECB in conjunction with the national central banks, to compute EAMPP, a novel index that captures the overall stance of the macroprudential policy in the euro area. We highlight the main stylised facts of this policy index and note that, over the last two decades, it has progressively tightened. This contrasts with a progressively accommodative monetary policy. The contrasting general trend of these two policies may not be surprising given this period of time has been characterised by both deflationary pressures and risks coming from the financial system.

To examine the effect of macroprudential policies and their interaction with monetary policy we employ a combination of a narrative approach and a structural VAR method developed by Barsky and Sims (2011) to extract both unanticipated or surprise macroprudential policy shocks and anticipated or news shocks. This identification strategy addresses the issue of non-uniqueness in economic models generated by foresight as shown by, among others, Leeper *et al.* (2013). Our main finding is that there are differences characterising the impact of each type of shock and that macroprudential policy contributes over the medium term to reduce credit growth, the pro-cyclicality of credit, systemic risk and, overall, financial instability. Moreover, macroprudential policies do not have a significant effect on price stability, the main target of monetary policy. Our findings also show a significant link between macroprudential and monetary policies that, for our sample period that includes the GFC and the sovereign debt crisis, implies an effective macroeconomic policy mix.

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Appendix

Table A1: Description of the variables, source, and whether seasonally adjusted.

Variable	Source	X-13 ARIMA
Real GDP	Federal Bank Reserve of St.Louis (FRED)	Yes
Consumer Price Index: Total All Items Less Food, Energy, Tobacco, and Alcohol	Federal Bank Reserve of St.Louis (FRED)	Yes
Inflation Expectations (ZEW survey series: 6 months ahead)	DataStream	No
Euro Interbank Offered Rate (EONIA)	Statistical Data Warehouse	No
Euro Area Macroprudential Policy Index (EAMPPI)	Authors' estimation using MaPPED database	No
STOXX 50 Volatility (VSTOXX)	Qontigo	Yes
DAX New Volatility (VDAX)	Datastream	Yes
Total Credit to the Private Non-Financial Sector	Bank for International Settlements (BIS)	Yes
Total Credit to Households and Non-Profit Institutions Serving Households	Bank for International Settlements (BIS)	Yes
Credit to Private Non-Financial Sector by Domestic Banks	Bank for International Settlements (BIS)	Yes

Table A2: Description of the forward-looking credit surveys and data sources employed in the robustness analyses.

Variable	Source
Credit standards-Large enterprises-Enterprise	Bank Lending Survey Statistics, Statistical Data Warehouse
Credit standards-Long-term loans-Enterprise	Bank Lending Survey Statistics, Statistical Data Warehouse
Credit standards-Overall-Enterprise	Bank Lending Survey Statistics, Statistical Data Warehouse
Credit standards-Small- and medium-sized enterprises-Enterprise	Bank Lending Survey Statistics, Statistical Data Warehouse
Credit standards-Short-term loans-Enterprise	Bank Lending Survey Statistics, Statistical Data Warehouse
Credit standards-Household-Consumer credit	Bank Lending Survey Statistics, Statistical Data Warehouse
Credit standards-Household-Loans for house purchase	Bank Lending Survey Statistics, Statistical Data Warehouse

Table A3: Weights for the construction of the EAMPP based on GDP shares (%).

	1995-2000	2001-2006	2007	2008	2009-2010	2011-2013	2014	2015-2019
Austria	3.28	3.21	3.20	3.19	3.17	3.16	3.15	3.15
Belgium	4.00	3.91	3.90	3.89	3.86	3.85	3.84	3.84
Cyprus	0.00	0.00	0.00	0.20	0.19	0.19	0.19	0.19
Estonia	0.00	0.00	0.00	0.00	0.00	0.17	0.17	0.17
Finland	2.05	2.01	2.00	1.99	1.98	1.98	1.97	1.97
France	22.04	21.55	21.47	21.41	21.25	21.22	21.17	21.17
Germany	28.68	28.05	27.95	27.87	27.66	27.62	27.56	27.56
Greece	0.00	2.21	2.20	2.19	2.18	2.17	2.17	2.17
Ireland	1.94	1.89	1.89	1.88	1.87	1.86	1.86	1.86
Italy	17.21	16.82	16.76	16.71	16.59	16.56	16.53	16.53
Latvia	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.21
Lithuania	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.43
Luxembourg	0.45	0.44	0.44	0.44	0.44	0.43	0.43	0.43
Malta	0.00	0.00	0.00	0.07	0.07	0.07	0.07	0.07
Netherlands	7.00	6.84	6.82	6.80	6.75	6.74	6.72	6.72
Portugal	1.89	1.84	1.84	1.83	1.82	1.82	1.81	1.81
Slovakia	0.00	0.00	0.00	0.00	0.74	0.74	0.73	0.73
Slovenia	0.00	0.00	0.39	0.38	0.38	0.38	0.38	0.38
Spain	11.47	11.21	11.17	11.14	11.06	11.04	11.02	11.02