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# Does Macroprudential Policy Leak? Evidence from Non-Bank Credit Intermediation in EU Countries

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# Does Macroprudential Policy Leak? Evidence from Non-Bank Credit Intermediation in EU Countries

Martin Hodula and Ngoc Anh Ngo *

## Abstract

We examine whether macroprudential policy actions affect shadow bank lending. We use a large dataset covering 23 European Union countries and synthesize a narrow measure of shadow banking focused on capturing credit intermediation by non-banks. To address the endogeneity bias inherent to modelling of the effects of macroprudential policy on the financial sector, we consider a novel index of the macroprudential authority's strength in pursuing its goals and use it to instrument for a macroprudential policy variable in an IV estimation framework. We robustly demonstrate that following a macroprudential policy tightening, shadow bank lending increases. We harness the cross-sectional dimension of our data to show that the effect applies especially to low-capitalized banking sectors, where macroprudential policy is expected to be more binding, leading to credit reallocation from banks to non-banks.

## Abstrakt

V tomto článku zkoumáme, zda makroobezřetnostní politika ovlivňuje úvěry poskytované subjekty stínového bankovnictví. S využitím rozsáhlého souboru dat zahrnujícího 23 zemí Evropské unie syntetizujeme zúžený ukazatel stínového bankovnictví zachycující zprostředkování úvěrů nebankovními subjekty. Zkreslení z důvodu endogenity, které je vlastní modelování vlivu makroobezřetnostní politiky na finanční sektor, řešíme tím, že zohledňujeme nový index síly makroobezřetnostní autority při plnění jejích cílů a využíváme jej jako instrumentální proměnnou pro makroobezřetnostní politiku v rámci odhadu pomocí metody instrumentálních proměnných. Robustně dokládáme, že po zpřísnění makroobezřetnostní politiky dochází k nárůstu úvěrů poskytovaných subjekty stínového bankovnictví. Na průřezové dimenzi našich dat ukazujeme, že tento efekt platí zejména pro bankovní sektory s nízkou kapitalizací, kde lze očekávat, že makroobezřetnostní politika je více svazující, což vede k realokaci úvěrů od bank k nebankovním subjektům.

**JEL Codes:** G21, G23, G28.
**Keywords:** European Union, instrumental variables, macroprudential policy, non-bank lending, regulatory leakages.

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# 1. Introduction

The European shadow banking sector has been on a speed run over the past two decades and now accounts for around 40% of the financial system's total assets. While it is true that shadow banking may provide the economy with additional funding, it does so without any access to public backstops and with excessive leverage and a highly runnable funding base (Plantin, 2015; Farhi and Tirole, 2020). However, regulatory efforts following the Global Financial Crisis of 2007–2009 have focused predominantly on traditional banks. While studies typically find that macroprudential policy efforts are successful in limiting excessive credit booms (Araujo et al., 2020), taming asset bubbles (Bianchi and Mendoza, 2018) and reducing systemic risk (Meuleman and Vander Vennet, 2020), they have also created incentives for banks to escape regulatory caps (Bernanke et al., 1991; Kashyap et al., 2010; Houston et al., 2012; Duca, 2016).

Using European country-level data on loans granted by shadow banking entities, we demonstrate that macroprudential policy tightening is associated with a novel type of "crowding-out": a move from traditional bank lending to possibly riskier "shadow bank" lending. The estimated effect is sizeable. Following the introduction or tightening of a macroprudential policy tool, we find that growth of shadow bank lending increases by about 0.5 pp in the short term. This contrasts with the typically estimated negative impact of macroprudential policy tightening on traditional bank lending (Cerutti et al., 2017a; Galati and Moessner, 2018; Jiménez et al., 2017; De Jonghe et al., 2020). The estimated effect survives a battery of robustness tests. In fact, the effect is found to be even more pronounced for less capitalized banking sectors and the application of borrower-based measures. We do not record any major differences in the estimation when differentiating between the euro area and other EU countries.

Our starting point is the creation of a new shadow banking database for 23 European Union countries.[1] It matches multiple data sources and therefore provides a comprehensive measure of the European shadow banking sector. In the paper, we focus on the credit intermediation function of shadow banking and synthesize a narrow measure of non-bank financial intermediation for each of our sample countries. Our measure of "shadow bank" lending consists of non-bank financial institutions that are involved in credit intermediation activities. In particular, we combine data collected by the European Central Bank (ECB) with country-level data from central bank data repositories, which allows us to correct for data gaps. Furthermore, we use the Eurostat and national databases to clean the data of entities not engaged in credit intermediation, such as captive-type financial institutions like trusts, units with sponsor funds and sovereign wealth funds, which are commonly (and incorrectly) present even in broad shadow banking measures. We refer to and understand this narrow measure as a close approximation of shadow bank lending.[2]

We then use the data in an instrumental variables estimation, which is our response to the endogeneity problem associated with modelling the impact of macroprudential policy on the real economy and the financial sector (Jiménez et al., 2017; Galati and Moessner, 2018; Akinci and Olmstead-Rumsey, 2018). We rely on a novel index measuring the strength of the macroprudential authority in pursuing its goals and use it as an instrument for our macroprudential policy variable. This echoes the literature demonstrating that a larger role of the central bank in macroprudential

[1] We build on the EU shadow banking database described in Hodula et al. (2020). We extend the original dataset, which ends in 2017, and substantially improve the precision of the broad shadow banking measure. Furthermore, we go beyond the broad measure and introduce a narrow measure of shadow banking.

[2] We do not include activities of investment funds or money market funds that may resemble credit intermediation. These activities are highly concentrated in just a few countries which serve as financial centres.

policy leads to speedier application of macroprudential measures (Lim et al., 2013; Masciandaro and Volpicella, 2016; Bengtsson, 2020).[3,4]

Our analysis provides two key policy implications. First, despite the recent advances, the EU data coverage of the shadow banking sector and its key functions needs to be improved. With improved data coverage, policymakers would be able to develop a more effective monitoring framework for shadow banking, including globally harmonized rules. This would in turn alleviate the problem of regulatory arbitrage, both across countries and across banks within a country (Claessens et al., 2021). Enhanced and unified regulation would arguably reduce the scope for excessive growth and undue risk in the shadow banking sector (Gennaioli et al., 2013) by giving monetary and macroprudential policymakers ammunition to do their job effectively. Additionally, macroprudential authorities may need to take possible leakage of their measures into the shadow banking sector into account, at least until the regulatory environment and data coverage are improved.

Judging from our estimates and the related literature, the effects of macroprudential policy on bank (and non-bank) lending may be prone to the "waterbed" effect, as described in Nelson et al. (2017) and also shown by Chen et al. (2018) and Hodula (2019) in the context of monetary policy shocks. Building on a rich literature that shows that bank lending decreases following a macroprudential policy tightening, we show that macroprudential policy may increase lending by other financial intermediaries. Efforts should be made at a country level to evaluate the extent to which shadow banking entities could act as either substitutes or complements to traditional (bank) credit intermediation. For instance, borrowers may voluntarily choose shadow credit over bank credit, or they may be forced to seek shadow loans after being denied access to bank loans. Tang (2019) shows that P2P lending (a sub-set of the shadow banking sector) can act as a substitute for bank lending in terms of serving infra-marginal bank borrowers yet complement bank lending with respect to small loans.[5] Understanding the role of shadow banking in financing the real economy is all the more important because there have been policy initiatives in Europe to enhance and even create new secondary markets to encourage banks to offload riskier loans (with higher capital requirements) to other intermediaries, including shadow banks (ECB 2017).[6]

Existing studies exploring the effect of macroprudential policy actions focus predominantly on traditional banks and disregard shadow banking. However, there are some notable exceptions. Kim et al. (2018) point out that banks in the U.S. responded to macroprudential policies by triggering a migration of leveraged lending to non-banks. Gebauer and Mazelis (2020) develop a DSGE model for the euro area and find that tighter capital requirements on commercial banks increase shadow bank lending. Irani et al. (2021) provide evidence on the role of bank capital constraints

[3] For an overview of the existing institutional arrangements, see Edge and Liang (2019).

[4] International organizations usually advocate for central banks having a prominent role. For example, the International Monetary Fund argues that central banks foster coordination between macroprudential and monetary policy and can *"help shield macroprudential policy from political interference that can slow the deployment of tools"* (IMF, 2014). In the European context, the European Systemic Risk Board recommends that *"the national central banks should have a leading role in macroprudential oversight because of their expertise related to setting policies for price and exchange rate stability, and existing responsibilities in the area of financial stability"* (ESRB, 2011).

[5] Using a large international panel of countries, Hodula (2021) argues that fintech credit platforms can act as both complements and substitutes for traditional bank credit, depending on broader characteristics of the domestic banking sector.

[6] See also "Development of secondary markets for non-performing loans," European Commission, 20 March 2018, https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/1446-Development-of-secondary-markets-for-non-performing-loans_en.

for the emergence of non-bank financial institutions in the U.S. In particular, weakly capitalized banks reduce loan exposure and less-regulated non-banks take up the slack. In the study most closely related to ours, Cizel et al. (2019) find some evidence of substitution towards loans and debt securities held by non-banks after macroprudential measures are implemented.

Our paper provides additional insights to the current literature, as it extends various features of the above-mentioned papers. A typical problem with evaluating the effects of macroprudential policy actions on credit intermediation is that policy decisions are taken with respect to credit developments, raising the prospect of reverse causality. We work with aggregate country-level data, which poses an identification challenge despite the advantageous cross-country dimension. One way of dealing with the endogeneity issue is to rely on GMM-type estimators, as done in Cizel et al. (2019). However, as shown in Roodman (2009) and Bun and Windmeijer (2010), GMM estimators are designed for panels with few time periods and many individuals, which is not the case here. We address the endogeneity issue by using instrumental variables (IV) estimation, with the strength of the macroprudential authority taken as an instrument for macroprudential policy actions. We construct a novel index of the strength of the macroprudential authority (in pursuing its goals) following the ESRB (2014) assessment of the central bank's role in macroprudential policy. We assume that macroprudential policy measures are more likely to be implemented if macroprudential policy is assigned to the central bank and not to a separate authority.[7] We demonstrate the appropriateness of our index for instrumenting macroprudential policy, which allows us to make stronger conclusions about the likely effect of a macroprudential policy tightening on shadow bank lending while retaining the benefits of working with cross-country data.

To our knowledge, we are the first to cover European Union countries. This offers a few data advantages. Recent data advances in EU shadow bank monitoring allow us to use a more precise measure of shadow bank credit intermediation. For example, Cizel et al. (2019) consider loans and debt securities held by all non-financial sectors of the economy as the non-bank credit measure. As such, their measure contains assets from entities which are generally not considered to be part of the shadow banking sector, such as insurance companies and pension funds. We consider loans granted by other financial institutions, deliberately ruling out insurance companies and pension funds (as they are commonly regulated) as well as investment and money market funds and captive financial institutions in the spirit of the Financial Stability Board narrow measure of shadow banking (FSB, 2020).

To capture macroprudential policy actions, we rely on the newest IMF database introduced in Alam et al. (2019). The database covers policy actions up until 2018. We extend the data for our sample to 2019. To put this into perspective, Cizel et al. (2019) rely on two databases covering macroprudential (Cerutti et al., 2017b) and prudential policy actions (Cerutti et al., 2017a) over the 2000–2014 period at most. Our period extension is significant, as we record over 156 macroprudential policy actions in the 2015–2019 period alone, as compared to 194 over the 2000–2014 period.

We contribute to the literature assessing leakages and spillover effects of macroprudential policy actions.[8] Aiyar et al. (2014) document that unregulated banks (resident foreign branches) increase lending in response to tighter capital requirements, while regulated banks reduce lending. Using a stylized model framework, Bianchi and Mendoza (2018) show that regulated agents reduce risk

[7] Further details on the construction of this variable are available in Appendix A.3.

[8] Forbes (2019) distinguishes between these two terms by defining leakages as shifts in credit to other institutions within the same country and spillovers as transfers in credit to other countries.

taking in response to debt taxes, while unregulated agents react to a safer environment by taking on more risk. Ahnert et al. (2021) show that macroprudential foreign exchange regulations may lead to a shift of market activities to less informed, less efficient, or unregulated sectors. Kang et al. (2017) find that liquidity and sectoral macroprudential policy measures often affect cross-border bank credit. A few studies also explore the effects of macroprudential policy tightening on economic activity (Richter et al., 2019). We show that macroprudential policy may leak beyond the traditional banking sector and thus cause a shift of lending from regulated banks to less regulated or unregulated other financial intermediaries – "shadow banks".[9]

The remainder of this paper is organized in five sections. Section 2 introduces our data and provides a simple event study. Section 3 describes the methodology behind our approach. Section 4 elaborates on our base specification results. In Section 5, these results are subject to a battery of robustness checks. Section 6 concludes.

## 2. Data

In this paper, we use quarterly country-level data to verify the impact of macroprudential policy actions on shadow bank lending. Our data in levels span the 1999Q1–2019Q4 period. The sample period is determined primarily by the availability of shadow banking sector data, but we deliberately restrict our sample to end in 2019Q4 to avoid the Covid-19 period, which is beyond the scope of this study.

We rely on three types of data. First, we collect data on loans granted by shadow bank entities (namely other financial intermediaries) and data on traditional bank loans to paint a complete picture of credit intermediation. Second, we require data that capture macroprudential policy actions. Third, we obtain several macro-financial controls from various data sources.

### 2.1 Data on Shadow and Traditional Credit Intermediation

The distinction between traditional and shadow banking is not applied consistently in the literature. Our measure of shadow credit intermediation encompasses loans granted by other financial institutions (OFIs). The OFI sector comprises financial vehicle corporations, security and derivative dealers, specialized financial corporations, financial corporations engaged in lending and residual entities. A detailed breakdown of our narrow shadow bank lending measure can be found in Appendix A.[10] Traditional bank loans are those granted by monetary financial institutions (MFIs). Our approach to identifying entities that engage in credit intermediation follows the European Systemic Risk Board's (ESRB) entity- and activity-based approach to distinguishing between the traditional and shadow banking sectors.

Using Eurostat as well as national data sources, we are able to enhance our analysis of shadow bank financial (credit) intermediation by identifying assets related to captive financial institutions. These engage in neither credit intermediation nor issuance of debt instruments, and they should therefore not be considered part of shadow banking (see, for example, the discussion in ESRB, 2020b). We

[9] In October 2018, the Financial Stability Board (FSB) announced that it would replace the term "shadow banking" with the term "non-bank financial intermediation". Consistent with this, the ESRB has renamed its annual "EU Shadow Banking Monitor" the "EU Non-Bank Financial Intermediation Risk Monitor".

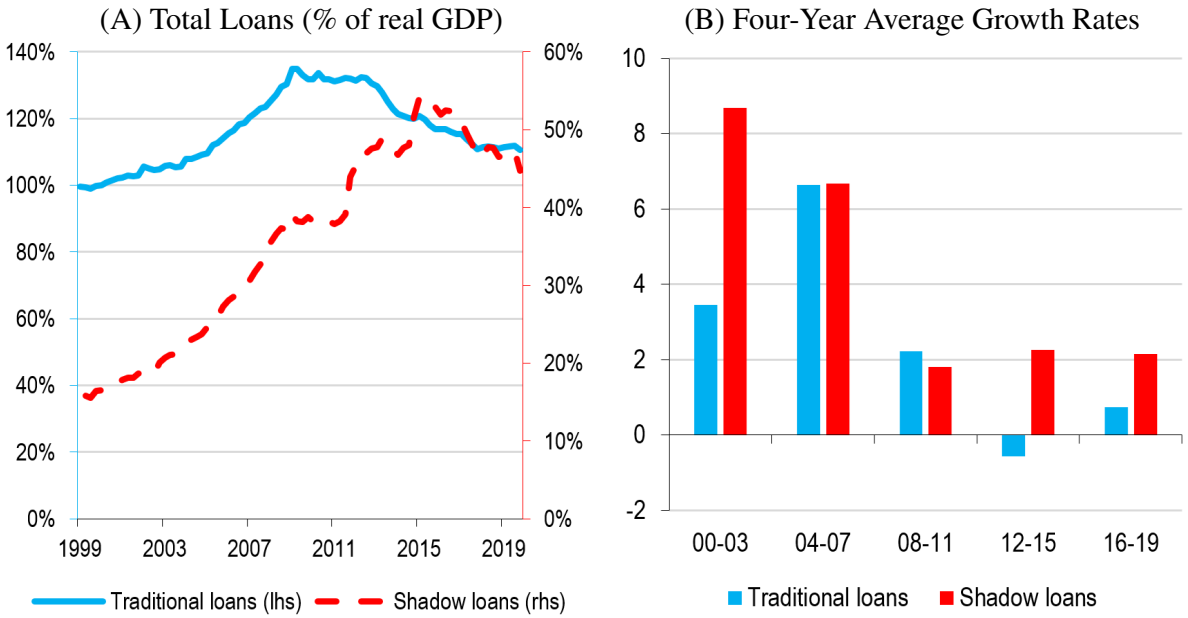
[10] Our narrow measure incorporates two economic functions as established by the FSB (2020): (i) Economic Function 2, comprising entities that are dependent on short-term funding to provide lending and (ii) Economic Function 5, which represents securitization-based credit intermediation. Securitized loans represent roughly 20% of total loans granted by OFIs (Figure A2).

follow this recommendation and exclude captive-type financial institutions to make our shadow banking measures more accurate.

Our sample consists of 23 European Union countries. Country inclusion in the sample is driven by the availability of shadow banking sector data. In the end, we compile an unbalanced panel starting in 1999Q1 and a balanced one starting in 2004Q1. The original EU member countries generally have longer time spans. Details on our sample can be found in the Appendix (Table B1).

To get a better sense of the quantitative side, Figure 1 plots total outstanding loans originated in the shadow and traditional banking sectors as a ratio to real GDP over the past two decades. Shadow and traditional credit intermediation evolved differently, especially in the aftermath of the Global Financial Crisis of 2007–2009. On average, shadow loans grew annually by about 7% prior to the crisis and by 2% in its aftermath. This is in stark contrast to the growth of traditional loans, which was 5% before the crisis and 0.1% after it. Traditional bank lending staged a slow and protracted recovery in the wake of the GFC, whereas shadow banks expanded their share of credit intermediation. Interestingly, Panel B of Figure 1 shows that during the 2012–2019 period (featuring major quantitative easing efforts by leading central banks as well as many macroprudential policy measures) practically all the growth occurred in the shadow banking sector. In terms of size, OFIs hold a significant portion of the financial sector's total assets. This share stood at 24% at the end of 2019. The share of loans granted by OFIs is stable through time, representing roughly 38% of OFIs' total assets (Figure A5).

***Figure 1: Shadow and Traditional Credit Intermediation in European Union Countries***




***Note:*** Aggregate data for 23 EU countries. Data for some of the "new" EU member countries are available from 2004 onwards.
***Source:*** ECB.

The increasing share of shadow financial intermediation was probably driven by both supply- and demand-side factors. On the credit supply side, the twin crises (the GFC and the sovereign debt crisis) in the EU left traditional banks' balance sheets in a worse state, with the fragile economic background triggering a surge in non-performing loans. Even after the recovery, stricter financial regulation and supervision, together with low economic growth and historically low interest rates

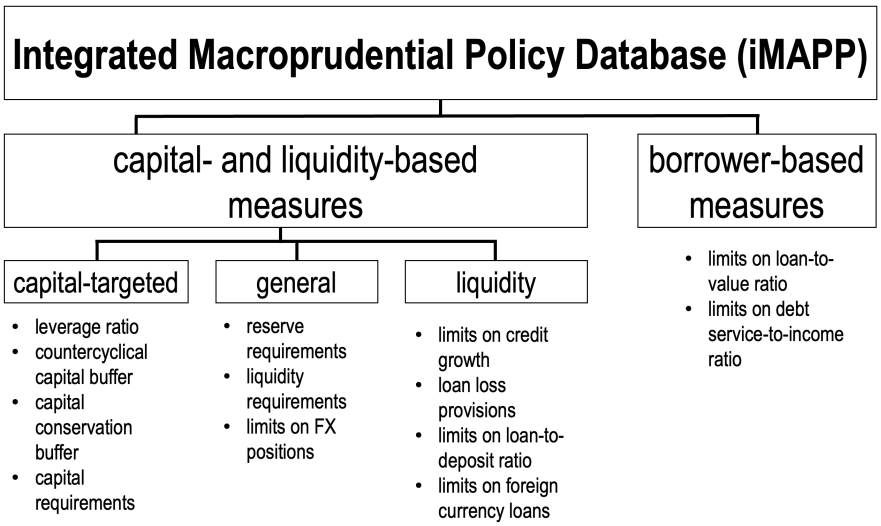
(reaching the zero lower bound), put pressure on the existing business models of banks. On the credit demand side, economic recessions and decreasing asset prices left the private non-financial sector with insufficient collateral to back up its loan applications. These factors jointly increased the incentive for all sectors to rely more heavily on shadow loans.

### 2.2 Data on Macroprudential Policy Actions

To capture macroprudential policy actions, we use the database of Alam et al. (2019). The integrated Macroprudential Policy Database (iMaPP) provides dummy-type indices of tightening and loosening actions for 17 macroprudential policy instruments and their subcategories and a detailed description of each policy action. The indices take the value of 1 for tightening actions, -1 for loosening actions and zero for no change.

Figure 2 depicts the categorization of the above-mentioned instruments in two main groups – capital-based instruments and borrower-based instruments. Broadly speaking, both types of instruments are aimed at achieving the same intermediate objectives of macroprudential policy – preventing and mitigating excessive credit growth and leverage and thus increasing the resilience of the financial sector as a whole. However, they differ in terms of their focus, transmission channels and potential impact on different agents. Capital-based measures are primarily aimed at banks, tasked to increase their resilience by building up capital reserves to cover for unforeseen events. Borrower-based measures operate by limiting borrowing relative to property values and/or income of households. In this case, however, the impact on bank resilience runs through the flow of new lending rather than the stock of loans, as is the case for capital-based measures. In what follows, we will consider three indicators of macroprudential policy, the first encompassing all categories of macroprudential policy, the second focusing on measures aimed at lenders and the third focusing on measures aimed at borrowers.

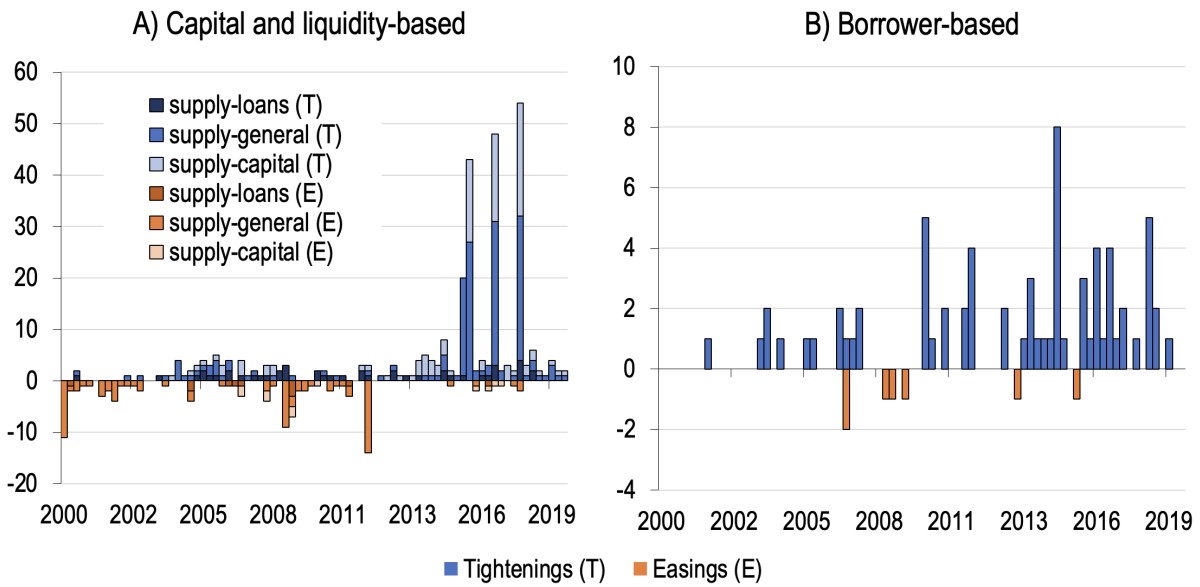
***Figure 2: Categorization of Macroprudential Policy Instruments in iMaPP***




***Source:*** Alam et al. (2019), own elaboration.

A visual inspection of Figure 3 shows that the frequency of macroprudential policy measures grew over time. A loosening of macroprudential policy occurred in most of the countries analysed in 2009 in reaction to the Global Financial Crisis, whereas the subsequent changes in measures were mostly of a tightening nature.

***Figure 3: Frequency of Macroprudential Policy Actions over 2000–2019 Period***




***Note:*** The dummy indices are based on the effective date when it differs from the announcement date, as the effective date is widely available. We divide capital- and liquidity-based macroprudential policy actions into three categories: supply-loans (limits on credit growth, loan loss provision requirements, limits on loan-to-deposit ratio and limits on foreign currency loans), supply-general (reserve requirements, liquidity requirements and limits on foreign exchange positions) and supply-capital (leverage ratio, countercyclical buffers, conservation buffers and capital requirements).
***Source:*** Alam et al. (2019), own elaboration.

Since the original Alam et al. (2019) database spans from January 1990 to December 2018, we extend it for our sample using data from Budnik and Kleibl (2018) and ESRB (2020a) following the methodology of the original index. This allows us to match the shadow banking data span.

## 2.3 Explanation of Control Variables

In the empirical part of the paper, we employ a wide range of control variables. We consider *Real GDP* expressed as the annual change to filter out the business cycle. We also use a binary *Crisis dummy* to account for the distinctive effects of economic downturns. We created this dummy based on the European financial crises database introduced in Lo Duca et al. (2017). The crisis dummy takes the value of 1 if there was a financial crisis in a country in our sample and 0 otherwise. We use the three-month inter-bank rate (*Interest Rate*) to capture monetary policy shocks that are likely to have a significant influence on credit intermediation.

To capture the conditions in the financial markets, we use two variables. *Term Spread* describes the difference between ten-year government bond yields and three-month inter-bank interest rates. This is meant to account for underlying changes in the term structure premium, as shadow banking activities are tightly linked to maturity transformation (Poszar, 2011; Luck and Schempp, 2015). The *VIX* index accounts for market volatility and serves as a basis for expectations about market developments in the future.

The period of protracted low interest rates could influence our analytical outcome, as the resulting low yields are probably affecting the shadow banking sector. Hodula (2019) argues that the

search-for-yield motive is a powerful driver of the shadow banking sector, but shows that the relationship passes mainly through assets other than loans. Still, the inclusion of the short-term interest rate and the slope of the yield curve (along with the consideration of year time fixed effects) should capture effects stemming from the low interest rate environment.

Summary statistics for all the variables used in the analysis can be found in Table B2 in the Appendix. Figure B1 shows a correlation matrix of all the variables that enter our analyses. Inspection of the estimated correlation coefficients does not reveal multicollinearity issues, but we still test for the presence of multicollinearity among our regressors formally by calculating the variance inflation factor and assessing its value for individual variables.

### 2.4 Event-Study Analysis of Macroprudential Policy Actions

Using a simple event-study framework, we make a first attempt to check whether the stock of shadow and traditional bank loans evolves differently following macroprudential policy events.[11] We calculate loan indexes ($t = 100$, where $t$ marks the macroprudential policy event) separately for shadow and bank loans. They have been detrended, that is, adjusted linearly to 0% on average. In this exercise, we only consider periods of tightening of macroprudential policy. Since we do not yet control for the effect of other variables, we are not interested in the strength of the effect itself, but rather its direction.

Judging from Figure 4, it becomes clear that while the stock of bank loans decreases following a macroprudential policy tightening, the stock of shadow loans seems to be somewhat inflated. The result holds even if we consider capital- and borrower-based measures separately (Figure A6). This alone is not sufficient evidence for the existence of a crowding-out effect of macroprudential policy, as we do not yet consider other potentially confounding factors. Still, it allows us to claim that macroprudential policy actions have possibly dissimilar impacts on the evolution of shadow and bank loans.

We next consider the evolution of the stock of total loans, summing shadow and bank loans. By doing so, we can check whether shadow loans crowd out bank loans to an extent that the increase in shadow loans following the policy event surpasses the decrease in bank loans. Figure A7 shows that this is not the case, as the stock of total loans decreases following a macroprudential policy tightening.

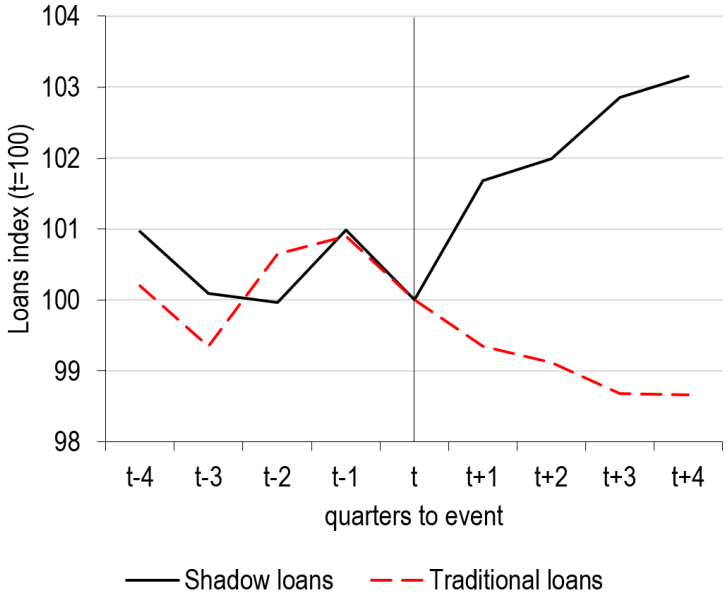
Given the low starting level of loan markets in Central and Eastern European countries at the beginning of our sample period, the substantial increase in shadow loans might have been due to the base effect. To check, Figure A8 in the Appendix compares the estimates for the original EA members (EA12) and the other EU countries (non-EA12). The results show that the stock of bank loans still decreases following a macroprudential policy tightening, while the stock of shadow loans continues to rise.

The analysis also shows that the effect of a macroprudential policy tightening on the stock of traditional loans is clearly visible prior to the entry of the policy tool into force, as we spot a gradual decrease in traditional loans already at time $t-1$. While the database of macroprudential policy actions introduced in Alam et al. (2019) is based on the effective date, we acknowledge that the

[11] A similar framework was used in Calvo et al. (2006), who investigated the behaviour of a number of macroeconomic variables (including the level of credit) around episodes of sudden stops in emerging markets.

announcement date might also be of importance and the focus on the former might bias the true effect of a macroprudential policy tightening downwards.

***Figure 4: Shadow and Bank Loans Around Nearly 250 Policy Events***




***Note:*** The graph shows the average stock of shadow and bank loans across 248 dates of macroprudential policy tightening in 23 EU countries.
***Source:*** ECB data, own computation.

The event study suggests that shadow and bank loans do not respond uniformly to a macroprudential policy tightening. In the empirical part of the paper, we check whether the naive evidence documented so far can survive increasingly demanding statistical tests.

## 3. Methodology

### 3.1 Dealing with Endogeneity and Reverse Causality

One potential challenge in identifying a causal relationship between macroprudential policy actions and the subsequent evolution of shadow loans is that decisions to take policy actions are based on financial conditions and hence are tied to the prospects of the financial sector. The endogeneity issue appears even more concerning, since the annual growth rates of shadow and bank loans are positively correlated (Figure A1). For our sample data and period, the correlation coefficient comes in at 0.40. Such endogeneity could introduce a significant upward bias into the estimates, as well as preventing us from making any causal claims.

To test if this is the case using our panel data, we examine a reverse regression specification of the contemporaneous relationship between shadow and traditional loan growth and the macroprudential policy index. Our reverse specification is a conventional panel estimator:

$$MaPP_{i,t} = \beta_1 \Delta SB_{i,t} + \beta_2 \Delta TB_{i,t} + \gamma \mathbf{X}_{i,t-1} + \delta_i + \varepsilon_t + \zeta_{i,t}, \quad (1)$$

where $MaPP_{i,t}$ represents a dummy-coded cumulative macroprudential policy index in country $i$ and quarter $t$, $SB_{i,t}$ and $TB_{i,t}$ are annualized growth of, respectively, shadow and traditional bank loans, $\gamma \mathbf{X}_{i,t-1}$ is a vector of controls linked to the evolution of the financial sector, $\delta_i$ and $\varepsilon_t$ are country-

and time-specific fixed effects, and $\zeta_{i,t}$ is an error term. The main coefficient of interest is $\beta$, which represents the partial correlation between macroprudential policy and the current development of traditional and shadow bank lending. A positive value would imply that faster loan growth coincides with the introduction of macroprudential policy actions.

The focus on loan growth as the target for macroprudential policy is justified by the well-documented fact that credit booms typically precede crises (Jordà et al., 2011; Schularick and Taylor, 2012). We use total credit to the private sector as our base variable.[12] The variable comprises bank and shadow loans as well as cross-border credit and debt security issuance, therefore allowing us to encompass the substitution effect from bank to shadow loans. Moreover, we can pick up the substitution from domestic to foreign borrowing that may arise when macroprudential measures are imposed on domestic bank credit (Reinhardt and Sowerbutts, 2015).

The vector of controls $\mathbf{X}_{i,t}$ includes real GDP growth, the three-month inter-bank rate and the term spread. We include yearly time dummies to condition for the prevailing financial conditions.

We run the specification in Eq. (1) using ordinary least squares with heteroscedasticity-corrected standard errors, but we also perform robustness checks with respect to the estimation method. Specifically, we use the Driscoll and Kraay (1998) estimator and report Driscoll-Kraay standard errors, which are supposed to be well calibrated when cross-sectional dependence is present (Hoechle, 2007). For country-specific dependence, we include country dummies and cluster by country.

The results are shown in Table C1 in the Appendix. The data indicate that macroprudential policy actions coincide with faster loan growth.[13] As such, there does indeed seem to be a risk of reverse causality and a need to address this issue. It is also interesting that monetary policy easing is positively correlated with increased use of macroprudential policy measures.

### 3.2 Baseline IV Approach

We address potential endogeneity using the instrumental variables (IV) approach. We propose to use the strength of the macroprudential authority in pursuing its goals to instrument for differences in the use of macroprudential measures across countries. Our assumption is that macroprudential policy measures are more likely to be implemented if macroprudential policy is assigned to the central bank and not to a separate authority. The fact that the majority of the policy actions in our sample are of a tightening nature lends additional support to the idea of using the strength of the macroprudential authority, as such decisions are more controversial because they interfere with the free market.

A larger role of the central bank in macroprudential policy was found to lead to speedier application of macroprudential measures (Lim et al., 2013; Masciandaro and Volpicella, 2016; Bengtsson, 2020). This echoes Recital 24 of Regulation (EU) No 1092/2010, which states that "*the national central banks should have a leading role in macro-prudential oversight because of their expertise and their existing responsibilities in the area of financial stability*". On a similar note, ESRB (2011) recommends that the EU member states "*ensure that the central bank plays a leading role in the macro-prudential policy*". Consideration of the strength of the macroprudential authority as an

[12] Drehmann (2013) reports that the early warning indicator properties of total credit are superior to those of bank credit.

[13] As a robustness check, we used lagged loan growth, substituting for the contemporaneous relationship. The results again indicated the presence of reverse causality. The results are available from the authors upon request.

instrument for macroprudential policy conduct is also supported by several game theory research papers. For instance, the papers usually advocate for a larger role of the central bank, as it makes coordination between monetary and macroprudential policy more efficient and welfare improving (Cecchetti and Kohler, 2014; Collard et al., 2017; Bodenstein et al., 2019; Carrillo et al., 2021). Several papers also show that welfare gains are maximized when macroprudential policy takes the lead in conflicting situations (Angelini et al., 2014; Tayler and Zilberman, 2016; Paoli and Paustian, 2017).

To quantify the strength of the macroprudential authority, we create an index which we term $INST_{i,t}$ for each country in our sample. The values of *INST* lie within a 0,1 interval, depending on whether the country's institutional arrangements fulfil the criteria set by ESRB (2011). ESRB (2014) in a follow-up report has already quantitatively assessed the degree to which member states have fulfilled this recommendation. We take the ESRB values as a base, but we check and adjust the rating if a country's institutional arrangements have changed since then. Further details on the statistics of *INST* are provided in Table A2.

We expect that the primary channel through which the institutional arrangements can affect credit activity is through the implementation of macroprudential policy measures. This has been found to be true for bank loan growth (Gadatsch et al., 2018). Furthermore, institutional arrangements are predetermined, which makes central bank involvement in macroprudential policy a valid instrument.

Our base specification is a conventional two-stage least squares panel estimator. Our first-stage specification for the instrumented macroprudential policy index in country $i$ in period $t$ satisfies:

$$\widehat{MaPP}_{i,t} = \beta INST_{i,t} + \gamma \mathbf{X}_{i,t-1} + \delta_i + \varepsilon_t + \zeta_{i,t}, \tag{2}$$

where $\widehat{MaPP}_{i,t}$ represents the instrumented macroprudential policy index, $INST_{i,t}$ is the institutional arrangements of macroprudential policy conduct, $\mathbf{X}_{i,t-1}$ is a vector of controls linked to the macroprudential policy decision-making process, $\delta_i$ and $\varepsilon_t$ are country and year fixed effects, and $\zeta_{i,t}$ is a residual term, assumed to satisfy the necessary conditions. We use real GDP growth, the interest rate, the term spread and the VIX index as covariates in $\mathbf{X}_{i,t-1}$.

Our second-stage specification is as follows:

$$\Delta SB_{i,t} = \beta_1 \widehat{MaPP}_{i,t-1} + \beta_2 \Delta TB_{i,t} + \gamma \mathbf{X}_{i,t-1} + \delta_i + \varepsilon_t + \zeta_{i,t}, \tag{3}$$

where $\Delta SB_{i,t}$ is the annual growth rate of shadow loans and $\Delta TB_{i,t}$ is the annual growth rate of traditional bank loans. Previously defined terms are the same as above. The main coefficient of interest is $\beta_1$, which denotes the partial correlation between the instrumented macroprudential policy index lagged by one period and the growth rate of shadow bank loans. We consider $MaPP_{i,t}$ as the cumulative sum of the macroprudential policy measures, where tightening adds one unit to the index and easing subtracts one unit from it.[14] A positive $\beta_1$ would lend support to the existence of a contemporaneous crowding-out effect under which traditional loan-targeted macroprudential policy expands shadow lending.

[14] Consideration of a cumulative macroprudential policy index is quite common in the related literature (Akinci and Olmstead-Rumsey, 2018; Cizel et al., 2019).

## 4. Baseline Specification Results

We start by examining the results of the first-stage IV specification to show that we have a strong instrument. We include our base specification control variables as well. The estimates are shown in Table 1.

Our selected instrument *INST* enters significantly with a positive sign at the 1% confidence level. A country in which the macroprudential authority has more strength to pursue its objectives seems to tighten its macroprudential policy more frequently. Economically, an institutional change that moves the country from non-compliant with the ESRB criteria ($INST = 0$) to fully compliant ($INST = 1$) is associated with a two-point higher value of the cumulative *MaPP* index, which is a material change given that our sample mean is 1.86. Since the majority of the actions in our sample were of a tightening nature, the positive sign was expected. The point estimate is robust to a wide range of perturbations in our specification. Altogether, we assert that we have a strong instrument in hand and proceed with the IV estimation using a two-stage least squares approach. To formally test for the appropriateness of our IV, we report F-statistics to check for a weak instrument and the Durbin-Wu-Hausman test to verify the endogeneity of *MaPP*.

***Table 1: First-Stage IV Regression***

| Dependent variable: | | | | | | |
|---|---|---|---|---|---|---|
| MaPP index | (1) | (2) | (3) | (4) | (5) | (6) |
| *INST* | 2.031*** | 2.031*** | 2.031*** | 1.611*** | 1.611*** | 1.611*** |
| | (0.586) | (0.586) | (0.586) | (0.485) | (0.485) | (0.485) |
| *Real GDP* | 0.190* | 0.190 | 0.190 | -0.054 | -0.054 | -0.054 |
| | (0.107) | (0.122) | (0.122) | (0.082) | (0.069) | (0.069) |
| *Interest Rate* | -1.444*** | -1.444*** | -1.444*** | -0.199*** | -0.199*** | -0.199*** |
| | (0.047) | (0.071) | (0.071) | (0.056) | (0.076) | (0.076) |
| *Term Spread* | -0.721*** | -0.721*** | -0.721*** | -0.056 | -0.056* | -0.056* |
| | (0.052) | (0.086) | (0.086) | (0.038) | (0.029) | (0.029) |
| *VIX* | 0.003 | 0.003 | 0.003 | 0.010 | 0.010 | 0.010 |
| | (0.013) | (0.011) | (0.011) | (0.013) | (0.012) | (0.012) |
| *N* | 1745 | 1745 | 1745 | 1745 | 1745 | 1745 |
| Adj. $R^2$ | 0.616 | 0.616 | 0.616 | 0.849 | 0.849 | 0.849 |
| Country FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | No | No | No | Yes | Yes | Yes |
| Standard Errors | Robust | DK | Clustered | Robust | DK | Clustered |

***Note:*** * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is the cumulative MaPP index. OLS estimator with standard errors in parentheses. Models (2) and (5) use the Driscoll-Kraay estimator. The sample period is 2000Q1–2019Q4. The constant was estimated but is not reported.

Our second-stage IV results are shown in Table 2. Our main variable of interest, *MaPP*, enters significantly positively. The instrumented coefficient point estimate in our model (1) specification comes in at 0.51. Therefore, following the activation of a macroprudential policy tightening measure, shadow loan growth accelerates by about 0.51 pp, which is a sizeable effect. This finding stands out, since we report an otherwise strong short-term correlation between shadow and traditional bank loans with a parameter estimate of 0.31. This shows that the two types of financial intermediation typically move in tandem – up until the point of macroprudential policy activation. Overall, the estimates suggest that macroprudential policy may leak to the shadow banking sector, causing reallocation of credit intermediation from traditional to shadow banking

The results for our control variables are of the expected sign and confirm some of the previous findings from the literature. Taken together, these lend additional support to our IV model specification and hence to our base estimates of the substitution effect corrected for reverse causality and endogeneity bias. Our estimates show that shadow loans are highly procyclical, owing to the reported statistically significant and positive parameters on real GDP growth. Our estimates confirm those of Adrian and Shin (2009) and Hodula et al. (2020). Linked to our focal point, the documented procyclicality introduces an important channel through which shadow loans may undermine the effectiveness of macroprudential policy measures. Lastly, our results indicate a positive relationship between monetary policy and growth of shadow loans, in line with recent studies in this area (Nelson et al., 2017; Chen et al., 2018; Hodula, 2019). A 1 pp increase in the short-term rate is found to be associated with a 0.87 pp acceleration in shadow bank loan growth, which is an even larger effect than the one reported for macroprudential policy.

***Table 2: Second-Stage IV Regression***

| Dependent variable: Shadow Loan Growth | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| *MaPP* | 0.506*** | 0.506*** | 0.506*** | 0.505*** | 0.505*** | 0.505*** |
| | (0.173) | (0.173) | (0.187) | (0.173) | (0.173) | (0.186) |
| *Traditional Loans* | 0.306*** | 0.306*** | 0.306*** | 0.296*** | 0.296*** | 0.296*** |
| | (0.051) | (0.051) | (0.045) | (0.049) | (0.049) | (0.045) |
| *Real GDP* | 0.486*** | 0.486*** | 0.486*** | 0.441*** | 0.441*** | 0.441*** |
| | (0.129) | (0.129) | (0.135) | (0.129) | (0.129) | (0.134) |
| *Interest Rate* | 0.861*** | 0.861*** | 0.861*** | 0.874*** | 0.874*** | 0.874*** |
| | (0.206) | (0.206) | (0.194) | (0.209) | (0.209) | (0.198) |
| *Term Spread* | 0.071 | 0.071 | 0.071 | 0.128 | 0.128 | 0.128 |
| | (0.145) | (0.145) | (0.152) | (0.154) | (0.154) | (0.160) |
| *Crisis Dummy* | 0.916 | 0.916 | 0.916 | | | |
| | (0.560) | (0.560) | (0.589) | | | |
| *VIX* | -0.194*** | -0.194*** | -0.194*** | -0.188*** | -0.188*** | -0.188*** |
| | (0.030) | (0.030) | (0.027) | (0.030) | (0.030) | (0.028) |
| *N* | 1,639 | 1,639 | 1,639 | 1,639 | 1,639 | 1,639 |
| Adj. $R^2$ | 0.207 | 0.207 | 0.207 | 0.215 | 0.215 | 0.215 |
| Country FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | No | No | No | Yes | Yes | Yes |
| Standard Errors | Robust | DK | Clustered | Robust | DK | Clustered |
| F-test | 64.28*** | 64.28*** | 64.28*** | 84.62*** | 84.62*** | 84.62*** |
| Durbin-Wu-Hausman test | 0.754 | 0.798 | 0.851 | 0.651 | 0.681 | 0.705 |

***Note:*** * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is annual shadow loan growth. OLS estimator with robust standard errors in parentheses if not stated otherwise. Models (2) and (5) use the Driscoll-Kraay estimator. The sample period is 2000Q1–2019Q4. The constant was estimated but is not reported. The F-test is used to verify the strength of the instruments. The Durbin-Wu-Hausman test is used to verify the endogeneity of MaPP. The null hypothesis is that MaPP is exogenous.

# 5. Robustness Check

In this section, we demonstrate that our base results - most notably that macroprudential policy actions are followed by growth in shadow bank loans – are quite robust. The checks we have undertaken can be split into two categories. The first presents additional regression results that capture whether the reported link between macroprudential policy and shadow bank loan growth differs: (i) when a country uses capital- or borrower-based measures, (ii) when a country's financial sector is well or poorly capitalized, and (iii) when we split the sample into two sub-groups of countries, accounting for the relative heterogeneity of the EU panel. The second category shows the robustness of our results to a variety of changes in the empirical specification.

## 5.1 Capital vs Borrower-Based Measures

In this exercise, we check whether the documented impact of macroprudential policy on shadow bank loan growth differs with respect to the type of policy in question. Specifically, we divide the policy actions into capital-based and borrower-based. Both capital- and borrower-based measures aim to strengthen the resilience of the banking system and reduce the potential for imbalances to accumulate. Borrower-based measures are applied almost exclusively to bank loans and directly restrict the amount of credit available to the private sector. This is in contrast to the post-2008 capital-based regulation, which is usually designed in a way that affects bank capitalization. As such, it not only affects the extent to which banks can engage in traditional activities, but may also influence banks' incentives to shift their activities outside the regulatory framework.

The estimates in Table C2 show that while both capital- and borrower-based measures speed up the growth of shadow bank loans (and therefore confirm our base estimates), we document significant differences in the magnitude of the response. The introduction of a capital-based measure, say the activation of a countercyclical capital buffer, raises the growth of shadow bank loans by about 0.8 pp, while the introduction of a borrower-based measure (for example, an LTV limit) has an impact of about 1.4 pp. Our evidence echoes the results of the existing literature on the effects of borrower-based measures, which finds them to be more effective in reducing leverage and traditional credit growth (Cerutti et al., 2017a). Furthermore, our results are in line with Fendoglu (2017), who also finds borrower-based measures to be more effective in curbing traditional credit, which may lead to a larger reallocation effect than the introduction of capital-based measures. Still, the identified effect of capital-based measures is sizeable and we join a strand of studies where capital-based measures have significant associations with lower traditional credit growth (Claessens et al., 2013). However, Araujo et al. (2020) indicate that the stronger impact of borrower-based measures may just be driven by much more intense tightening of these tools compared to others. We cannot argue against this, as our data do not allow for measurement of the strength of macroprudential policy tightening or loosening.

### 5.2 Less vs More Capitalized Banking Systems

Next, we check whether the level of banking sector capitalization affects the significance of our estimates. In general, less capitalized banking sectors might be more prone to a cutback in lending following a regulatory tightening.[15] In this case, the credit reallocation effect might be more pronounced, as shadow bank loans would typically step in because shadow banks are not as strongly affected by regulation as their traditional counterparts. For this purpose, we split our sample into two sub-samples labelled "more" and "less" capitalized countries. The split is based on the average ratio of Tier 1 capital to risk weighted assets (RWA) of country *i* over our sample period. We order countries based on the average values and consider the top and bottom eight countries from our sample.[16]

The point estimates from Table C3 are consistent with our prior intuition that in less capitalized banking sectors, the credit reallocation effect might be of greater importance. While the estimated parameter *MaPP* appears to be quantitatively unchanged, it enters significantly at the 5% confidence level only for the less capitalized countries, as the significance disappears for the more capitalized countries. In the less capitalized countries, the introduction of an additional macroprudential policy measure results in a 0.5 increase in the growth of shadow bank loans. In general, low-capitalized banking sectors have a greater incentive to try to circumvent the increase in funding costs spurred by a macroprudential policy tightening via regulatory arbitrage. While traditional banks are subject to regulatory capital requirements that put an upper bound on their leverage, the shadow banking system enables bank assets to be refinanced with higher leverage than that permitted for traditional banks (Plantin, 2015). Furthermore, shadow banks tend to enter markets in which traditional banks face tight regulation (Buchak et al., 2018; Farhi and Tirole, 2020).

### 5.3 Old vs New EU Member Countries

Next, we split our panel into two subgroups which we label "old member countries" (OMCs) and "new member countries" (NMCs). The country list and country groupings are available in Table B1. This panel split allows us to check for several possibly important differences between our countries that might not have been picked up by fixed effects. This partitioning effectively splits the sample into more and less financially developed countries, and groups together the original euro area member countries, which have a long tradition of single monetary policy conduct. The NMCs bear the legacy of the communist era. While the communist systems are now largely defunct, they have left behind a legacy of greater cultural tolerance of "shadow" practices and a shadow economy (Eilat and Zinnes, 2002; Schneider et al., 2010; Kelmarson et al., 2019). Furthermore, numerous papers in the literature argue that less developed EU members may have generally worse institutional and regulatory frameworks and lower market discipline, capital capacity and technical skills (Claessens et al., 2002; Čihák and Fonteyne, 2009).

We record quantitatively similar estimates for the two panels (Table C4). Qualitatively, in the OMCs, the results are surrounded by wider confidence bands, as the estimates are found to be significant at the 5% or 10% level, in contrast to 1% significance for the NMC estimates. This may be explained by the fact that more macroprudential policy measures were taken in the NMCs in the

[15] There is both macro- and micro-level evidence on this issue (Jiménez et al., 2012; Kosak et al., 2015).

[16] More capitalized countries: Belgium, Ireland, Luxembourg, Finland, Estonia, Lithuania, Malta, Slovakia.
Less capitalized countries: Greece, Spain, France, Italy, Portugal, Slovenia, Sweden.
While the choice of the top and bottom eight countries representing the two sub-samples was arbitrary, we perform several robustness checks which show that the estimates are not sensitive to the inclusion of more or fewer countries, apart from the obvious loss or gain in degrees of freedom. These estimates are readily available from the authors upon request.

period studied. Still, the fact that the signs of the parameters are the same confirms that our base estimates are not driven by either country group.

### 5.4 Sensitivity Checks

In this section, we demonstrate the validity of our base estimates with respect to a variety of changes in the empirical specification. For each sensitivity check, we report the point estimate and the respective standard error for our coefficient of interest, *MaPP*. The estimates are shown in Table C5.

First, we drop countries with a large share of shadow banking, namely Luxembourg, the Netherlands and Ireland. These countries act to a large extent as international hubs in the EU shadow banking system. Many of the shadow bank entities that fall under the OFI sector statistics do not engage in financial intermediation, as they act mostly on behalf of international investors and hold non-domestic assets. Country-level exploration studies all agree that the actual size of the shadow banking sector (while substantial) is much smaller than the international statistics suggest (Broos et al., 2012; Duclos and Morhs, 2017; Golden et al., 2018).

We also try weighting by the level of financial development and financial openness. This is to account for two facts found in the literature. First, more developed countries are faster in adopting various financial innovations (Claessens et al., 2018) and second, greater financial openness provides more scope for leakages in prudential regulation across countries (Buch and Goldberg, 2017). Weighting in either manner leaves our coefficient estimate for the variable of interest significant for all model specifications, with the majority entering at least at the 5% confidence level.

Next, we test whether the inclusion of house prices alters the specification outcome in any way. European mortgage-backed securities were widely traded both prior to the Global Financial Crisis of 2007–2009 (Deku et al., 2019) and in its aftermath (ESRB, 2020b) and house prices could therefore explain a signification portion of the variability of shadow bank loans (securitized loans formed over 22% of total shadow loans as of the end of 2019; see Figure A2). Reassuringly, we continue to report qualitatively and quantitatively similar parameters for our main variable.

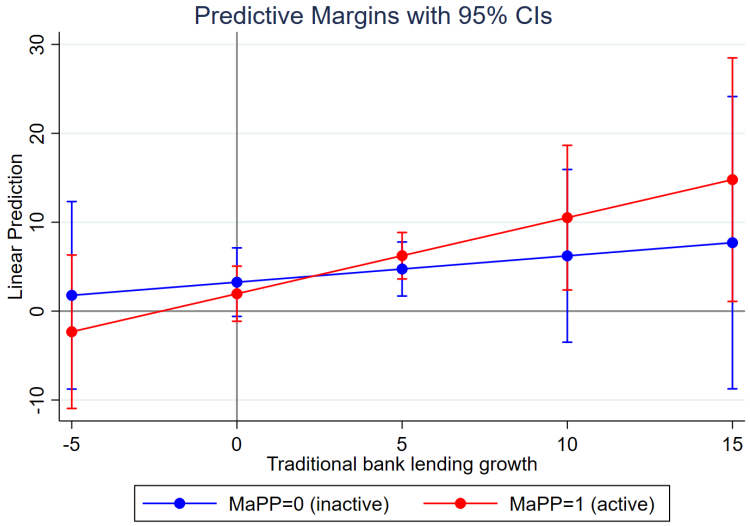
We further consider the inclusion of lagged shadow loan growth (Table C6). All specifications enter with qualitatively similar values on our *MaPP* variable of interest and remain statistically significant. The coefficient point estimates are modestly smaller, but are still indicative of a substantial impact of macroprudential policy on shadow loan growth.

Finally, we consider shadow bank loans as a ratio to real GDP as the dependent variable. We are aware that economic interpretation of the estimated coefficients would be troublesome, since the stock of loans is compared to the flow of GDP. We are merely aiming to check for the robustness of our estimates with regard to the potential heterogeneity in the EU panel. Similarly, we consider the ratio of traditional bank loans to real GDP as a control variable, instead of the annual growth rate. The rest of the control variables enter the estimation in the same way as they do in the base model in Eq. 3. Our results with this alternative dependent variable continue to enter with the expected signs (Table C7).

### 5.5 Calculating Marginal Effects

Finally, we consider an augmented version of our baseline specification in Eq. 3 enriched with an interaction term $MaPP_{i,t-1} \times TB_{i,t-1}$. The interaction term captures the contemporaneous relationship between shadow and traditional bank lending conditional on macroprudential policy actions. After estimating the parameter, we calculate the marginal effects at the mean values of traditional bank lending growth and plot the adjusted effects for different values of *MaPP* (Figure 5). We consider *MaPP* equal to zero, which would imply that macroprudential policy is not active, and equal to one, which would represent one active instrument. The estimated marginal effect lends support to the view that macroprudential policy may lead to credit reallocation towards non-banks. For $MaPP = 0$, a 10% increase in traditional bank lending is associated with 6% growth in shadow lending. For $MaPP = 1$, for example after considering the effect of a macroprudential policy tightening, a 10% increase in traditional lending is linked with more than 10% growth in shadow lending.

***Figure 5: Marginal Effects of Change in Traditional Bank Lending Growth***




The observed difference in the effect between the two scenarios suggests that the relationship between shadow and traditional bank lending is dependent on the macroprudential policy actions. When macroprudential policy is inactive, i.e. when the value of *MaPP* is held at zero, the marginal effects are mostly insignificant. In contrast, when macroprudential policy is switched on, we detect mostly upward-sloping lines with statistically significant marginal effects, suggesting that macroprudential policy was associated with an increase in shadow bank lending at a time of traditional bank lending growth.

## 6. Conclusion

We compile a new dataset for 23 European Union countries to present new evidence on the empirical link between macroprudential policy actions and shadow bank lending. Our findings provide lessons for the use of macroprudential policy and for the design of the regulatory framework.

We robustly show that tightening macroprudential policy leads to increased growth in shadow bank lending. When exploring the cross-country dimension of our dataset, we further find that the leakage of macroprudential policy to shadow bank lending is even more pronounced for less capitalized banking sectors. Overall, we provide evidence suggesting that macroprudential policy

tightening can cause reallocation of credit intermediation from the regulated traditional banking sector to the less regulated shadow banking sector. There are multiple channels likely to be at play. First, a tightening of macroprudential policy generally limits bank lending, which may leave some borrowers outside traditional credit intermediation. These entities would then turn to alternative forms of credit. Second, tighter macroprudential policy may increase bank funding costs, which may then raise traditional banks' incentives to securitize their existing loan contracts. To verify which of these channels are at play is beyond the scope of the paper and remains a fruitful area for future research. However, to be able to draw conclusions about the channels of transmission from macroprudential policy to shadow bank lending, one would require detailed loan-level data on credit provision from "shadow" banks, along with borrower characteristics.

Our findings link to the theoretical frameworks on macroprudential policy leakages and regulatory arbitrage introduced in Plantin (2015) and Farhi and Tirole (2020) and extended in Bengui and Bianchi (2018). Our results are also relevant to the broader policy debate concerning the appropriate configuration of bank regulation. On the one hand, shadow credit could provide an additional source of funding for both financial and non-financial entities, especially when bank capital constraints bind traditional credit intermediation. On the other hand, the documented reallocation of credit towards the less regulated shadow banking sector could become counterproductive if the sector itself becomes unstable, especially during times of stress (Gorton and Metrick, 2012). And while all banks are susceptible to runs (Diamond and Dybvig, 1983), shadow banks do not have access to public guarantees and safety nets.

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# Appendix A: Data

## A.1 A Further Look at the Shadow Banking Data

The data on loans granted by shadow banking entities were taken from the European System of Accounts (ESA2010) financial sector accounts maintained by the ECB. Specifically, we collect data on loans granted by other financial institutions (OFIs). The sector comprises the following types of entities: other financial intermediaries (S.125), financial auxiliaries (S.126) and captive financial institutions and money lenders (S.127).

While the entities included in the OFI sector pursue a variety of business models, we are interested only in total loans granted, trimming down other asset categories. Furthermore, we use Eurostat data to identify loans assigned to captive institutions and money lenders (ESA2010 subsector S.127) and subtract them from our data. Captive financial institutions are largely set up by multinational firms to channel funds to other parts of their own firm or to attract external funding for their parent company. FSB (2020) states that captives have very little engagement in any investment or borrowing with entities external to the group.

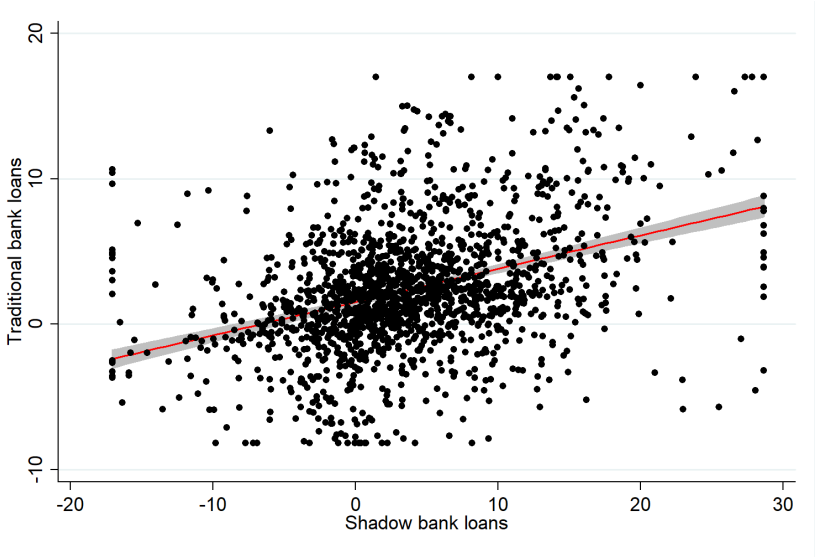
In the end, our shadow bank loans measure is defined as follows: total loans granted by other financial institutions (S.125+S.126) to the total economy, excluding captive institutions and money lenders (S.127).

According to the latest EBA (2020) assessment, OFIs' activities can be clustered into the following groups:

- Cluster 1: consumer and corporate lenders, including factoring, leasing, consumer credit/retail credit/microcredit, guarantee providers, mortgage lenders, saving institutions and other types of lenders;
- Cluster 2: securitization vehicles;
- Cluster 3: crowdfunding;
- Cluster 4: credit unions and mutuals.

On inspecting other properties of the data, we find that on average around 60% of total loans granted reflect long-term debt (over 1 year). This share ranges from 40% to 90% in our sample. This suggests that a significant proportion of loans are (collateralized) loans for house purchase. This partially explains the high correlation we find between the shadow and traditional bank loans time series across our sample of countries (Figure A1).

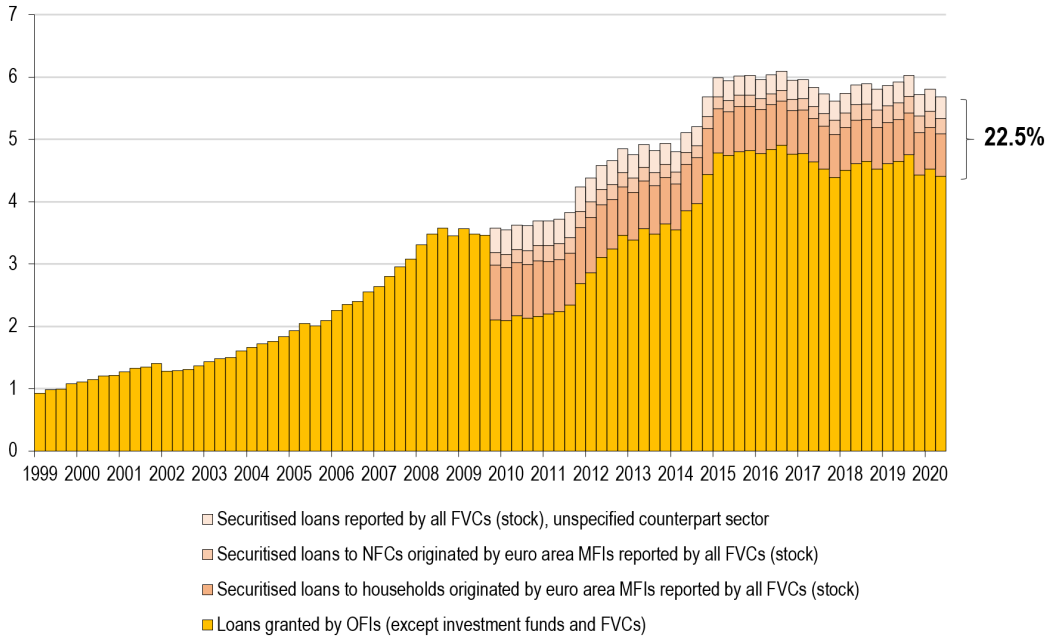
***Figure A1: Scatterplot of Traditional and Shadow Bank Loan Growth Rates***




***Note:*** Winsorized at 1% and 99%.

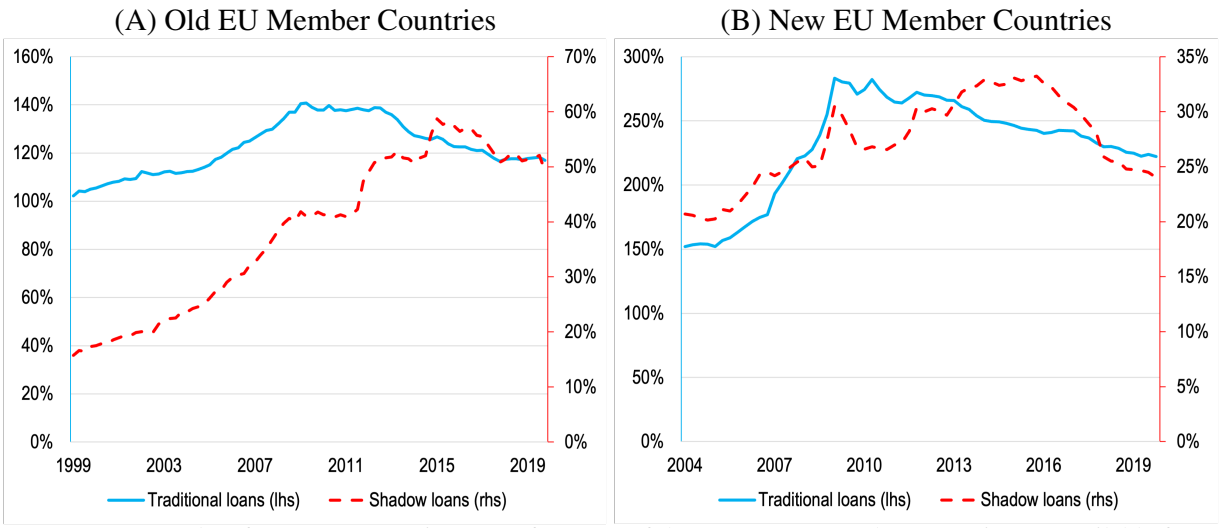
Figure A2 offers a more detailed look at shadow loans using a sub-sample of euro area countries in a changing composition. It shows that a significant portion of the loan stock is made up of securitized loans granted by financial vehicle corporations (FVCs). This share dropped from about 40% at the end of 2009 to 22% at the end of 2020. Data availability restricts us from tracing this share further into the past.

***Figure A2: Loans and Securitized Loans in Euro Area***



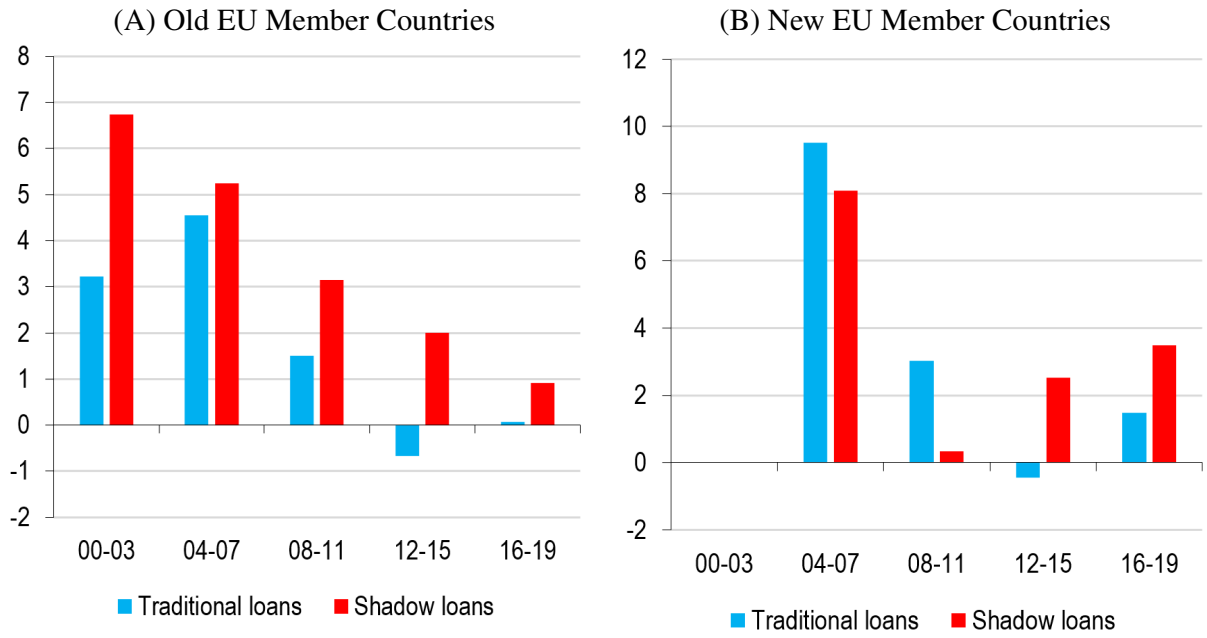

***Note:*** Winsorized at 1% and 99%.

***Figure A3: Total Traditional and Shadow Banking Loans (% of real GDP)***




***Note:*** Aggregate data for 23 EU countries. Data for some of the "New" EU member countries are available from 2004 onwards.
***Source:*** ECB.

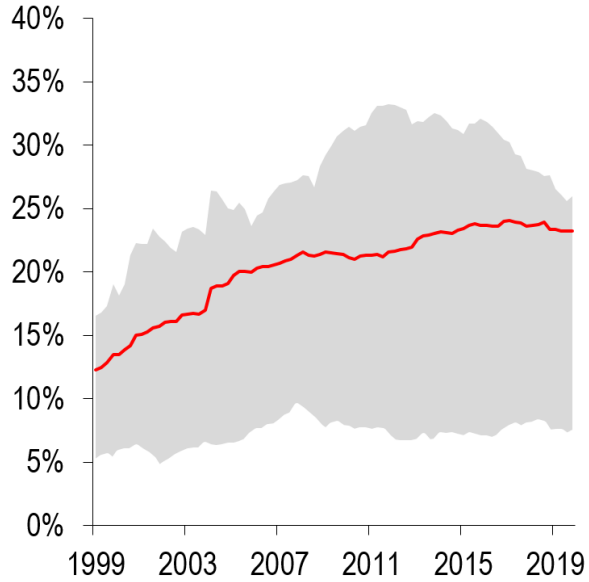
***Figure A4: Four-Year Average Growth Rates of Traditional and Shadow Banking***



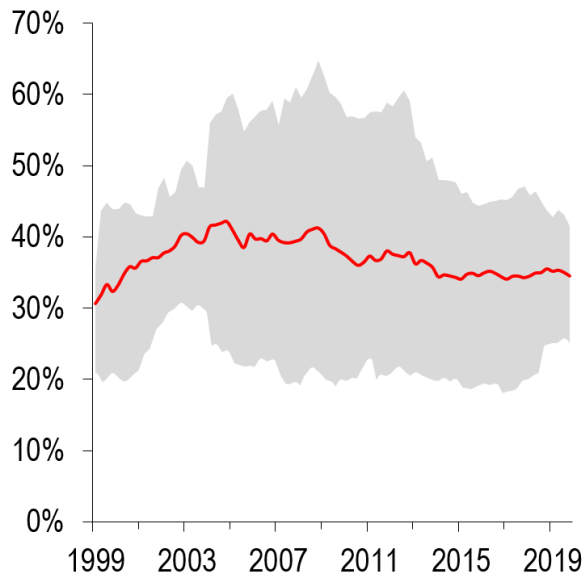

***Note:*** Aggregate data for 23 EU countries. Data for some of the "New" EU member countries are available from 2004 onwards.
***Source:*** ECB.

***Figure A5: Position of OFI Assets and Loans within Financial Sector***

(A) Share of OFI Assets in Total Financial Sector Assets




(B) Share of OFI Loans Granted in Total OFI Assets

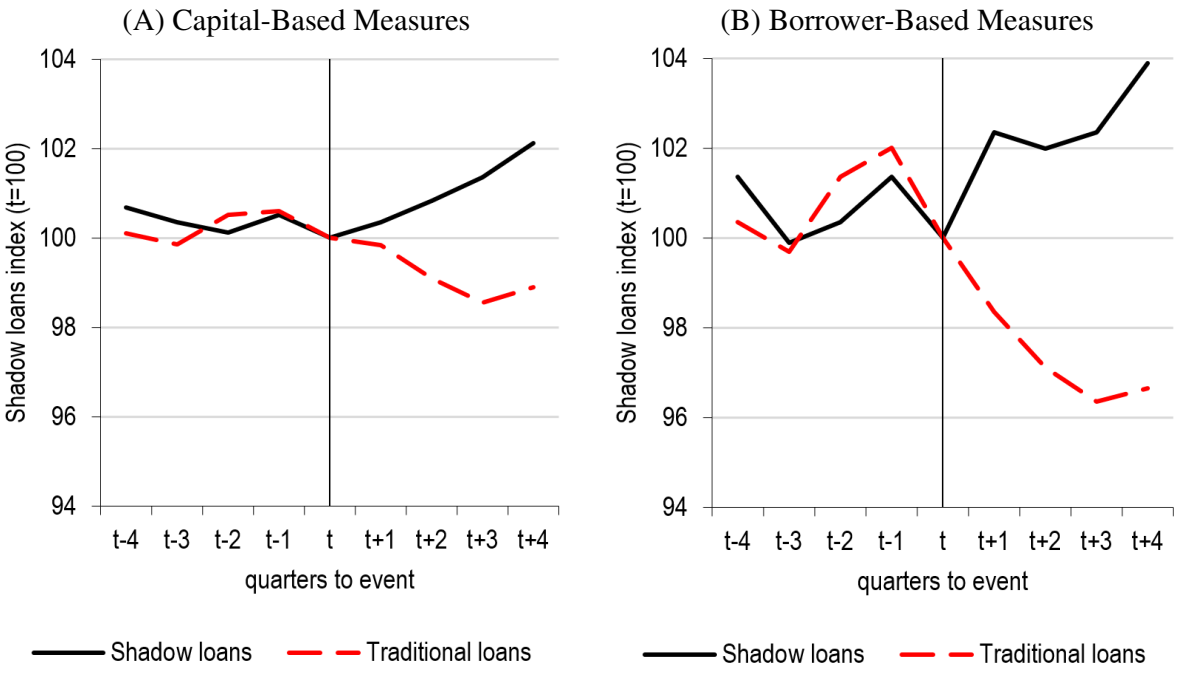



***Note:*** Total financial sector assets comprise assets of monetary financial institutions, investment funds, money market funds, insurance corporations and pension funds, and other financial intermediaries. The sample consists of 23 EU countries. Data for some of the "New" EU member countries are available from 2004 onwards.
***Source:*** ECB.

## A.2 Shadow and Bank Loans Around Policy Events

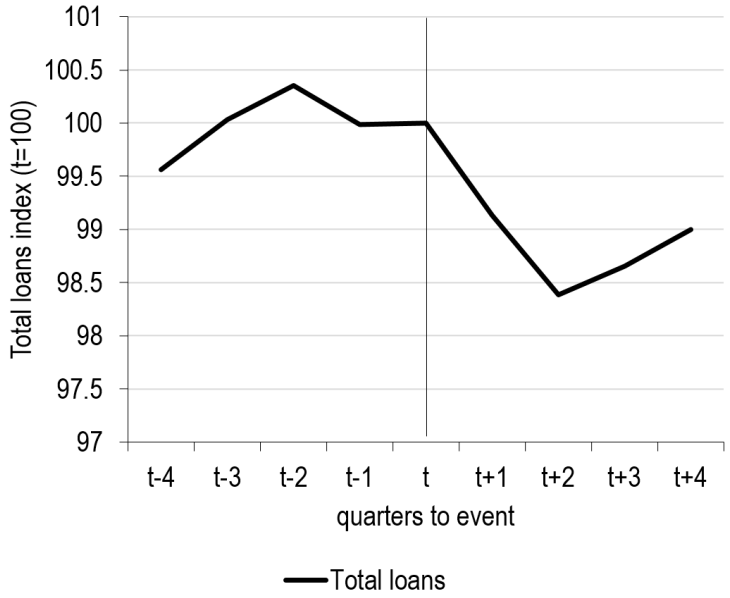
Figures A6, A7 and A8 depict the evolution of the stock of shadow and traditional bank loans around macroprudential policy events (t = 100). As regards Figure A6, we observe that following borrower-based measures, the decrease in the stock of traditional bank loans is more pronounced. This is consistent with the literature on the effects of macroprudential policy measures (Cerutti et al., 2017a; Fendoglu, 2017).

***Figure A6: Shadow and Bank Loans Around Policy Events***



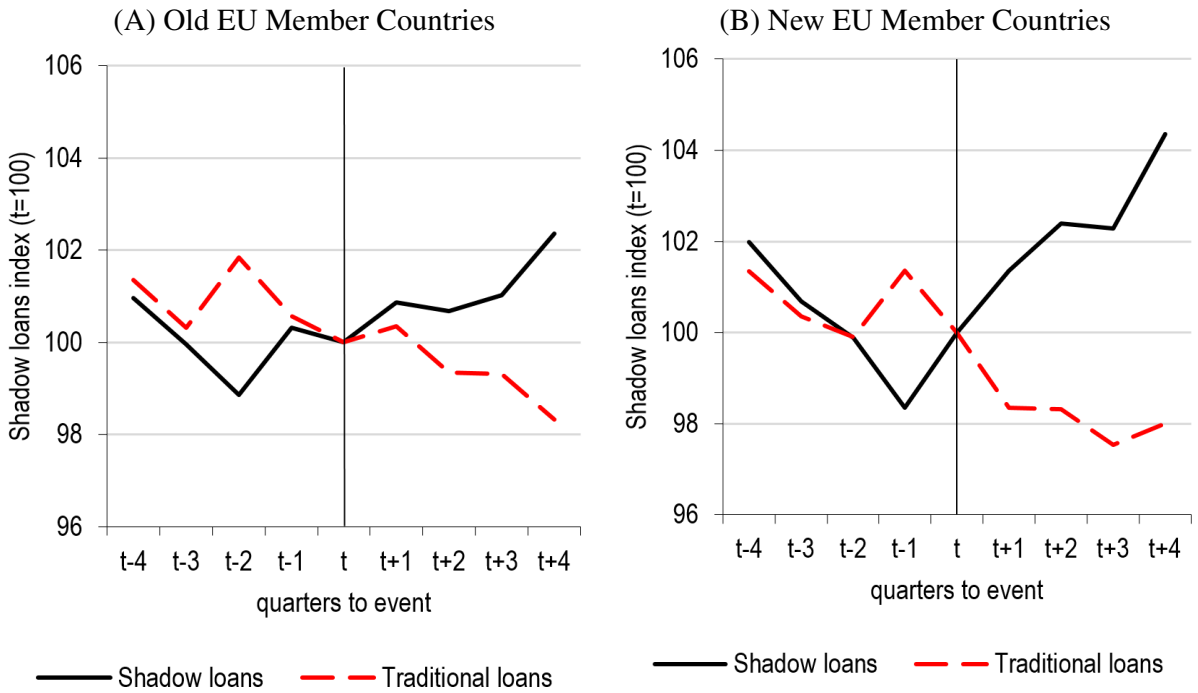

***Note:*** The graph shows the average stock of shadow and bank loans across a total of 248 dates of macroprudential policy tightening. 191 events are associated with capital-based measures and 57 events are associated with borrower-based measures.
***Source:*** ECB data, own computation.

***Figure A7: Total Loans Around Policy Events***




***Note:*** The graph shows the average stock of loans across 248 dates of macroprudential policy tightening in 24 EU countries.
***Source:*** ECB data, own computation.

***Figure A8: Shadow and Bank Loans Around Policy Events in EA12 and Non-EA12 Countries***




***Note:*** The graph shows the average stock of shadow and bank loans across 157 and 91 dates of macroprudential policy tightening in EA12 and non-EA12 countries respectively.
***Source:*** ECB data, own computation.

### A.3 Index of Macroprudential Authority Strength

We use the ESRB (2014) assessment of the implementation of the ESRB's Recommendation on the macro-prudential mandate of national authorities to set up a macroprudential authority strength index.[17] In 2014, the ESRB evaluated the degree to which EU member states were compliant with the Recommendation. We are interested in the assessment related to sub-recommendation B.3., which requires that the central bank play a leading role in macroprudential policy.

Table A1 summarizes the extent of the central bank's role in the macroprudential policy of individual countries. The ESRB grades countries according to their efforts to implement the ESRB Recommendation on a zero to one scale (0 = Non-compliant; 0.25 = Materially non-compliant; 0.5 = Partially compliant; 0.75 = Largely compliant; 1 = Fully compliant).

***Table A1: Institutional Framework of National Macroprudential Authority***

| | Board | Central bank | FSA | Government |
|---|---|---|---|---|
| National macroprudential authority | Austria, Denmark, France, Germany, Italy, Luxembourg, Netherlands, Poland, Slovenia, Spain | Belgium, Cyprus, Czech Republic, Estonia, Greece, Hungary, Ireland, Latvia, Lithuania, Malta, Portugal, Slovakia | Finland and Sweden | None |

***Note:*** FSA = Financial Stability Authority.
***Source:*** ESRB Recommendation on the macro-prudential mandate of national authorities (ESRB/2011/3), Follow-up Report - Overall Assessment (June 2014).

Table A2 shows the index values for our sample countries together with our 2017 assessment, which changed the grades for some countries.

[17] ESRB/2011/3 of 22 December 2011 - as presented in OJ C 41/1.

***Table A2: Strength of National Macroprudential Authorities and Number of Macroprudential Policy Actions***

| | Number of policy actions | | | | | | INST | |
|---|---|---|---|---|---|---|---|---|
| Period | 00-03 | 04-07 | 08-11 | 12-15 | 16-19 | Sum | B3 (2014) | B3 (2017) |
| Belgium | 1 | 0 | 2 | 3 | 6 | 12 | 0.75 | 1 |
| Germany | 1 | 0 | 1 | 3 | 4 | 9 | 0.75 | 0.75 |
| Ireland | 2 | 2 | 0 | 5 | 3 | 12 | 1 | 1 |
| Greece | 1 | 2 | 1 | 2 | 3 | 9 | 1 | 1 |
| Spain | 2 | 1 | 4 | 2 | 4 | 13 | 0.25 | 0.75 |
| France | 1 | 0 | 1 | 3 | 6 | 11 | 0.5 | 0.5 |
| Italy | 1 | 1 | 0 | 3 | 2 | 7 | 1 | 1 |
| Netherlands | 1 | 1 | 2 | 5 | 3 | 12 | 0.75 | 1 |
| Austria | 2 | 0 | 4 | 2 | 5 | 13 | 0.5 | 0.5 |
| Portugal | 1 | 0 | 1 | 2 | 5 | 9 | 1 | 1 |
| Finland | 1 | 1 | 2 | 3 | 5 | 12 | 0 | 0.25 |
| Estonia | 2 | 3 | 5 | 4 | 3 | 17 | 0.75 | 1 |
| Cyprus | 1 | 0 | 0 | 3 | 5 | 9 | 0.75 | 1 |
| Latvia | 3 | 7 | 6 | 3 | 4 | 23 | 1 | 1 |
| Lithuania | 0 | 1 | 3 | 3 | 4 | 11 | 0.75 | 1 |
| Malta | 1 | 0 | 1 | 5 | 4 | 11 | 1 | 1 |
| Slovenia | 1 | 2 | 0 | 2 | 5 | 10 | 0.75 | 0.75 |
| Slovakia | 4 | 2 | 2 | 4 | 7 | 19 | 1 | 1 |
| Czechia | 2 | 0 | 0 | 4 | 9 | 15 | 1 | 1 |
| Hungary | 3 | 1 | 5 | 6 | 8 | 23 | 1 | 1 |
| Poland | 0 | 2 | 7 | 5 | 5 | 19 | 0.5 | 1 |
| Sweden | 0 | 1 | 1 | 5 | 4 | 11 | 0.25 | 0.25 |

***Source:*** Alam et al. (2019) and ESRB (2014), own computation.

# Appendix B: Sample Details

***Table B1: Country List***

| Country | Shadow banking data availability since | OMC | NMC | C/RWA (2000–2017 avrg) | More capitalized (top 8) | Less capitalized (bottom 8) |
|---|---|---|---|---|---|---|
| Belgium | 1999Q1 | X | | 15.61 | X | |
| Germany | 1999Q1 | X | | 15.06 | | |
| Ireland | 2002Q1 | X | | 16.29 | X | |
| Greece | 1999Q1 | X | | 12.34 | | X |
| Spain | 1998Q4 | X | | 12.57 | | X |
| France | 1998Q4 | X | | 13.29 | | X |
| Italy | 1999Q1 | X | | 11.90 | | X |
| Luxembourg | 2001Q1 | X | | 17.93 | X | |
| Netherlands | 1999Q1 | X | | 14.58 | | |
| Austria | 1999Q1 | X | | 14.89 | | |
| Portugal | 1999Q1 | X | | 11.06 | | X |
| Finland | 1998Q4 | X | | 15.66 | X | |
| Estonia | 2004Q1 | | X | 19.58 | X | |
| Cyprus | 2004Q1 | | X | 13.41 | | X |
| Latvia | 2004Q1 | | X | 14.90 | | |
| Lithuania | 1998Q4 | | X | 15.10 | X | |
| Malta | 2004Q1 | | X | 15.29 | X | |
| Slovenia | 2004Q1 | | X | 13.36 | | X |
| Slovakia | 2004Q1 | | X | 16.09 | X | |
| Czechia | 2004Q1 | | X | 14.80 | | |
| Hungary | 1998Q4 | | X | 14.18 | | |
| Poland | 2003Q4 | | X | 14.06 | | |
| Sweden | 1998Q4 | * | | 13.76 | | X |

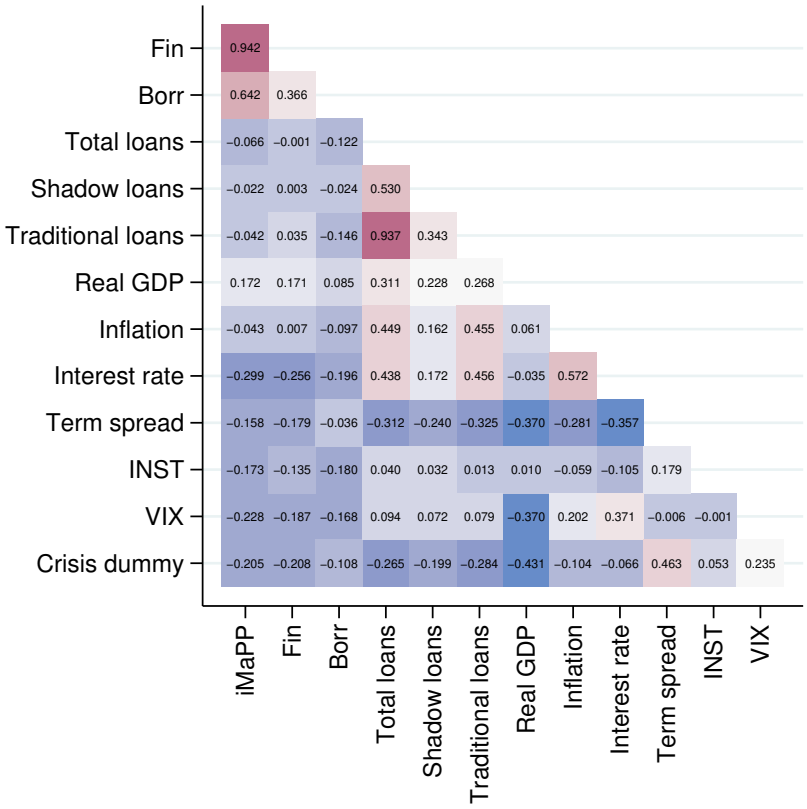
***Note:*** OMC = old member country, NMC = new member country, C/RWA = bank regulatory capital to risk-weighted assets calculated as a simple average over the 2000–2017 period. * Sweden was excluded from the OMC group due to its independent monetary policy.
***Source:*** The C/RWA data were taken from the FRED database.

***Table B2: Descriptive Statistics***

| Mnemonic | Variable | N | Mean | Std. Dev. | Min | Max | Units | Source |
|---|---|---|---|---|---|---|---|---|
| *iMaPP* | MPP index | 1,840 | 1.86 | 5.48 | -7 | 25 | index | Alam et al. (2019) |
| *Fin* | MPP index (financial) | 1,840 | 0.75 | 4.46 | -6 | 18 | index | Alam et al. (2019) |
| *Borr* | MPP index (borrower) | 1,840 | 0.79 | 1.68 | -1 | 11 | index | Alam et al. (2019) |
| *Total Loans* | Total private sector loans | 1,668 | 2.80 | 4.77 | -14.95 | 24.92 | % | ECB |
| *Shadow Loans* | Shadow bank loans | 1,668 | 3.90 | 8.37 | -26.74 | 83.54 | % | ECB |
| *Traditional Loans* | Traditional bank loans | 1,668 | 2.38 | 4.67 | -15.13 | 22.50 | % | ECB |
| *Real GDP* | Real GDP (growth) | 1,836 | 1.04 | 1.61 | -8.86 | 11.04 | % | ECB |
| *Inflation* | Inflation rate | 1,840 | 2.30 | 2.14 | -3.87 | 17.53 | % | ECB |
| *Interest Rate* | 3M EURIBOR | 1,807 | 2.22 | 2.49 | -0.78 | 15.67 | % | ECB |
| *Term Spread* | Term spread calculated as difference between 10Y government bond yields and 3M inter-bank interest rates | 1,768 | 1.62 | 2.16 | -6.64 | 24.70 | % | Eurostat |
| *INST* | Strength of National Macroprudential Authorities | 1,840 | 0.68 | 0.27 | 0.25 | 1.00 | index | ESRB (2014) and own calculation |
| *VIX* | CBOE Volatility Index | 1,840 | 19.48 | 7.80 | 10.31 | 58.59 | index | CBOE |
| *House prices* | Real house price growth | 1,432 | 4.05 | 8.77 | -44.86 | 51.19 | % | BIS |

***Note:*** The variables are in annualized growth rates, except for interest rates, INST, the MPP index and all dummy variables, which are in levels.

***Figure B1: Correlation Matrix***




***Note:*** Fin = macroprudential policy index encompassing capital-based measures, Borr = macroprudential policy index encompassing borrower-based measures, INST = macroprudential authority strength index.

# Appendix C: Additional Estimates

***Table C1: Reverse Specifications***

| Dependent variable: | | | | | | |
|---|---|---|---|---|---|---|
| MaPP index | (1) | (2) | (3) | (4) | (5) | (6) |
| *Shadow Loans* | 0.037*** | 0.037*** | 0.037*** | 0.045*** | 0.045*** | 0.045*** |
| | (0.014) | (0.014) | (0.014) | (0.008) | (0.008) | (0.008) |
| *Traditional Loans* | 0.088*** | 0.088*** | 0.088*** | 0.105*** | 0.105*** | 0.105*** |
| | (0.025) | (0.024) | (0.024) | (0.016) | (0.016) | (0.016) |
| *Real GDP* | 0.181** | 0.181** | 0.181** | 0.167*** | 0.167*** | 0.167*** |
| | (0.077) | (0.080) | (0.080) | (0.056) | (0.048) | (0.048) |
| *Interest Rate* | -1.294*** | -1.294*** | -1.294*** | -0.228*** | -0.228*** | -0.228*** |
| | (0.055) | (0.090) | (0.090) | (0.055) | (0.087) | (0.087) |
| *Term Spread* | -0.008 | -0.008 | -0.008 | -0.007 | -0.007 | -0.007 |
| | (0.014) | (0.013) | (0.013) | (0.011) | (0.009) | (0.009) |
| *N* | 1,668 | 1,668 | 1,668 | 1,668 | 1,668 | 1,668 |
| Adj. $R^2$ | 0.570 | 0.570 | 0.570 | 0.860 | 0.860 | 0.860 |
| Country FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | No | No | No | Yes | Yes | Yes |
| Standard Errors | Robust | DK | Clustered | Robust | DK | Clustered |

***Note:*** * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is the MaPP index. OLS estimator with standard errors in parentheses. Models (2) and (5) use the Driscoll-Kraay estimator. The sample period is 2000Q1–2019Q4.

***Table C2: Differences Between Use of Capital- and Borrower-Based Measures***

| Dependent variable: Shadow Loan Growth | *Capital-Based Measures* | | | *Borrower-Based Measures* | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| *MaPP Index* | 0.837** | 0.837*** | 0.837*** | 1.459*** | 1.459*** | 1.459*** |
| | (0.327) | (0.304) | (0.247) | (0.525) | (0.476) | (0.225) |
| *Traditional Loans* | 0.241*** | 0.241*** | 0.241** | 0.388*** | 0.388*** | 0.388*** |
| | (0.055) | (0.053) | (0.104) | (0.052) | (0.061) | (0.120) |
| *Real GDP* | 0.509*** | 0.509*** | 0.509 | 0.444*** | 0.444*** | 0.444* |
| | (0.143) | (0.145) | (0.324) | (0.133) | (0.118) | (0.266) |
| *Interest Rate* | 1.024*** | 1.024*** | 1.024 | 0.545*** | 0.545*** | 0.545*** |
| | (0.263) | (0.259) | (0.705) | (0.107) | (0.151) | (0.212) |
| *Term Spread* | 0.195 | 0.195 | 0.195 | -0.167 | -0.167 | -0.167 |
| | (0.200) | (0.185) | (0.502) | (0.102) | (0.104) | (0.216) |
| *Crisis Dummy* | 1.022 | 1.022* | 1.022 | 0.823 | 0.823 | 0.823 |
| | (0.643) | (0.608) | (1.233) | (0.563) | (0.527) | (0.733) |
| *VIX* | -0.201*** | -0.201*** | -0.201*** | -0.194*** | -0.194*** | -0.194*** |
| | (0.028) | (0.031) | (0.039) | (0.027) | (0.028) | (0.036) |
| *N* | 1,639 | 1,639 | 1,639 | 1,639 | 1,639 | 1,639 |
| Adj. $R^2$ | 0.278 | 0.278 | 0.278 | 0.253 | 0.253 | 0.253 |
| Country FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | No | No | Yes | No | No | Yes |
| Standard Errors | Robust | DK | Clustered | Robust | DK | Clustered |
| F-test | 51.48*** | 51.48*** | 51.48*** | 61.86*** | 61.86*** | 61.86*** |
| DWH test | 0.546 | 0.598 | 0.677 | 0.897 | 0.905 | 0.956 |

***Note:*** * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is annual shadow loan growth. OLS estimator with robust standard errors in parentheses if not stated otherwise. Models (2) and (5) use the Driscoll-Kraay estimator. The sample period is 2000Q1–2019Q4. The constant was estimated but is not reported. The F-test is used to verify the strength of the instruments. DWH stands for the Durbin-Wu-Hausman test, which is used to verify the endogeneity of MaPP. The null hypothesis is that MaPP is exogenous.

***Table C3: Differences Between More and Less Capitalized Countries***

| Dependent variable: Shadow Loan Growth | *More Capitalized* | | | *Less Capitalized* | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| *MaPP Index* | 0.438 | 0.438 | 0.438 | 0.502** | 0.502** | 0.502** |
| | (0.445) | (0.435) | (0.434) | (0.214) | (0.220) | (0.250) |
| *Traditional Loans* | 0.294** | 0.294** | 0.294** | 0.206*** | 0.206** | 0.206** |
| | (0.140) | (0.122) | (0.120) | (0.078) | (0.095) | (0.193) |
| *Real GDP* | 1.046** | 1.046** | 1.046** | 0.395 | 0.395 | 0.395 |
| | (0.486) | (0.499) | (0.465) | (0.346) | (0.399) | (0.507) |
| *Interest Rate* | 0.684 | 0.684 | 0.684 | 0.358 | 0.358 | 0.358 |
| | (0.659) | (0.710) | (0.587) | (0.394) | (0.523) | (0.738) |
| *Term Spread* | 0.867 | 0.867 | 0.867 | -0.026 | -0.026 | -0.026 |
| | (0.759) | (0.771) | (0.829) | (0.132) | (0.143) | (0.197) |
| *Crisis Dummy* | -1.458* | -1.458* | -1.458* | 1.749** | 1.749* | 1.749** |
| | (0.895) | (0.841) | (0.852) | (0.785) | (0.941) | (0.694) |
| *VIX* | -0.271*** | -0.271*** | -0.271*** | -0.212*** | -0.212*** | -0.212*** |
| | (0.078) | (0.076) | (0.092) | (0.042) | (0.047) | (0.060) |
| *N* | 549 | 549 | 549 | 594 | 594 | 594 |
| Adj. $R^2$ | 0.140 | 0.140 | 0.140 | 0.281 | 0.281 | 0.281 |
| Country FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | No | No | No | No | No | No |
| Standard Errors | Robust | DK | Clustered | Robust | DK | Clustered |
| F-test | 29.75*** | 29.75*** | 29.75*** | 54.39*** | 54.39*** | 54.39*** |
| DWH test | 0.895 | 0.958 | 0.985 | 0.489 | 0.507 | 0.563 |

***Note:*** * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is annual shadow loan growth. OLS estimator with robust standard errors in parentheses if not stated otherwise. Models (2) and (5) use the Driscoll-Kraay estimator. The sample period is 2000Q1–2019Q4. The constant was estimated but is not reported. The F-test is used to verify the strength of the instruments. DWH stands for the Durbin-Wu-Hausman test, which is used to verify the endogeneity of MaPP. The null hypothesis is that MaPP is exogenous.

***Table C4: Differences Between Old and New EU Member Countries***

| Dependent variable: Shadow Loan Growth | *Old Member Countries* | | | *New Member Countries* | | |
|---|---|---|---|---|---|---|
| | MaPP | Cap | Borr | MaPP | Cap | Borr |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| *MaPP Index* | 0.886** | 1.355** | 1.901* | 0.504*** | 0.718*** | 1.948*** |
| | (0.405) | (0.661) | (1.123) | (0.173) | (0.254) | (0.652) |
| *Traditional Loans* | 0.366*** | 0.381*** | 0.341*** | 0.362*** | 0.294*** | 0.498*** |
| | (0.105) | (0.107) | (0.115) | (0.073) | (0.067) | (0.101) |
| *Real GDP* | 0.694** | 0.799** | 0.768** | 0.835*** | 0.880*** | 0.733*** |
| | (0.311) | (0.354) | (0.330) | (0.203) | (0.218) | (0.196) |
| *Interest Rate* | 0.336** | 0.494** | 0.371** | 1.015*** | 1.133*** | 0.701*** |
| | (0.167) | (0.215) | (0.190) | (0.222) | (0.246) | (0.199) |
| *Term Spread* | -0.109 | -0.053 | -0.028 | 0.104 | 0.250 | -0.249 |
| | (0.160) | (0.169) | (0.158) | (0.301) | (0.339) | (0.243) |
| *Crisis Dummy* | -1.924*** | -2.057*** | -1.944*** | 1.849* | 1.700 | 2.307** |
| | (0.602) | (0.676) | (0.651) | (1.051) | (1.097) | (1.050) |
| *VIX* | -0.196*** | -0.199*** | -0.213*** | -0.167*** | -0.185*** | -0.137*** |
| | (0.032) | (0.034) | (0.042) | (0.049) | (0.050) | (0.049) |
| *N* | 632 | 632 | 632 | 634 | 634 | 634 |
| Adj. $R^2$ | 0.163 | 0.151 | 0.151 | 0.180 | 0.155 | 0.155 |
| Country FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | No | No | No | No | No | No |
| Standard Errors | Robust | DK | Clustered | Robust | DK | Clustered |
| F-test | 36.89*** | 36.89*** | 36.89*** | 55.97*** | 55.97*** | 55.97*** |
| DWH test | 0.783 | 0.851 | 0.893 | 0.405 | 0.433 | 0.480 |

***Note:*** * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is annual shadow loan growth. OLS estimator with robust standard errors in parentheses if not stated otherwise. Models (2) and (5) use the Driscoll-Kraay estimator. The sample period is 2000Q1–2019Q4. The constant was estimated but is not reported. The F-test is used to verify the strength of the instruments. DWH stands for the Durbin-Wu-Hausman test, which is used to verify the endogeneity of MaPP. The null hypothesis is that MaPP is exogenous.

***Table C5: Sample Sensitivity Analysis***

| Dependent variable: | | | | | | |
|---|---|---|---|---|---|---|
| Shadow Loan Growth | (1) | (2) | (3) | (4) | (5) | (6) |
| *Baseline* | 0.506*** | 0.506*** | 0.506*** | 0.494*** | 0.494*** | 0.494*** |
| | (0.187) | (0.173) | (0.149) | (0.190) | (0.174) | (0.187) |
| *Drop Large* | 0.521*** | 0.521*** | 0.521*** | 0.619*** | 0.619*** | 0.619 *** |
| | (0.146) | (0.146) | (0.127) | (0.176) | (0.174) | (0.178) |
| *FDI Weighted* | 0.486** | 0.486** | 0.486 ** | 0.420** | 0.420** | 0.420 ** |
| | (0.197) | (0.193) | (0.152) | (0.180) | (0.170) | (0.110) |
| *Chinn − Ito Weighted* | 0.531** | 0.523** | 0.537 ** | 0.505*** | 0.513** | 0.513 ** |
| | (0.202) | (0.205) | (0.210) | (0.130) | (0.190) | (0.202) |
| *Add House Prices* | 0.434** | 0.434** | 0.434 ** | 0.391*** | 0.391** | 0.391 ** |
| | (0.184) | (0.182) | (0.182) | (0.156) | (0.155) | (0.155) |
| Country FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | No | No | No | Yes | Yes | Yes |
| Standard Errors | Robust | DK | Clustered | Robust | DK | Clustered |

***Note:*** * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is annual shadow loan growth. OLS estimator with robust standard errors in parentheses if not stated otherwise. Models (2) and (5) use the Driscoll-Kraay estimator. The sample period is 2000Q1–2019Q4. The constant was estimated but is not reported.

***Table C6: IV Regression with Lagged Dependent Variable***

| Dependent variable: | | | | | | |
|---|---|---|---|---|---|---|
| Shadow Loan Growth | (1) | (2) | (3) | (4) | (5) | (6) |
| *Shadow Loan Growth*$(t-1)$ | 0.425*** | 0.425*** | 0.425*** | 0.469*** | 0.469*** | 0.469*** |
| | (0.028) | (0.037) | (0.037) | (0.026) | (0.034) | (0.034) |
| *MaPP* | 0.371** | 0.371** | 0.371** | 0.361** | 0.361** | 0.361** |
| | (0.161) | (0.159) | (0.159) | (0.161) | (0.160) | (0.160) |
| *Traditional Loans* | 0.172*** | 0.172*** | 0.172*** | 0.129** | 0.129** | 0.129** |
| | (0.042) | (0.048) | (0.048) | (0.056) | (0.053) | (0.053) |
| *Real GDP* | 0.163*** | 0.163*** | 0.163*** | 0.296*** | 0.296*** | 0.296*** |
| | (0.021) | (0.019) | (0.019) | (0.031) | (0.025) | (0.025) |
| *Interest Rate* | 0.470*** | 0.470*** | 0.470*** | -0.124 | -0.124 | -0.124 |
| | (0.168) | (0.169) | (0.169) | (0.143) | (0.182) | (0.182) |
| *Term Spread* | 0.050 | 0.050 | 0.050 | -0.235*** | -0.235** | -0.235** |
| | (0.126) | (0.126) | (0.126) | (0.084) | (0.108) | (0.108) |
| *Crisis Dummy* | 0.723 | 0.723 | 0.723 | | | |
| | (0.521) | (0.517) | (0.517) | | | |
| *VIX* | -0.167*** | -0.167*** | -0.167*** | -0.203*** | -0.203*** | -0.203*** |
| | (0.024) | (0.026) | (0.026) | (0.035) | (0.040) | (0.040) |
| *N* | 1,562 | 1,562 | 1,562 | 1,562 | 1,562 | 1,562 |
| Adj. $R^2$ | 0.445 | 0.445 | 0.445 | 0.536 | 0.536 | 0.536 |
| Country FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | No | No | No | Yes | Yes | Yes |
| Standard Errors | Robust | DK | Clustered | Robust | DK | Clustered |
| F-test | 64.63*** | 64.63*** | 64.63*** | 84.64*** | 84.64*** | 84.64*** |
| DWH test | 0.341 | 0.358 | 0.851 | 0.531 | 0.547 | 0.570 |

***Note:*** * $p<0.10$, ** $p<0.05$, *** $p<0.01$. The dependent variable is annual shadow loan growth. OLS estimator with robust standard errors in parentheses if not stated otherwise. Models (2) and (5) use the Driscoll-Kraay estimator. The sample period is 2000Q1–2019Q4. The constant was estimated but is not reported. The F-test is used to verify the strength of the instruments. DWH stands for the Durbin-Wu-Hausman test, which is used to verify the endogeneity of MaPP. The null hypothesis is that MaPP is exogenous.

***Table C7: IV Regression with Shadow Loans to GDP Ratio as Dependent Variable***

| Dependent variable: | | | | | | |
|---|---|---|---|---|---|---|
| Shadow Loans Ratio | (1) | (2) | (3) | (4) | (5) | (6) |
| *MaPP* | 0.140*** | 0.140*** | 0.140*** | 0.175*** | 0.175*** | 0.175*** |
| | (0.024) | (0.022) | (0.022) | (0.026) | (0.024) | (0.024) |
| *Traditional Loans Ratio* | 0.823*** | 0.823*** | 0.823*** | 0.857*** | 0.857*** | 0.857*** |
| | (0.035) | (0.036) | (0.036) | (0.035) | (0.035) | (0.035) |
| *Interest Rate* | 0.119*** | 0.119*** | 0.119*** | 0.109*** | 0.109*** | 0.109*** |
| | (0.024) | (0.021) | (0.021) | (0.021) | (0.020) | (0.020) |
| *Term Spread* | -0.110*** | -0.110*** | -0.110*** | -0.084*** | -0.084*** | -0.084*** |
| | (0.020) | (0.017) | (0.017) | (0.015) | (0.012) | (0.012) |
| *Crisis Dummy* | -0.334*** | -0.334*** | -0.334*** | | | |
| | (0.079) | (0.070) | (0.070) | | | |
| *VIX* | -0.009** | -0.009*** | -0.009*** | -0.009 | -0.009 | -0.009 |
| | (0.004) | (0.003) | (0.003) | (0.006) | (0.005) | (0.005) |
| *N* | 1,677 | 1,677 | 1,677 | 1,677 | 1,677 | 1,677 |
| Adj. $R^2$ | 0.351 | 0.351 | 0.351 | 0.423 | 0.423 | 0.423 |
| Country FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | No | No | No | Yes | Yes | Yes |
| Standard Errors | Robust | DK | Clustered | Robust | DK | Clustered |
| F-test | 69.23*** | 69.23*** | 69.23*** | 88.56*** | 88.56*** | 88.56*** |
| DWH test | 1.254 | 1.384 | 1.447 | 1.153 | 1.254 | 1.299 |

***Note:*** * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is annual shadow loan growth. OLS estimator with robust standard errors in parentheses if not stated otherwise. Models (2) and (5) use the Driscoll-Kraay estimator. The sample period is 2000Q1–2019Q4. The constant was estimated but is not reported. The F-test is used to verify the strength of the instruments. DWH stands for the Durbin-Wu-Hausman test, which is used to verify the endogeneity of MaPP. The null hypothesis is that MaPP is exogenous.

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