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Martin Hodula

Monetary Policy and Shadow Banking: Trapped between a Rock and a Hard Place

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Monetary Policy and Shadow Banking: Trapped between a Rock and a Hard Place

Martin Hodula*

Abstract

In this paper, I collect data on the euro area shadow banking system and demonstrate that tightening of monetary policy conditions in the run-up to the global financial crisis successfully reduced the growth of traditional banking but strengthened the growth of shadow banking due to a general escape from high funding costs. After the crisis, when interest rates were depressed to all-time lows, the empirical link between monetary policy and traditional banking was significantly weakened, while the relationship with shadow banking turned from positive to negative, i.e., the post-crisis monetary easing is found to have caused massive inflows into investment funds as a result of search for yield induced by persistently low interest rates.

Abstrakt

V tomto článku sbírám data o systému stínového bankovnictví v eurozóně a ukazuji, že zpřísňování měnové politiky v období před světovou finanční krizí sice úspěšně zpomalilo růst tradičního bankovnictví, ale vzhledem k obecné snaze vyhnout se vysokým nákladům financování posílilo růst stínového bankovnictví. Když po krizi úrokové sazby poklesly na historická minima, došlo ke značnému oslabení empirické vazby mezi měnovou politikou a tradičním bankovnictvím, zatímco vazba na stínové bankovnictví se změnila z kladné na zápornou, tj. pokrizové uvolňování měnové politiky způsobilo masivní příliv prostředků do investičních fondů v důsledku honby za výnosem vyvolané setrvale nízkými úrokovými sazbami.

JEL Codes: E52, G21, G23.

Keywords: Interactions, monetary policy, shadow banking, traditional banking.

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The views expressed in this paper are mine and do not necessarily represent those of the Czech National Bank or its management.

1. Introduction

A popular narrative is that low interest rates in the run-up to the global financial crisis (GFC) fueled leverage growth and prepared the ground for the global calamity in 2007–2008. The crisis started in the U.S. sub-prime mortgage market, but financial woes then spilled over into the real economy, resulting in recessions in almost all industrialized countries. As a result, economists started to argue that monetary policy should have been tighter, particularly because its effects extend beyond the reach of more targeted regulatory tools. This view echoes the "leaning against the wind" (LAW) that marks the debate about whether to use monetary policy to address risks to financial stability (for an overview of the debate, see Kockerols and Kok, 2019). As noted by Jeremy Stein, a former Fed Governor, there may be situations where LAW is warranted, as it "gets into all the cracks" of the financial system (Stein, 2013). Thus, due either to the nature of financial stability risks or to the potentially limited effectiveness of the macroprudential tools targeted, some LAW may improve welfare (BIS, 2014, 2016; Olsen, 2015; Filardo and Rungcharoenkitkul, 2016; Gourio et al., 2018; and many others).

This paper contributes to the literature related to the LAW debate by documenting evidence pertaining to the relationship between monetary policy and the balance sheet growth of both bank and non-bank (shadow) financial intermediaries while considering possible nonlinearities.[1] The evidence presented in the paper serves as empirical verification of a basic assumption behind the LAW concept, namely that there is a negative relationship between monetary policy and growth of financial intermediaries. Such a premise is reasonable. Monetary policy interest rate channel logic dictates that tighter monetary conditions (generally associated with a hike in interest rates) impose additional capital costs on traditional banks, to which they respond by cutting back on lending. Nevertheless, traditional banks may be motivated to circumvent the increased funding costs by increasing their market activities (securitization, for instance), which ultimately leads to a migration of assets out of the traditional banking system into the shadow one. Moreover, higher interest rates increase repayment costs on existing loan contracts, which may translate into higher motivation of economic agents to refinance bank loans in the shadows. This "funding costs" motive would imply a negative relationship between monetary policy and traditional banks but a positive one with their shadow counterparts.

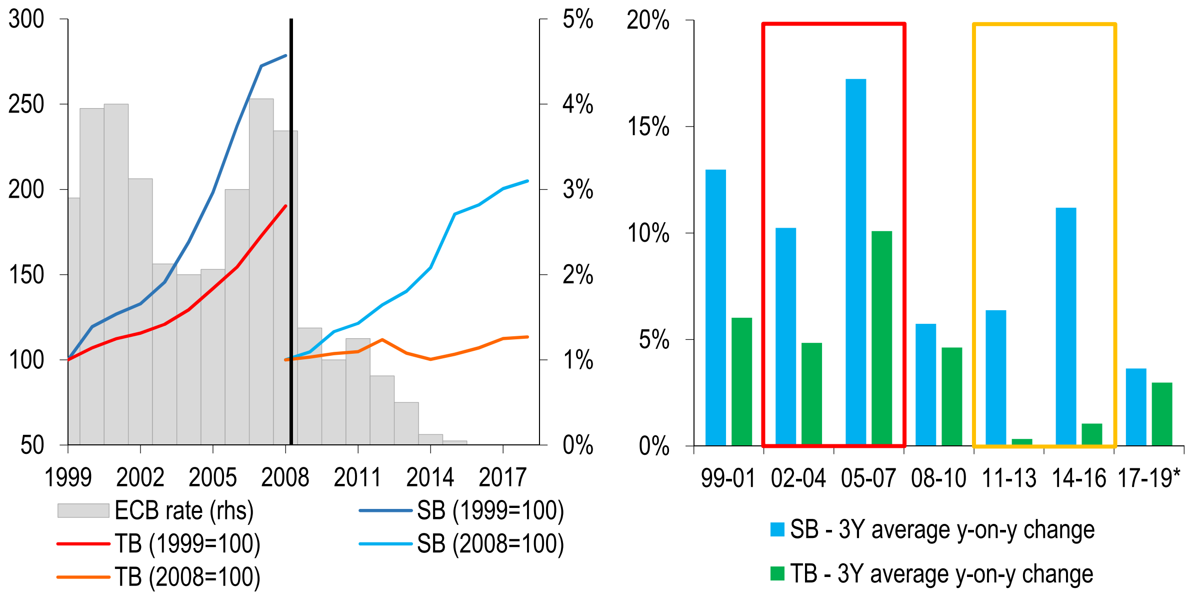
Another contribution of the paper is that it seeks to assess the effectiveness of monetary policy at "getting in the cracks." As the effects of monetary policy decisions spread through the cracks of the system, what mark do they impress on financial stability? The answer to this question has profound consequences for the conduct of both monetary and macroprudential policy. Should the monetary policy effects on bank and non-bank financial intermediaries be uneven, central bankers would have yet another reason to reconsider their prevailing notions of price stability and economic equilibria. Last but not least, the paper is among the first to describe and accommodate European data on the shadow banking system in a stylized empirical framework. Throughout the paper, I follow the European Systemic Risk Board (ESRB) entity-based approach to identify

[1] 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" (see FSB, 2018 and ESRB, 2019).

shadow banking assets. The entity-based approach consists of aggregating the balance sheet data of financial institutions taken from financial accounts and monetary statistics.[2]

It can be easily documented that the balance sheets of bank and non-bank financial intermediaries evolved differently in the run-up to the crisis (Figure 1). Both traditional and shadow banking prospered and grew rapidly during the Great Moderation. In this context, the long-lasting accommodative monetary policy was found to be the key factor in the accumulation of imbalances that led to the GFC outbreak (Obstfeld and Rogoff, 2009; White, 2009; Pozsar et al., 2010). Maddaloni and Peydró (2013) and Jiménez et al. (2014) explain how low short-term rates helped boost credit and macroeconomic dynamics through their contribution to the softening of lending standards. Interestingly, the growth rates of bank and non-bank financial intermediaries reached their highest values only after the ECB rate had returned to high levels during the 2005–2007 period. In this respect, Woodford (2010) argues that the increase in short-term rates did reduce the demand and checkable deposits of households and firms but did not prevent the increase of shadow banking liabilities.

Figure 1: ECB Rate and Balance Sheet Expansions of Traditional Banks and Non-Banks in the Euro Area



Note: SB is the shadow banking system (defined as the sum of the total financial assets of other financial intermediaries, investment funds, and money market funds) and TB is the traditional banking system (the sum of the total assets of monetary financial institutions). The data is in nominal terms. The vertical line in the left-hand graph denotes the global financial crisis outbreak. The ECB rate is the simple average of ECB refinancing rates. The right-hand graph covers the period from 1999 Q1 to 2019 Q1.

Source: ECB/Eurosystem data

[2] These data are based on the solo balance sheets of entities, i.e., not accounting for consolidation across groups (in either accounting or regulatory terms).

However, with the continuous decrease of market interest rates post-GFC, it would be natural to question the validity of the funding cost motive. Why did the shadow banking system continue to grow even past the GFC when interest rates reached all-time lows? In a low interest rate environment, traditional banks are not constrained by funding costs but lack profitable investment opportunities. The funding cost motive is rendered moot, but another motive – the "search for yield" – might arise. The lower yields associated with low interest rates generally motivate investors to look for more profitable investments. In other words, a long-lasting accommodative monetary policy may have the potential to induce excessive risk-taking and underpricing of risk if investors start buying higher-yielding assets, irrespective of their risk profile, in a search for yield induced by low interest rates on low-risk assets.

My results can be summarized as follows. I present robust evidence of a dissimilar relationship between monetary policy actions and growth of traditional and shadow banking. Moreover, I identify a non-negligible dependence of the relationships on the relative magnitude of interest rates in the economy. In this respect, I find that in the high interest rate environment prior to the GFC, monetary policy tightening reduced growth of traditional banking as expected but expanded growth of shadow banking activities (mainly securitization) due to the prevalence of the funding cost motive. On the contrary, when rates were reduced to all-time lows in the post-GFC period, I find the funding cost motive to have been rendered moot, only to be replaced with the search for yield motive. I find that the reduction of policy rates after the GFC has led to persistent inflows into investment funds. Overall, monetary policy seems to be truly trapped between a rock and a hard place, since the growing share of shadow banking in the financial system might weaken its ability to "get in the cracks," undermining the very fundamentals of LAW.

2. Related Literature

Since the seminal work of Sims (1980), many studies have attempted to verify and quantify the impact of monetary surprises on financial markets (Bernanke and Kuttner, 2005; Chen, 2007; Kurov, 2010; Kontonikas et al., 2013; Maio, 2014; and many others). The authors generally agree that monetary policy is an important driver of stock and equity price dynamics. In a related strand of literature, studies have focused on the analysis of monetary policy transmission channels, mainly the bank-lending channel (Kashyap and Stein, 1995, 2000; Salachas et al., 2017) and the impact of monetary policy on the balance sheet dynamics of financial intermediaries (Adrian and Shin, 2008, 2010). Recent findings by Angeloni et al. (2015) show that monetary policy shocks also have a significant and protracted impact on various bank risk measures. These results are largely supported by the micro studies of Altunbas et al. (2010) and Jiménez et al. (2014). My paper focuses on both bank- and non-bank financial intermediaries and can thus be considered a complement to the existing body of literature. The focus is more on the aggregate balance sheet dynamics rather than on prices and valuation effects.

Due to a lack of statistical data on shadow banking[3] and the ambiguity regarding its definition, there are only a handful of empirical studies concerning continental Europe to provide the much-needed empirical insights. IMF (2014) collects evidence from cross-country data covering some European countries. Specifically, it examines a large set of 26 mostly developed economies and concludes that search for yield, regulatory arbitrage, institutional cash pools, and financial

[3] See Grillet-Aubert et al. (2016) for an assessment of the remaining data gaps in Europe.

development contribute to the growth of shadow banking. Beck and Kotz (2016) use flow-of-funds data for the euro area non-bank financial intermediation sector and reveal a declining role of banks (and, simultaneously, an increase in non-bank intermediation). They also show that non-bank institutions have tended to take positions in riskier assets. Abad et al. (2017) analyze the cross-sector and cross-border linkages between EU banks and shadow banking entities within the global financial system. They document that many of the EU banks' exposures are to non-EU entities, particularly U.S.-domiciled shadow banking entities. Bengtsson (2013) focuses on European money market funds and discusses transmission channels through which financial instability may spread to the wider financial system. Bua and Dunne (2019) explore the effects of the ECB's unconventional monetary policy actions on money market funds' behavior. Hodula (2018) provides a system-wide assessment of the potential factors of shadow banking growth for a panel of 24 EU countries, showing that the EU shadow banking system is highly procyclical and positively related to increasing demand of long-term institutional investors, more stringent capital regulation, and financial development.

To my knowledge, there are two other papers that focus on the relationship between monetary policy and shadow banking growth. Nelson et al. (2017) investigate US data over the 1966–2007 period and show that a contractionary monetary policy shock had a persistent negative impact on the level of traditional banking assets but increased shadow banking assets and securitization activity. Chen et al. (2018) find that contractionary monetary policy during 2009–2015 caused shadow banking loans in China to rise rapidly. My paper is the first that tests for possible nonlinearities in the relationship and accommodates European data. Like the above-mentioned papers, I find that contractionary monetary policy significantly contributed to the growth of shadow banking. However, I show that this result is valid only under certain conditions and should not be mistaken for a stylized fact. This links to the fact that I establish empirical evidence that monetary policy easing after the GFC has also significantly contributed to the rise of shadow banking.

2. Estimation of the ECB Monetary Policy Stance

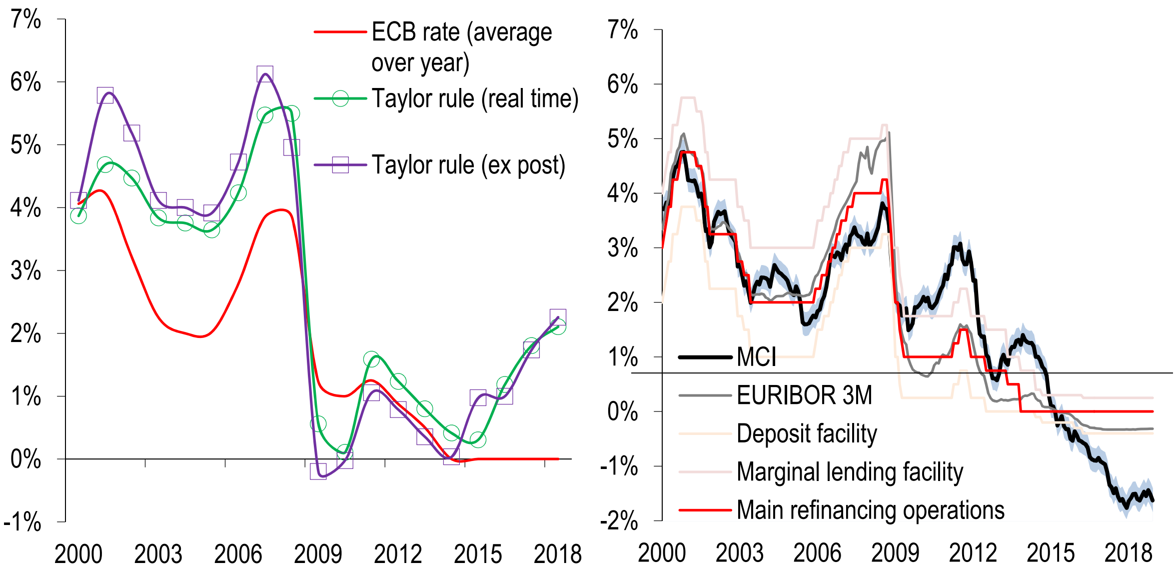
Very early academic literature used monetary aggregates to capture the monetary policy stance (Friedman and Schwartz, 1963; Cagan, 1972). Yet money is endogenous, so the use of monetary aggregates such as M1 or M2 is no longer justified. Starting with Bernanke and Blinder (1992), it became common practice in the literature to use the interest rate set by the central bank (or the inter-bank rate) as the indicator of monetary policy measures. However, one might question whether monetary policy transmits perfectly to the real economy. The first solution was presented by Romer and Romer (1989, 2004), who proposed a test to identify shocks using historical narratives instead of relying on purely statistical evidence. Still, policy decisions are also endogenous, and it is not clear whether this approach effectively isolates policy shocks from the influence of other factors (Lombardi and Zhu, 2014). As a second solution, authors started to use vector autoregression (VAR) models to identify monetary policy shocks, interpreting them as policy changes (early examples include Bernanke and Blinder, 1992; Christiano and Eichenbaum, 1992; Sims, 1992).

Both alternatives run into difficulties in the post-GFC environment. First, standard monetary policy measures that are in any way related to the central bank rate ran into trouble when policy rates reached the lower bound in many countries. This is a common liquidity trap situation, i.e., the public is prepared to hold whatever amount of money is supplied, and increases in money supply cannot induce economic agents to hold more bonds so as to reduce interest rates below zero. Second, the rapid decline of the policy rate to zero or near-zero values was accompanied by a great variety of unconventional measures such as large-scale asset purchases, maturity extensions, and forward guidance. As a result, alternative metrics of the monetary policy stance to assess the impact of unconventional policy measures have emerged.

Chen et al. (2012) proposed to use US term and corporate spreads to analyze the impact of US quantitative easing. Meaning and Zhu (2012) used the size and maturity of the Federal Reserve balance sheet. A common drawback of these approaches is that they only work when monetary policy has already hit the lower bound. It is unlikely that they would be good indicators of monetary policy over an extended period of time. In a different strand of literature, Black (1995) suggested to use the information from the yield curve. The idea is to extract shadow rates that can turn negative, driven by the dynamics of the term structure of interest rates. This approach was widely used to assess the effects of US monetary policy (Bomfim, 2003; Kim and Singleton, 2012; Krippner, 2012). Recently, Wu and Xia (2016) estimated the US shadow rate and traced its effects on macroeconomic variables. They showed that the effect is similar to that of the federal funds rate. However, as shown by Christensen and Rudebusch (2015), estimates of the shadow rate are sensitive to model specification. They also seem to reflect market expectations of very short-term nominal interest rates and therefore are likely to be a rather noisy indicator of the monetary policy stance. A promising alternative is to construct a composite indicator as a combination of variables describing monetary policy and the monetary stance, similarly to what is done in Lombardi and Zhu (2014) for the US or Babecka-Kucharcukova et al. (2016) for the euro area. This monetary conditions index (MCI) captures the effect of conventional and unconventional monetary policies. The estimation procedure and robustness analysis are summarized in Appendix B.

Figure 2 plots the main ECB rate against the Taylor rule and the estimated MCI for the euro area. The evolution of the MCI (right-hand graph) is similar to that obtained by Babecka-Kucharcukova et al. (2016) and Malovaná and Frait (2017). The MCI closely follows the path of the main ECB policy rates, especially prior to and shortly after the GFC. This is not surprising, since no additional policy tools were in use at the time. Still, as is apparent from the left-hand graph, the Taylor rule would have implied a higher interest rate in the run-up to the GFC. The MCI starts to deviate from the policy rates in 2011. The signaled tightening of ECB monetary policy after the end of 2012 reflects a significant decrease of the ECB balance sheet. Numerous authors argue that such a tightening occurs even when the main policy rate is at a historical low, which may point to disrupted monetary transmission (Orphanides, 2012; Babecka-Kucharcukova et al., 2016). As of 2014, the MCI indicates a significant easing of monetary conditions in euro area. This is related to the implementation of the Securities Markets Programme (SMP) and the Long-Term Refinancing Operations (LTRO) program. In 2015, the ECB launched its expanded asset purchase programs, which is captured by a loosening of the MCI. The year 2014 is also the time when both the ECB rates and the overall MCI started to significantly deviate from the Taylor rule implied rate. According to ex post data, the ECB should have started to normalize its policy somewhere around 2014, but did the exact opposite when it launched its bond purchase programs.

Figure 2: ECB Rate vs. Taylor Rule Implied Rate and Estimated Monetary Conditions Index



Note: The Taylor rule is estimated from the standard equation: $i_t^i = r^* + \pi_t + 0.5(\pi_t - \pi_t^*) + 0.5\bar{y}_t^i$. The real interest rate r^* was assumed to be 2% prior to the GFC and to have been reduced to 1% once the recession hit. This assumption is in line with most of the relevant studies (for a literature review, see Brand et al., 2018). The output gap $\bar{y}_t^i$ is estimated by the European Commission and was taken from its website. The real-time Taylor rule considers information about the output gap at the time the policy decision is made. The ex post Taylor rule considers the output gap after all revisions. The MCI was standardized so that an increase means tightening of monetary conditions and a decrease means easing.

4. Data on Non-Bank (Shadow) Financial Intermediation

This section describes the data on non-bank financial intermediation in Europe and the process of retrieving it, then proceeds to explain the transformation applied to the raw data. Throughout the paper, I follow the ESRB definition of the European shadow banking system, which, in its broad measure, comprises financial assets of other financial intermediaries, investment funds, and money market funds.[4] An overview of all data used, including the underlying statistics, is presented in Table A1 in the Appendix.

My sample consists of the following 12 original euro area member countries: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, and Spain. As of the end of 2018, they jointly accounted for more than 70% of the total assets of the EU shadow banking system, as well as the traditional banking sector. Since 2000 (2001 for Greece), they have followed a single monetary policy regime, which is critical for the study. I do not include in my sample several countries that have also adopted the euro, namely, Cyprus, Estonia, Latvia, Lithuania, Malta, Slovakia, and Slovenia. This exclusion is made for purely practical reasons. First, these countries joined the euro area not all at once, but in several different years, which would be troublesome to account for in an empirical framework. Second, these are mostly Central and Eastern European (CEE) countries, and the importance of the shadow banking system for financial intermediation in the CEE has previously been shown to be relatively low.

[4] This broad definition of shadow banking in its current form has been used by the ESRB in its annual shadow banking monitoring reports since 2016.

Shadow banking in CEE countries has also been found to be driven by different factors compared to the original euro area members (Hodula, 2018). Third, data on shadow banking in CEE countries has been collected (at best) from 2004 onwards.

To construct data on financial assets for the shadow banking system in the euro area, I use two ECB/Eurosystem statistics: the financial accounts data and the monetary statistics. The financial accounts data covers most shadow banking entities, grouped under Other Financial Intermediaries (OFIs), which can be further broken down into Financial Vehicle Corporations (FVCs) and Investment Funds. The OFI sector comprises all financial institutions other than those included in the sectors Monetary Financial Institutions (MFIs) and Insurance Corporations and Pension Funds (ICPFs). The monetary statistics provide additional information in the form of data on money market funds (MMFs), as well as on the balance sheets and flows of some institutions that are part of the OFI sector. A detailed description of the investment funds and OFI sectors is available in Table 1. The monetary statistics also hold information on MFIs, i.e., the traditional deposit-taking institutions.

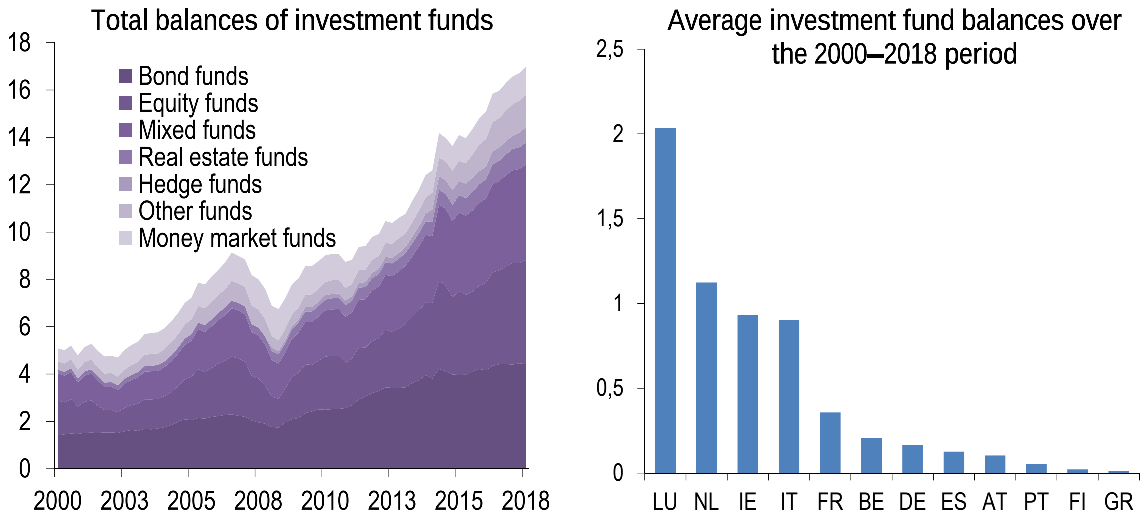
Table 1: Overview of Investment Funds and OFIs According to ESA 2010

<table>
<tr><td colspan="2">Money market funds (MMFs) (ESA S.123)
(part of the monetary financial institutions (MFI) sector)</td></tr>
<tr><td colspan="2">Non-MMF investment funds (ESA S.124)</td></tr>
<tr><td>Bond funds
Equity funds
Mixed funds
Real estate funds
Hedge funds
Other funds</td><td>Allocated to investment policy according to the assets in which they primarily invest</td></tr>
<tr><td>Exchange-traded funds
Private equity funds</td><td>Exchange-traded funds and private equity funds are included in the above types depending on the strategy of the fund</td></tr>
<tr><td colspan="2">Other financial intermediaries according to the ESRB methodology (OFI, ESA S.125)</td></tr>
<tr><td>FVCs</td><td>Financial vehicle corporations engaged in securitisation (i.e. special purpose entities engaged in securitisation)</td></tr>
<tr><td>FCLs</td><td>Financial corporations engaged in lending (i.e. financial leasing, factoring, hire purchase)</td></tr>
<tr><td>SDDs</td><td>Security and derivative dealers (i.e. dealers on own account)</td></tr>
<tr><td>SFCs</td><td>Specialised financial corporations (e.g. venture capital, export/import financing, central counterparties)</td></tr>
<tr><td>OFI residuals</td><td>Difference between total financial sector assets and known sub-sectors</td></tr>
<tr><td colspan="2">Financial auxiliaries (ESA S.126)
(e.g. insurance or loan brokers, fund managers, head offices of financial groups, financial guarantors)</td></tr>
<tr><td colspan="2">Captive financial institutions and money lenders (S.127)
(e.g. special purpose entities not engaged in securitisation, “brass plate” companies, holding companies)</td></tr>
</table>

4.1 Investment Funds and Money Market Fund Data

Data on the total balances of various investment funds was collected from the ECB Euro Area Accounts (*3.3.2 Non-MMF investment funds*). Figure 3 (left-hand graph) shows the evolution of total investment fund assets in the EU. The left-hand graph shows that investment funds grew the fastest after the global financial crisis, mainly because they offered a way for investors to secure their money in longer-term and safer instruments when the market crashed. The continuous growth of investment funds in the post-crisis years is a natural by-product of the deepening of financial markets, with a concomitant rise in the rest of the economy and the wealth of economic agents. It is not without interest that investment funds in the EU are highly concentrated (Figure 3, right-hand graph). Approximately 85% of the total assets of EU investment funds are allocated to five countries. By average balance value over the 2000–2018 period, these are Luxembourg, the Netherlands, Ireland, Italy, and France. Regarding the upcoming analyses, it is important to note that investment funds are generally distinguished as open- or closed-end. For open-end funds, the number of outstanding shares may vary on a daily basis, while closed-end funds have a fixed number of shares or units that are publicly traded. Consequently, closed-end funds are limited in their ability to carry out liquidity transformation and should in principle be monitored separately from open-end funds. Nevertheless, closed-end funds represent only 2% of the assets of non-MMF investment funds, with the exception of real estate funds, where 20% of the assets are in closed-end funds. Given the relatively small share of closed-end funds, there will be no explicit distinction between closed and open funds in the following text. In addition, both fund categories can engage in securities financing transactions (repos and securities lending) that are critically linked to shadow banking risks.

Figure 3: Investment Funds in Euro Area Countries (EUR Trillions, 2000–2018)



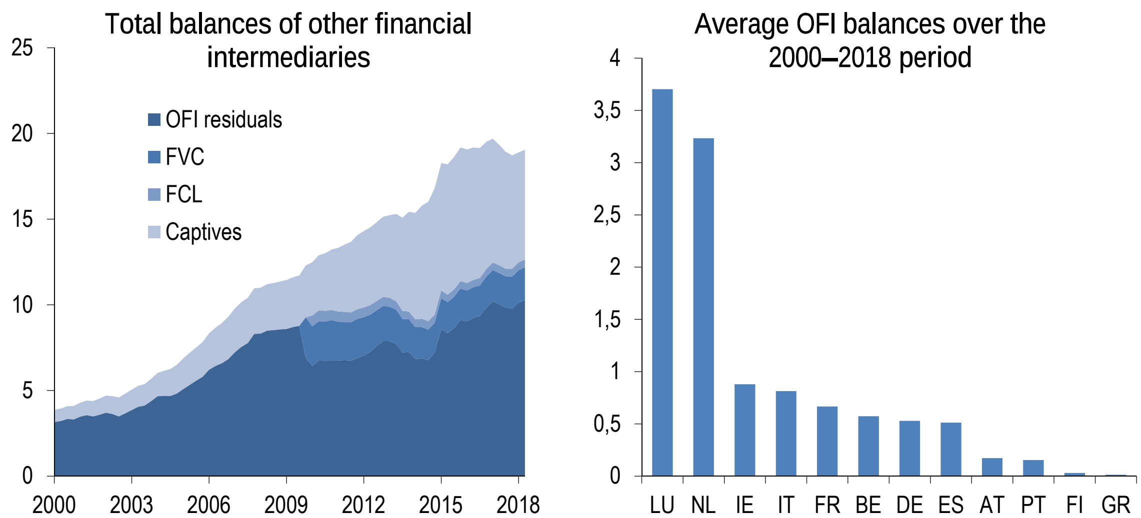
Source: ECB/Eurosystem data

Money market funds data are collected as part of the money and banking statistics by the Eurosystem and can be extracted from the balance sheets of MFIs. In general, MMFs are treated by the financial literature as being part of external shadow banking entities (Pozsar et al., 2012; Adrian and Ashcraft, 2012). MMFs typically invest in short-term money market instruments issued by financial institutions, governments, and corporations. This, of course, contributes significantly to high interconnection with the traditional banking sector, as a significant part of MMFs' assets is invested in debt securities and loans from the banking sector. MMF shares can be redeemed on a daily basis, and the redemptions are often offered to investors at par. This makes MMFs an attractive alternative to bank deposits.

4.2 Other Financial Intermediaries Data

Data on the total balances of OFIs are also available in the ECB Euro Area Accounts (*3.3.3 Other financial institutions*). The entities included in the OFI category pursue a variety of business models and their engagement in shadow banking activities differs accordingly. Figure 4 (right-hand graph) plots the total assets of the OFI sector for the euro area. While for most investment funds EU-wide supervisory data is available, OFI sector coverage lags behind.[5] The challenges inherent in consistently defining and analyzing the entities included in these sectors are also reflected by the OFI residual sector, which covers entities for which a more granular sectoral breakdown is not in place at either the EU or the euro area level. FVCs, for which data is available from 2009, are an important part of the OFI sector, since these entities carry out securitization activities. Note that the OFI sector data available from the ECB database also includes captive institutions and money lenders (ESA2010 subsector S.127). This subsector may include a significant amount of assets which are related in nature to the real economy rather than the financial sector (captive institutions, trusts, units with sponsor funds, sovereign wealth funds, etc.). These assets are dependent on a significantly different set of factors than the rest of the shadow banking system (i.e., taxation, corporate governance, real sector regulation, etc.). Partial exclusion of these assets is possible, as Eurostat publishes national data on captive financial institutions. Some major players (NL, IE) are missing from the database. However, they publish data separately. The Dutch might call the entities "specialized financial institutions" and the Irish "non-securitization special purpose entities," but they all engage in captive-like activities.

Figure 4: OFIs in Euro Area Countries (EUR Trillions, 2000–2018).



Source: ECB/Eurosystem data. The data on captive institutions was drawn from Eurostat and national central bank databases (Central Bank of Ireland, De Nederlandsche Bank, Nationale Bank van België/Banque Nationale de Belgique, Banque Centrale du Luxembourg).

[5] Data on SDDs and SFCs is not collected on an EU-wide level yet. New information will become available after full implementation of the European Market Infrastructure Regulation (EMIR) and the Securities Financing Transaction Regulation (SFTR). Some preliminary results can be found in Kenny et al. (2016), who analyze the Irish CDS data.

5. The Link Between Monetary Policy and Financial Intermediaries

In this section, I use the constructed sets of panel data on both bank- and non-bank financial intermediaries in an empirical framework. I demonstrate that traditional and shadow banking respond to changes in monetary policy differently. Specifically, I show that the responses of shadow banking and its components are level-dependent with respect to the relative magnitude of interest rates in the economy. To support my arguments, I describe the mechanics of the two main motives explaining the level-dependency – the funding cost motive and the search for yield motive.

5.1 Panel Regressions

With the aggregate balances of the traditional and shadow banking dataset, I run the following dynamic panel regressions:

$$\Delta ln\left(assets_{it}^{SB,TB}\right) = \vartheta_i + \alpha_i \Delta \ln\left(assets_{i,t-1}^{SB,TB}\right) + \beta MCI_{it} + \xi Controls_{it} + \varepsilon_{it}, \quad (1)$$

where the dependent variable $\Delta ln(assets_{it})$ is the annual growth rate of the total assets of traditional (TB) and shadow (SB) banking in period t and country i. In the specification, I consider one lag of the dependent variable to limit the problem of omitted variables and to obtain white noise residuals. MCI_{it} is the monetary conditions index.

A word of caution is in order when discussing the identification of the model parameters. Specifically, one might argue that the state of the financial system could also affect monetary policy. However, I believe that the endogeneity problem is manageable given the sample properties, estimation method, and robustness checks. First, the ECB has never been lenient towards practicing LAW and there is no evidence on the matter. Second, I mainly rely on the generalized method of moments (GMM) estimator for dynamic panel data, which should further mitigate the endogeneity issue. Third, I perform a number of robustness checks concerning the estimator choice to verify my results.

Given the fact that the development of bank and non-bank financial intermediaries may be potentially affected by a wide set of macroeconomic and financial variables, I introduce a wide range of controls in the regression, stacked in the vector $Controls_{it}$. Some are country-specific, whereas other variables are only included in the regression models of traditional or shadow banking. My reasoning for the selection of control variables is as follows:

- *Real GDP growth* – Adrian and Shin (2009b) argued that shadow bank leverage is inherently procyclical, which may undermine financial system stability. Hodula (2018) verified that the European shadow banking system is highly procyclical. Inspired by this, I include real economic and price level developments as control variables, notwithstanding the fact that both variables also help control for macroeconomic factors other than exogenous monetary policy.

- *Term spread* – Both FSB (2017) and ESRB (2019) often mention maturity transformation as one of the key characteristics that describe European shadow banking activities. The term spread is meant to control for changes in the term structure premium and capture the maturity transformation function of the shadow banking system.

- *Insurance corporations and pension funds* (ICPF) – Pozsar (2011) argued that the rapid growth of shadow banking can be attributed to the rising demand of institutional cash pools, which I proxy by ICPFs' total assets, for alternatives to insured deposits and safe assets.

- *Regulation index* – Fahri and Tirole (2017) and Plantin (2014) argued that increased regulation of traditional banks may push them into unregulated parts of the financial sector. Buchak et al. (2018) showed that shadow banks often intrude onto those areas of the market where traditional banks face greater regulatory constraints. To do this fact justice, I include the regulation index to control for possible cross-country regulatory arbitrage.

- *Financial development index* (FDI) – Financial development (or financial innovation) is generally meant to facilitate the allocation of resources by financial intermediaries to their most productive use (Greenwood, Sanchez, and Wang, 2010; Laeven, Levine, and Michalopoulos, 2015). However, as argued by Laeven (2013), there are notable examples including some shadow banking activities. I include the FDI to control for changes in each country's level of financial development.

In the shadow banking model, I also include the growth of MFI assets as a dependent variable, mainly to reflect the fact that traditional banks frequently sponsor shadow banking activities – often through financial vehicle corporations, but traditional banks might be involved in investment funds as well. In the traditional banking model, I also include standard bank-specific controls that are extensively used in the literature (capital ratio, NPL ratio, ROA, liquidity ratio).

In order to verify whether the effect of monetary policy on traditional and shadow banking is in any way sensitive to changing the interest rate environment, I augment equation (1) with an interaction term given by the product of the MCI and a dummy reflecting the relative magnitude of interest rates in the economy. Formally written, I estimate:

$$\Delta ln\left(assets_{it}^{SB,TB}\right) = \vartheta_i + \alpha_i \Delta \ln\left(assets_{i,t-1}^{SB,TB}\right) + \beta MCI_{it} + \gamma MCI_{it} \times lowrate_{it} + \\ + \xi Controls_{it} + \varepsilon_{it}. \qquad (2)$$

The dummy $lowrate_{it}$ takes the value of 1 if the three-month interbank rate is lower than 1.25% and 0 otherwise. The threshold level is chosen with respect to the experimental results of Claessens et al. (2018). They set the threshold for a low interest rate environment based on a large sample of 3,385 banks. The resulting value is close to the median value for the given sample of internationally operating banks. I also test for different cutoffs and the results are broadly consistent. I report results for one alternative threshold level, 0.21%, which is the simple median value of the three-month interbank rate.

Finally, to control for the possibly reduced effectiveness of monetary policy during periods of economic downturn (see Borio and Gambacorta, 2017), I introduce another interaction term into the model that is the product of the MCI and a financial crisis dummy ($crisis_{it}$). The dummy takes the value of 1 if the country is experiencing a financial crisis (see Table D1 in Appendix D). The financial crisis periods were selected based on the new European financial crises database (please refer to Duca et al., 2017, for the underlying paper describing the methodology for identifying crisis periods). Again, I also test for different crisis specifications based on the Leaven and Valencia database, which yields quantitatively and qualitatively similar results. Specifically, the model becomes:

$$\Delta ln\left(assets_{it}^{SB,TB}\right) = \vartheta_i + \alpha_i \Delta \ln\left(assets_{i,t-1}^{SB,TB}\right) + \beta MCI_{it} + \gamma MCI_{it} \times lowrate_{it} + \\ + \lambda MCI_{it} \times crisis_{it} + \xi Controls_{it} + \varepsilon_{it}. \quad (3)$$

5.2 Results of the Aggregate Balances Model

The results for the aggregate balances model are presented in the first and fifth columns of Table 2. The results for the aggregate data suggest that the baseline regression is a valid benchmark. Already some interesting patterns emerge. The response of growth of traditional banking to changes in the monetary policy stance is negative and statistically significant. This conforms to the view that restrictive monetary policy raises funding costs, after which traditional banks cut back on lending. A 1 percentage point (pp) monetary policy shock tends to dampen the growth of traditional banks' balance sheets by about 1.5 pp in the short term (within a year) and about 2.5 pp in the long term.[6] On the contrary, the baseline model reports statistically insignificant results for the growth of shadow banking. These results may point to the presence of a level-dependent relationship, or simply the fact that the individual components of the shadow banking system respond differently to monetary policy actions.

When accounting for possible level-dependency using the interaction dummy $lowrate_{it}$, the relationship between traditional/shadow banking growth and monetary policy becomes a little clearer. First off, the results reported in the second and third columns of Table 2 point to a general loss of monetary policy effectiveness in a low interest rate environment. Monetary policy tightening no longer reduces the growth of traditional banks' balance sheets, as the sign of the related parameter turns positive. Second, the results for the shadow banking model (the sixth and seventh columns of Table 2) show that in a high interest rate environment, monetary policy tightening does not have the desired impact on the shadow banking system, as the related coefficient is positive and statistically significant. In fact, a 1 pp monetary policy tightening was associated with growth of the shadow banking system that is about 0.5 pp higher in the short term and 0.8 pp higher in the long term. This result would invalidate the idea behind LAW, which requires a negative relationship between monetary policy actions and growth of financial intermediaries (both bank and non-bank). Still, the individual components of the shadow banking system (OFIs and investment funds) may respond differently to macroeconomic drivers. This might mask the true extent to which changes in monetary policy affect shadow banking growth.

Note that all the coefficients on the control variables have the expected sign; some of the responses are worth discussing in detail. First, the evidence indicates that both the traditional and shadow banking systems are highly procyclical, owing to the positive relationship identified with real GDP growth. This obviously raises a number of issues for financial and macroeconomic stability. After the GFC, a number of macroprudential measures were introduced to reduce the procyclical character of the banking business. These measures, however, are not in place for shadow banking entities, over which the regulatory body has only limited oversight. Second,

[6] The long-term impact of monetary policy on growth of financial intermediaries is calculated as $\frac{\beta}{1-\alpha}$. The associated standard error for this and similar coefficients below is calculated by means of the delta method (Rao, 1973).

tightening of prudential regulation generally increases the presence of non-banks in the system. This is consistent with the notion that traditional banks have an incentive to shift activities to the non-banking sector in response to certain regulatory changes (regulatory arbitrage). Third, institutional cash pools are confirmed as a prominent contributor to shadow banking growth in Europe.[7]

Table 2: Monetary Policy and Growth of Aggregate Balances of Financial Intermediaries

	Dependent variable: (Δ total assets)							
	Traditional banking (TB)				Shadow banking (SB)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Explanatory variables	Baseline	Low interest rates	Financial crises	Different low rate dummy	Baseline	Low interest rates	Financial crises	Different low rate dummy
Lagged dependent variable	0.417*** (0.064)	0.421*** (0.063)	0.422*** (0.063)	0.418*** (0.064)	0.309*** (0.027)	0.309*** (0.028)	0.308*** (0.028)	0.310*** (0.028)
MCI	-1.504*** (0.532)	-1.611*** (0.546)	-1.486** (0.598)	-1.385** (0.579)	0.362 (0.431)	0.469 (0.566)	0.640 (0.569)	0.791 (0.542)
MCI x lowrates		0.521*** (0.123)	0.522*** (0.118)	0.008 (0.160)		0.211 (0.481)	0.390 (0.473)	0.131 (0.604)
MCI x crisis			-0.378 (0.327)	-0.374 (0.326)			-0.537** (0.264)	-0.530* (0.273)
Real GDP growth	0.490*** (0.064)	0.494*** (0.064)	0.495*** (0.064)	0.492*** (0.065)	0.281** (0.127)	0.274** (0.128)	0.277** (0.127)	0.266** (0.130)
Institutional cash pools growth	-0.042 (0.044)	-0.038 (0.044)	-0.039 (0.044)	-0.042 (0.043)	0.646*** (0.146)	0.646*** (0.146)	0.643*** (0.146)	0.634*** (0.147)
Term spread	-0.042 (0.074)	-0.038 (0.074)	-0.044 (0.073)	-0.048 (0.073)	0.127*** (0.048)	0.128*** (0.049)	0.133*** (0.050)	0.134*** (0.049)
Regulation index	-0.180*** (0.054)	-0.170*** (0.052)	-0.169*** (0.053)	-0.179*** (0.055)	0.166** (0.070)	0.165** (0.068)	0.163** (0.068)	0.169*** (0.065)
Financial development	2.275** (0.934)	2.226** (0.907)	2.214** (0.907)	2.262** (0.931)	1.236*** (0.127)	1.264*** (0.139)	1.300*** (0.137)	1.333** (0.644)
Traditional banking					-0.050 (0.087)	-0.050 (0.087)	-0.052 (0.087)	-0.051 (0.086)
Bank controls	yes	yes	yes	yes	no	no	no	no
Country fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
MCI long-run effect	-2.581*** (0.989)	-2.782*** (1.021)	-2.568** (1.102)	-2.379** (1.057)	0.523 (0.610)	0.678 (0.799)	0.925 (0.796)	1.146 (0.752)
MCI long-run effect in low interest rates		0.900*** (0.205)	0.902*** (0.195)	0.013 (0.275)		0.306 (0.688)	0.564 (0.668)	0.189 (0.870)
Hansen	0.248	0.267	0.251	0.238	0.218	0.129	0.278	0.264
AR(2)	0.346	0.314	0.323	0.308	0.378	0.369	0.406	0.398
No. of obs.	888	888	888	888	888	888	888	888

Note: Results of dynamic panel regression. The estimation is done using the system version of the GMM estimator (Blundell and Bond, 1998). Driscoll and Kraay (1998) robust standard errors are in parentheses. Statistical significance at the 1%, 5%, and 10% level is indicated by ***, **, and *, respectively. AR(2) reports p-values for the test of the null hypothesis that the errors in the first difference regression exhibit no second-order serial correlation. Hansen reports p-values for the test of the null hypothesis that the instruments used are valid.

[7] Similar results regarding the relationship between shadow banking and institutional cash pools (assets of insurance corporations and pension funds) were obtained in Hodula (2018). Yet the development of insurance companies and pension funds in Europe remains on the periphery of research interest for both central banks and academics, despite its growing role in shaping the financial sector.

5.3 Results of a Traditional and Shadow Lending Model

In this section, I test whether the different responses of traditional and shadow banking growth to monetary policy reported in the previous section can be attributed to the complementary character of shadow loans to their traditional counterparts (Figure A1). To this end, I consider a reduced-form version of the model in eq. (1) to (3) and consider the dynamics of loans originating from traditional and shadow banking as the dependent variable $\Delta ln\left(loans_{it}^{SB,TB}\right)$. This adds to the debate whether the loss of monetary policy effectiveness in a low interest rate environment is caused by headwinds that typically blow in the wake of balance sheet recessions, or by inherent nonlinearities linked to the level of interest rates. Since a monetary restriction puts pressure on banks to decrease the supply of credit, could shadow loans step forth to service the existing demand for credit instead?

The results reported in the first and fifth columns of Table 3 suggest that this might indeed be the case. They point to a statistically significant negative relationship between monetary policy and traditional banks' lending. However, shadow lending seems not to be affected by monetary policy restrictions. Adding interaction dummies to the regressions sheds further light on the reported relationships. First, the results confirm the above-mentioned loss of monetary policy effectiveness with respect to traditional banking in a low interest rate environment (column 3). This finding is similar to the results obtained by Gambacorta and Marqués-Ibáñez (2011) and Borio and Gambacorta (2017) for semi-micro samples of European banks in studies that directly analyze the effectiveness of monetary policy on bank lending in a low interest rate environment. Second, in a high interest rate environment, tighter monetary policy seems to be associated with increased growth of shadow lending, which complements traditional bank loans. However, in the aftermath of the GFC, when rates were pushed to all-time lows, the coefficient turns insignificant and even negative. This may be explained by the fact that in an environment of cheap bank loans (and sufficient supply of these loans), shadow loans become redundant.

The results for the control variables put these findings in a broader macroeconomic perspective. Both traditional and shadow lending are found to be highly procyclical. This finding should be viewed in the light of bank regulation, where the Basel III reforms in particular made an effort to reduce the procyclicality of bank lending. In some countries, shadow loans may turn out to undermine the effectiveness of capital-based regulations (such as the countercyclical capital buffer) or the introduction of LTV limits. Further, the results point to a positive relationship between prudential regulation stringency and shadow banking lending, and a negative relationship with traditional lending. The former is in line with a plurality of studies showing that more stringent capital regulation limits traditional bank lending (Hyun and Rhee, 2011, and Fraisse et al., 2017, to name a few), which may increase the demand for shadow loans, especially from households and non-financial corporations.

Table 3: Monetary Policy and Growth of Lending

	Dependent variable: (Δ outstanding loans)							
	Traditional banking (TB)				Shadow banking (SB)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Explanatory variables	Baseline	Low interest rates	Financial crises	Different low rate dummy	Baseline	Low interest rates	Financial crises	Different low rate dummy
Lagged dependent variable	0.295*** (0.049)	0.301*** (0.049)	0.265*** (0.051)	0.262*** (0.050)	0.311*** (0.057)	0.300*** (0.057)	0.300*** (0.056)	0.298*** (0.056)
MCI	-1.380*** (0.382)	-1.619*** (0.413)	-2.800*** (0.557)	-2.736*** (0.553)	0.814*** (0.315)	1.438** (0.683)	1.442** (0.680)	1.532** (0.613)
MCI x lowrates		-0.326 (0.507)	-0.342 (0.415)	0.738* (0.399)		0.372 (0.339)	0.383 (0.353)	-1.216* (0.702)
MCI x crisis			0.574* (0.381)	0.386 (0.330)			-0.109 (0.657)	-0.243 (0.669)
Real GDP growth	0.125 (0.118)	0.122 (0.118)	0.166* (0.080)	0.313*** (0.114)	0.471* (0.267)	0.360 (0.295)	0.356 (0.293)	0.305 (0.318)
Institutional cash pools growth	1.452*** (0.172)	1.454*** (0.175)	1.277*** (0.175)	1.223*** (0.173)	0.319*** (0.113)	0.364*** (0.116)	0.362*** (0.118)	0.370*** (0.121)
Term spread	-0.097** (0.045)	-0.090** (0.045)	-0.014 (0.046)	-0.019 (0.045)	-0.086 (0.121)	-0.083 (0.106)	-0.087 (0.101)	-0.102 (0.102)
Regulation index	-0.037 (0.051)	-0.015 (0.053)	-0.069 (0.053)	-0.085* (0.051)	0.054 (0.128)	0.119 (0.127)	0.117 (0.121)	0.130 (0.112)
Financial development	-3.150*** (0.653)	-3.216*** (0.661)	-2.605*** (0.661)	-2.496*** (0.651)	1.850*** (0.627)	1.213 (0.784)	1.245* (0.756)	1.295** (0.648)
Bank controls	yes	yes	yes	yes	no	no	no	no
Country fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
MCI long-run effect	-1.956*** (0.562)	-2.315*** (0.618)	-3.808*** (0.776)	-3.710*** (0.761)	1.181*** (0.492)	2.054** (0.980)	2.061** (0.984)	2.182** (0.894)
MCI long-run effect in low interest rates		-0.466 (0.725)	-0.465 (0.489)	1.000* (0.541)		0.531 (0.507)	0.547 (0.531)	-1.732* (0.973)
Hansen	0.205	0.178	0.284	0.203	0.315	0.278	0.284	0.334
AR(2)	0.239	0.249	0.370	0.241	0.465	0.541	0.514	0.501
No. of obs.	888	888	888	888	888	888	888	888

Note: See Table 2.

6. What Matters: Search for Yield or Funding Costs?

Up to this point, the results have indicated that monetary policy does impact traditional and shadow banking differently, even when controlling for downturns associated with financial crises and a low interest rate environment. However, they do not shed light on the actual mechanism at work. As argued in the previous section, there might be two motives driving the relationships – the funding cost motive and the search for yield motive. To quantify these two motives, and hence to unravel the true response of non-bank financial intermediation to monetary policy, I decompose the aggregate shadow banking measure into two components: OFIs and investment funds. OFIs should perform securitization activities and thus should mainly represent the funding cost motive, while investment funds should reflect the search for yield effect. The regression equation for the decomposed shadow banking measure is as follows:

$$\Delta ln\left(shadow_{it}^{OFI,IF}\right) = \vartheta_i + \alpha_i \Delta \ln\left(shadow_{i,t-1}^{OFI,IF}\right) + \beta MCI_{it} + \gamma MCI_{it} \times lowrate_{it} + \lambda MCI_{it} \times crisis_{it} + \xi Controls_{it} + \varepsilon_{it}. \quad (4)$$

The results of the decomposed shadow banking model are reported in Table 4. The differences between the models with OFIs and investment funds as dependent variables are striking and to a large extent confirm the original hypotheses. The previous set of results already confirmed that tighter monetary policy might be associated with decreasing growth of traditional banks' balance sheets, especially in a high interest rate environment. However, in such a policy setup, traditional banks might be motivated to circumvent the increased funding costs by increasing their involvement in shadow banking activities, mainly securitization. Securitization vehicles (FVCs) are part of the OFI sector. The results for the OFI model with interaction dummies, reported in the third column of Table 4, provide empirical support for the funding cost motive. They show that the relationship between the MCI and growth of OFIs is positive in the high interest rate environment only, and insignificant when rates are low. A 1 pp monetary tightening in the run-up to the GFC was associated with about a 1.3 pp increase in the growth of OFI balance sheets in the short term, and about a 2.5 pp rise in the long term. Switching the dependent variable for shadow loans does not alter the sign or significance of the estimated parameters. This points to the relevance of demand for shadow products not only from traditional banks and other institutional investors, but also from households and nonfinancial corporations, who might turn to shadow banking to roll over their existing debt when operating in a high interest rate environment. This suggests that the funding cost motive dominates when interest rates are high.

The fact that the relationship between the MCI and growth of OFIs is found insignificant in a low interest rate environment can be explained in two ways: either it reflects a general escape from risk and cleansing of balance sheets of toxic assets during recessions, or it simply means that in a low interest rate environment, banks are not constrained by their funding costs but lack profitable investment opportunities. The funding cost motive is rendered moot (hence the growth of OFIs slows down), but another motive – the search for yield – might arise. The results in the seventh column of Table 4 suggest that the search for yield motive may operate through investment funds. The regressions show that easing of monetary policy conditions in a very low interest rate environment may be associated with significant inflows into investment funds (about 1.2 pp in the short term and almost 2 pp in the long run). In other words, a long-lasting accommodative monetary policy may have the potential to induce excessive risk-taking and underpricing of risk if investors start buying higher-yielding assets, irrespective of their risk profile, in a search for yield induced by low interest rates on low-risk assets.

Since the literature generally agrees on a prominent role for regulatory arbitrage when explaining the ups and downs of the shadow banking system, it is worth taking a closer look at the relationship between OFIs and investment funds on one side and the regulation index on the other. I find that tighter prudential regulation is positively related to growth of OFIs, while no significant relationship is identified in the case of investment funds. This suggests that the regulatory arbitrage is more likely to run through the use of OFIs' products than investment funds. I offer the following explanation of why this might be true. First, a great share of OFIs' assets are created by financial vehicle corporations engaged in securitization. This securitization and its related products have been identified as a prominent tool for regulatory arbitrage (Calomiris and Mason, 2004; Acharya et al., 2013; Efing, 2016). Tightening of prudential regulation may thus increase the motives for securitization, especially when funding costs are relatively high. Second, OFIs also contain assets of entities that provide financial leasing services and hire purchase. There is a plurality of studies showing that more stringent capital regulation limits traditional bank lending (Hyun and Rhee, 2011; Fraisse et al., 2017; Kolcunová and Malovaná, 2019), which may increase the demand for non-bank loan-like products, especially from households and non-financial corporations.

Table 4: Disentangling the Relationship Between Monetary Policy and Shadow Banking

	Dependent variable: (**Δ** outstanding assets)							
	Other financial intermediaries (OFIs)				Investment funds (IFs)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Explanatory variables	Baseline	Low interest rates	Financial crises	Different low rate dummy	Baseline	Low interest rates	Financial crises	Different low rate dummy
Lagged dependent variable	0.414*** (0.027)	0.415*** (0.027)	0.415*** (0.027)	0.415*** (0.027)	0.371*** (0.026)	0.370*** (0.026)	0.371*** (0.026)	0.373*** (0.026)
MCI	0.804*** (0.157)	1.224* (0.658)	1.150* (0.559)	1.231* (0.705)	-0.796 (1.155)	-0.502 (1.143)	-0.617 (1.200)	-0.583 (1.219)
MCI x lowrates		-1.075 (1.106)	-1.086 (1.107)	-0.651 (1.135)		-1.358*** (0.176)	-1.372*** (0.181)	-0.968** (0.419)
MCI x crisis			-0.776 (1.233)	-1.985* (1.132)			-0.354** (0.179)	-0.355 (0.382)
Traditional banking	0.246 (0.183)	0.245 (0.182)	0.232 (0.182)	0.205 0.179)	-0.334* (0.173)	-0.333* (0.174)	-0.331* (0.173)	-0.329* (0.174)
Regulation index	0.425* (0.219)	0.653* (0.387)	0.515* (0.288)	0.534 (0.391)	0.078 (0.213)	0.057 (0.211)	0.056 (0.211)	0.062 (0.207)
Macro-finance controls (4)	yes	yes	yes	yes	yes	yes	yes	yes
Country fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
MCI long-run effect	1.078* (0.641)	2.092* (1.016)	1.966* (0.817)	2.104* (1.385)	-1.265 (1.824)	-0.796 (1.806)	-0.980 (1.898)	-0.928 (1.934)
MCI long-run effect in low interest rates		-1.837 (1.797)	-1.856 (1.495)	-1.113 (1.942)		-2.154*** (0.311)	-2.179*** (0.319)	-1.542** (0.662)
Hansen	0.176	0.168	0.168	0.197	0.197	0.137	0.205	0.112
AR(2)	0.251	0.253	0.284	0.244	0.278	0.267	0.289	0.237
No. of obs.	888	888	888	888	888	888	888	888

Note: See Table 2. Macro-finance controls contain real GDP growth, institutional cash pools growth, the term spread, and the financial development index.

7. Robustness Checks

In general, the robustness checks I perform can be split into two groups. The first group contains robustness checks that verify the baseline model results from Sections 5 and 6. The second group presents an additional set of regression results aimed at better capturing the funding cost and search for yield motives.

Under the first group, I verify the results obtained so far with respect to (i) the choice of estimator and (ii) the choice of the threshold variable that marks the transition from a high to low interest rate environment.

(i) While the GMM estimator employed in the main text is extensively used in the literature, it may produce biased estimates in panels where the time period (T) is relatively large compared to the sample size (N). Roodman (2009) shows that the substantial number of instruments produced in such a panel may render the GMM estimator invalid even though the individual instruments may be valid. Some studies also show that using the instrumental variables technique to avoid bias often leads to poor small-sample properties (Kiviet, 1995; Bun and Windmeijer, 2010). To do this literature justice, I estimate the baseline model using a bootstrap-based bias-corrected (BBBC) estimator as proposed by De Vos et al. (2015). Generally, the estimated parameters do not exhibit any significant differences across various model specifications (see Table E1 in Appendix E) and the results reported in the main text can thus be considered robust to the estimator choice.

(ii) In the main text, I use the three-month inter-bank rate as a threshold variable to capture the switch from a high to low interest rate environment. To check the estimates, I replace the inter-bank rate with the natural rate of interest. This experiment reflects the notion that traditional banks set their strategies with respect to some neutral interest rate that better reflects the current monetary conditions. The natural rate of interest is estimated using the structural multi-country model of the euro area developed in Hlédik and Vlček (2018). The results are shown in Table E2 in Appendix E. The estimates are qualitatively as well as quantitatively similar to those reported in the main text.

Under the second group, I estimate an additional set of regressions. To account for supply-side effects, I introduce another dummy, $lowmargins_{it}$, and multiply it by the MCI in a low rate environment. By doing so, I control for possible discontinuity in traditional banks' reaction to a changing MCI. In other words, the actual reaction could depend more on profit margins than on the actual interest rates. If rates fall to a very low level and lead to margin compression, bank profitability goes down and there may be an incentive to place assets on less regulated markets in riskier products. The $lowmargins_{it}$ variable takes the value 1 if the size of the net interest margin is in the first quartile of the distribution (0.82%), and 0 otherwise. The results are presented in Table E3 in Appendix E. They largely support the previous set of results reported in the main text. As expected, they help better capture the search for yield motive. Specifically, they confirm the mostly negative relationship between the MCI and investment funds; however, the relationship is found to be statistically significant only when margins are low. Tightly compressed profit margins motivate investors to look for more profitable investment opportunities, making investment in investment funds attractive, especially in those funds that are open-ended with redemptions on a daily basis.

8. Conclusions

In this paper, I presented new evidence on the empirical link between monetary policy, traditional banking, and shadow banking in the euro area. To that end, I used a Monetary Conditions Index (MCI) and collected euro area-wide data on traditional and shadow banking. I showed that the responses of financial intermediaries to changing monetary policy conditions are dependent on the relative magnitude of interest rates in the economy. To support my arguments, I described the functionality of two main motives explaining the level-dependency – the "funding cost" motive and the "search for yield" motive.

Two key findings stand out. First, while monetary policy tightening was found to reduce the growth of traditional banks in the run-up to the GFC, it also led to an expansion of shadow banking activities. This result can be explained by the dominance of the funding cost motive, since traditional banks facing high interest rates are more likely to try to circumvent the increased funding costs by turning to the shadow sector and taking advantage of securitization. Next, I showed that the observed relationships changed after interest rates were pushed to all-time lows. The empirical link between monetary policy and traditional banks disappeared, while the relationship with shadow banking entities (namely, investment funds) turned negative, i.e., the post-crisis monetary easing caused massive inflows into investment funds as a result of search for yield induced by persistently low interest rates.

The results advance our understanding of the empirical link between monetary policy and financial intermediaries, and have some non-trivial implications for policy practitioners. The empirical evidence casts doubt on the ability of monetary policy to “get in the cracks” and to effectively “lean against the wind.” Further, it identifies and describes yet another channel through which monetary policy may influence the stability of the financial system. In this respect, the presented findings support the literature that recommends maintaining close cooperation between monetary policy and macroprudential and supervisory authorities.

References

ABAD, J., M. D'ERRICCO, N. KILLEEN, V. LUZ, T. PELTONEN, R. PORTES, AND T. URBANO (2017): "Mapping the Interconnectedness between EU Banks and Shadow Banking Entities." ESRB Working Paper No. 40.

ADRIAN, T. AND H. S. SHIN (2008): "Financial Intermediaries, Financial Stability, and Monetary Policy." Federal Reserve Bank of New York Staff Report No. 346.

ADRIAN, T. AND H. S. SHIN (2010): "Financial Intermediaries and Monetary Economics." In Friedman B., & Woodford, M. (Eds.), Handbook of Monetary Economics, Vol. 3 (pp. 601–650). Amsterdam, Netherlands: Elsevier.

ACHARYA, V., P. SCHNABL, AND G. SUAREZ (2013): "Securitisation without Risk Transfer." *Journal of Financial Economics* 107(3), pp. 515–536.

ALTUNBAS, Y., L. GAMBACORTA, AND D. MARQUES-IBANEZ (2010): "Bank Risk and Monetary Policy." *Journal of Financial Stability* 6(3), pp. 121–129.

ANGELONI, I., E. FAIA, AND M. L. DUCA (2015): "Monetary Policy and Risk Taking." *Journal of Economic Dynamics and Control* 52, pp. 285–307.

BABECKA-KUCHARCUKOVA, O., P. CLAEYS, AND B. VASICEK (2016): "Spillover of the ECB's Monetary Policy Outside the Euro Area: How Different Is Conventional from Unconventional Policy?" *Journal of Policy Modeling* 38(2), pp. 199–225.

BECK, G. W. AND H. H. KOTZ (2016): "Euro Area Shadow Banking Activities in a Low-Interest-Rate Environment: A Flow-of-Funds Perspective." White Paper 37, Goethe University Frankfurt, Research Center SAFE – Sustainable Architecture for Finance in Europe.

BENGTSSON, E. (2013): "Shadow Banking and Financial Stability: European Money Market Funds in the Global Financial Crisis." *Journal of International Money and Finance* 32, pp. 579–594.

BERNANKE, B. S. AND K. N. KUTTNER (2005): "What Explains the Stock Market's Reaction to Federal Reserve Policy?" *Journal of Finance* 60(3), pp. 1221–1257.

BERNANKE, B. AND A. BLINDER (1992): "The Federal Funds Rate and the Channels of Monetary Transmission." *American Economic Review* 82, pp. 901–921.

BIS (2014): "84th Annual Report." Basel: Bank for International Settlements.

BIS (2016): "86th Annual Report." Basel: Bank for International Settlements.

BLACK, F. (1995): "Interest Rates as Options." *Journal of Finance* 50, pp. 1371–1376.

BLUNDELL, R. AND S. BOND (1998): "Initial Conditions and Moment Restrictions in Dynamic Panel Data Models." *Journal of Econometrics* 87, pp. 115–143.

BOMFIM, A. (2003): "Interest Rates as Options: Assessing the Markets' View of the Liquidity Trap." Federal Reserve Board Finance and Economics Discussion Series, 2003-45.

BORIO, C. AND L. GAMBACORTA (2017): "Monetary Policy and Bank Lending in a Low Interest Rate Environment: Diminishing Effectiveness?" *Journal of Macroeconomics* 54(B), pp. 217–231.

BRAND, C., M. BIELECKI, AND A. PENALVER (2018): “The Natural Rate of Interest: Estimates, Drivers, and Challenges to Monetary Policy.” ECB Working Paper No. 2017.

BUA, G. AND P. G. DUNNE (2019): “Monetary Policy and Money Market Funds.” Economic Letters 9/EL/19, Central Bank of Ireland.

BUCHAK, G., G. MATVOS, T. PISKORSKI, AND A. SERU (2018): “Fintech, Regulatory Arbitrage, and the Rise of Shadow Banks.” *Journal of Financial Economics* 130(3), pp. 453–483.

BUDNIK, K. AND J. KLEIBL (2018): “Macroprudential Regulation in the European Union in 1995–2014: Introducing a New Data Set on Policy Actions of a Macroprudential Nature.” ECB Working Paper No. 2123.

BUN, M. J. G. AND F. WINDMEIJER (2010): “The Weak Instrument Problem of the System GMM Estimator in Dynamic Panel Data Models.” *Econometrics Journal* 13(1), pp. 95–126.

CAGAN, P. (1972): “A Model of Monetary Effects on Interest Rates.” In NBER book The Channels of Monetary Effects on Interest Rates (1972), pp. 85–99.

CALOMIRIS, C. W. AND J. R. MASON (2004): “Credit Card Securitization and Regulatory Arbitrage.” *Journal of Financial Services Research* 26(1), pp. 5–27.

CERUTTI, E., R. CORREA, E. FIORENTINO, AND E. SEGALLA (2017): “Changes in Prudential Policy Instruments – A New Cross-Country Database.” *International Journal of Central Banking* 13, pp. 477–503.

CHEN, K., J. REN, AND T. ZHA (2018): “The Nexus of Monetary Policy and Shadow Banking in China.” *American Economic Review* 108(12), pp. 3891–3936.

CHEN, Q., A. FILARDO, D. HE, AND F. ZHU (2012): “International Spillovers of Central Bank Balance Sheet Policies.” *BIS Papers* 66, pp. 220–264.

CHEN, S. S. (2007): “Does Monetary Policy Have Asymmetric Effects on Stock Returns?” *Journal of Money, Credit and Banking* 39(2), pp. 667–688.

CHRISTENSEN, J. AND G. RUDEBUSCH (2015): “Estimating Shadow-Rate Term Structure Models with Near-Zero Yields.” *Journal of Financial Econometrics* 13(2), pp. 226–259.

CHRISTIANO, L. J. AND M. EICHENBAUM (1992): “Current Real-Business-Cycle Theories and Aggregate Labor-Market Fluctuations.” *American Economic Review* 82(3), pp. 430–450.

CLAESSENS, S., N. COLEMAN, AND M. DONNELLY (2018): “‘Low-For-Long’ Interest Rates and Banks’ Interest Margins and Profitability: Cross-Country Evidence.” *Journal of Financial Intermediation* 35(PA), pp. 1–16.

DE VOS, I., G. EVERAERT, AND I. RUYSSEN (2015): “Bootstrap-Based Bias Correction and Inference for Dynamic Panels with Fixed Effects.” *Stata Journal* 15(4), pp. 986–1018.

DRISCOLL, J. AND A. KRAAY (1998): “Consistent Covariance Matrix Estimation with Spatially Dependent Panel Data.” *Review of Economics and Statistics* 80(4), pp. 549–560.

DUCA, L. M., A. KOBAN, M. BASTEN, B. BENGTSSON, B. KLAUS, P. KUSMIERCZYK, J. H. LANG, C. DETKEN, AND T. PELTONEN (2017): “A New Database for Financial Crises in European Countries.” ESRB Occasional Paper Series No. 194.

EFING, M. (2016): “Arbitraging the Basel Securitisation Framework: Evidence from German ABS Investment.” ESRB Working Paper Series No. 22.

ESRB (2019): "EU Non-Bank Financial Intermediation Risk Monitor 2019." Frankfurt: European Systemic Risk Board.

FAHRI, E. AND J. TIROLE (2017): "Shadow Banking and the Four Pillars of Traditional Financial Intermediation." NBER Working Paper No. 23930.

FILARDO, A. AND P. RUNGCHAROENKITKUL (2016): "Quantitative Case for Leaning Against the Wind." BIS Working Paper No. 594.

FRAISSE, H., M. LÉ, AND F. THESMAR (2017): "The Real Effects of Bank Capital Requirements." ESRB Working Paper No. 47.

FRIEDMAN, M. AND A. SCHWARTZ (1963): "A Monetary History of the United States 1867–1960." Princeton University Press, Princeton, New Jersey.

FSB (2018): "Enhancing Resilience of Non-Bank Financial Intermediation." Basel: Financial Stability Board.

GAMBACORTA, L. AND D. MARQUÉS-IBÁÑEZ (2011): "The Bank Lending Channel: Lessons from the Crisis." *Economic Policy*, April 2011.

GOSPODINOV, N., AND S. NG (2013): "Commodity Prices, Convenience Yields, and Inflation." *Review of Economics and Statistics* 95(1), pp. 206–219.

GOURIO, F., A. K. KASHYAP, AND J. W. SIM (2018): "The Trade-Offs in Leaning Against the Wind." *IMF Economic Review* 66(1), pp. 70–115.

GREENWOOD, J., J. M. SANCHEZ AND CH. WANG (2010): "Financing Development: The Role of Information Costs." *American Economic Review* 100(4), pp. 1875–1891.

GRILLET-AUBERT, L., J. B. HAQUIN, C. JACKSON, N. KILLEEN, AND C. WEISTROFFER (2016): "Assessing Shadow Banking – Non-Bank Financial Intermediation in Europe." ESRB Occasional Paper No. 10.

HLÉDIK, T. AND J. VLČEK (2018): "Multi-country Model of the Euro Area." Forthcoming.

HODULA, M. (2018): "Off the Radar: Exploring the Rise of Shadow Banking in the EU." CNB Working Paper No. 16/2018.

HYUN, J. S. AND B. R. RHEE (2011): "Bank Capital Regulation and Credit Supply." *Journal of Banking & Finance* 35(2), pp. 323–330.

IMF (2014): "Shadow Banking around the Globe: How Large, and How Risky?" International Monetary Fund: Washington, D.C.

JIMÉNEZ, G., S. ONGENA, J. L. PEYDRÓ, AND J. SAURINA (2014): "Hazardous Times for Monetary Policy: What Do Twenty-Three Million Bank Loans Say About the Effects of Monetary Policy on Credit Risk-Taking?" *Econometrica* 82(2), pp. 463–505.

KASHYAP, A. K. AND J. C. STEIN (1995): "The Impact of Monetary Policy on Bank Balance Sheets." *Carnegie-Rochester Conference Series on Public Policy* 42, pp. 151–195.

KASHYAP, A. K. AND J. C. STEIN (2000): "What Do a Million Observations on Banks Say about the Transmission of Monetary Policy?" *American Economic Review* 90(3), pp. 407–428.

KENNY, O., K. MOLONEY, AND N. KILLEEN (2016): "Network Analysis using EMIR Credit Default Swap Data: Micro-level Evidence from Irish-Domiciled Special Purpose Vehicles

(SPVs).” IFC Bulletins chapters, In: Bank for International Settlements (ed.), Combining Micro and Macro Data for Financial Stability Analysis, No. 41. Basel: Bank for International Settlements.

KIM, D. AND K. SINGLETON (2012): “Term Structure Models and the Zero Bound: An Empirical Investigation of Japanese Yields.” *Journal of Econometrics* 170, pp. 32–49.

KIVIET, J. F. (1995): “On Bias, Inconsistency, and Efficiency of Various Estimators in Dynamic Panel Data Models.” *Journal of Econometrics* 68(1), pp. 53–78.

KOCKEROLS, T. AND C. KOK (2019): “Leaning Against the Wind: Macroprudential Policy and the Financial Cycle.” ECB Working Paper No. 2223.

KOLCUNOVÁ, D. AND S. MALOVANÁ (2019): “The Effect of Higher Capital Requirements on Bank Lending: The Capital Surplus Matters.” CNB Working Paper No. 2/2019.

KONTONIKAS, A., R. MACDONALD, AND A. SAGGU (2013): “Stock Market Reaction to Fed Funds Rate Surprises: State Dependence and the Financial Crisis.” *Journal of Banking & Finance* 37(11), pp. 4025–4037.

KRIPPNER, L. (2012): “Modifying Gaussian Term Structure Models when Interest Rates Are Near the Zero Lower Bound.” Reserve Bank of New Zealand Discussion Paper No. 2012/02.

KUROV, A. (2010): “Investor Sentiment and the Stock Market’s Reaction to Monetary Policy.” *Journal of Banking & Finance* 34(1), pp. 139–149.

LAEVEN, L. (2013): “Financial Innovations and Shadow Banking.” In: The Social Value of the Financial Sector Too Big to Fail or Just Too Big? World Scientific Book Chapters, Chapter 12, pp. 229–235.

LAEVEN, L., R. LEVINE AND S. MACHALOPOULOS (2015): “Financial Innovation and Endogenous Growth.” *Journal of Financial Intermediation* 24(1), pp. 1–24.

LOMBARDI, M. AND F. ZHU (2014): “A Shadow Policy Rate to Calibrate US Monetary Policy at the Zero Lower Bound.” BIS Working Paper No. 452.

MADDALONI, A. AND J. L. PEYDRÓ (2013): “Monetary Policy, Macroprudential Policy, and Banking Stability: Evidence from the Euro Area.” *International Journal of Central Banking* 9(1), pp. 121–169.

MAIO, P. (2014): “Another Look at the Stock Return Response to Monetary Policy Actions.” *Review of Finance* 18(1), pp. 321–371.

MALOVANÁ, S. AND J. FRAIT (2017): “Monetary Policy and Macroprudential Policy: Rivals or Teammates?” *Journal of Financial Stability* 32, pp. 1–16.

MEANING, J. AND F. ZHU (2012): “The Impact of Federal Reserve Asset Purchase Programmes: Another Twist.” *BIS Quarterly Review* March 2012, pp. 23–32.

NELSON, B., G. PINTER, AND K. THEODORIDIS (2017): “Do Contractionary Monetary Policy Shocks Expand Shadow Banking?” *Journal of Applied Econometrics* 33(2), pp. 198–211.

OBSTFELD, M. AND K. S. ROGOFF (2009): “Global Imbalances and the Financial Crisis: Products of Common Causes.” CEPR Discussion Paper No. DP7606.

OLSEN, Ø. (2015): “Integrating Financial Stability and Monetary Policy Analysis.” Speech at the London School of Economics, London, April 27, 2015, Norges Bank.

ORPHANIDES, A. (2012): “ECB Policy and Fed Normalization.” CEPR Policy Insight No. 74.

PLANTIN, G. (2014): “Shadow Banking and Bank Capital Regulation.” *Review of Financial Studies* 28, pp. 146–175.

POZSAR, Z. (2011): “Institutional Cash Pools and the Triffin Dilemma of the U.S. Banking System.” IMF Working Paper No. 11/190.

POZSAR, Z., T. ADRIAN, A. ASHCRAFT, AND H. BOESKY (2010): “Shadow Banking.” Federal Reserve Bank of New York Staff Report No. 458.

RAO, C. (1973): “Linear Statistical Inference and Its Applications.” 2nd edition, Wiley, New York.

ROMER, C. AND P. ROMER (1989): “Does Monetary Policy Matter? A New Test in the Spirit of Friedman and Schwartz.” NBER Macroeconomics Annual, NBER, Cambridge, MA.

ROMER, C. AND P. ROMER (2004): “A New Measure of Monetary Shocks: Derivation and Implications.” *American Economic Review* 94, pp. 1055–1084.

ROODMAN, D. (2009): “A Note on the Theme of Too Many Instruments.” *Oxford Bulletin of Economics and Statistics* 71(1), pp. 135–158.

SALACHAS, E. N., N. T. LAOPODIS, AND G. P. KOURETAS (2017): “The Bank-Lending Channel and Monetary Policy during Pre- and Post-2007 Crisis.” *Journal of International Financial Markets, Institutions and Money* 47, pp. 176–187.

SIMS, C. (1980): “Macroeconomics and Reality.” *Econometrica* 48(1), pp. 1–48.

SIMS, C. (1992): “Interpreting the Macroeconomic Time Series Facts: The Effects of Monetary Policy.” *European Economic Review* 36, pp. 975–1000.

STEIN, J. C. (2013): “Overheating in Credit Markets: Origins, Measurement, and Policy Responses.” Washington, D.C.: Speech, Federal Reserve Board.

SVIRYDZENKA, K. (2016): “Introducing a New Broad-Based Index of Financial Development.” IMF Working Paper No. 16/5.

WHITE, W. (2009): “Should Monetary Policy ‘Lean or Clean’?” Federal Reserve Bank of Dallas Working Paper No. 34.

WOODFORD, M. (2010): “Financial Intermediation and Macroeconomic Analysis.” *Journal of Economic Perspectives* 24(4), pp. 21–44.

WU, J. C. AND F. D. XIA (2016): “Measuring the Macroeconomic Impact of Monetary Policy at the Zero Lower Bound.” *Journal of Money, Credit, and Banking* 48(2–3), pp. 253–291.

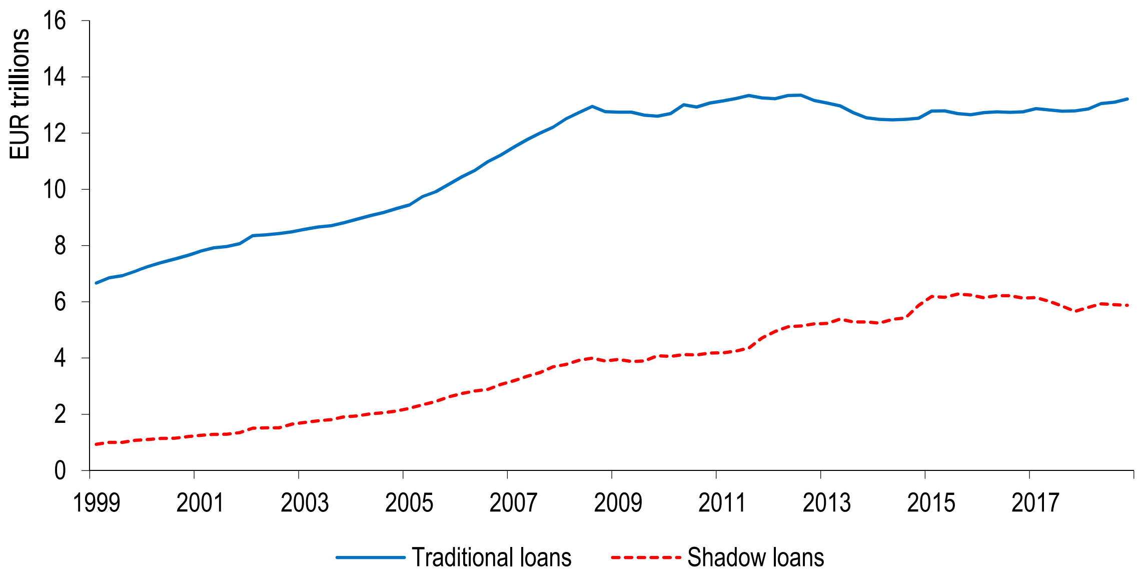
Appendix A: Summary Statistics

Table A1: Data Overview and Summary Statistics

	Mnemonics	Description	Min	Max	Median	Std. dev.	Source
A	ofi	Total financial assets of other financial institutions (financial corporations other than MFIs, insurance corporations, pension funds, and non-MMF investment funds)	-27.41	28.61	2.87	6.36	ECB
B	if	Total financial assets of non-MMF investment funds	-33.48	75.47	2.95	8.69	ECB
C	mmf	MMF shares/units issued reported by MFIs excluding ESCB in euro area (total maturity)	-12.53	13.84	3.45	5.84	ECB
D	sb	Total financial assets of shadow banking entities (A+F+G)	-17.52	23.50	2.40	5.14	ECB
E	sb_loans	Total loans granted by shadow banking entities	-26.75	23.49	2.96	6.80	ECB
F	mfi	Total financial assets of MFIs	-12.20	14.88	2.02	3.68	ECB
G	mfi_loans	Loans granted by MFIs	-15.13	13.29	1.50	3.68	ECB
H	icpf	Total financial assets of ICPFs	-6.71	22.51	2.35	2.94	ECB
I	euribor	3-month inter-bank rates (3M EURIBOR)	-0.33	5.02	1.53	1.74	Eurostat
J	mci	Monetary conditions index, normalized to 2W repo rate	-1.69	4.68	2.12	1.68	own calculation
K	mci_net	Monetary conditions index (non-normalized)	-2.83	2.44	0.32	1.39	own calculation
L	natural	Natural rate of interest	-0.19	1.48	0.47	0.46	Hlédik and Vlček (2018)
M	gdp	Gross domestic product at market prices, chain linked volumes (2010), seasonally and calendar-adjusted data	-4.90	14.36	1.44	1.70	Eurostat
N	inf	Inflation rate calculated from HICP (2015=100), 12-month average rate of change	-2.50	5.17	1.93	1.25	Eurostat
O	spread	Term spread calculated as difference between 10Y government bond yield and 3-month inter-bank rate	-0.72	24.70	1.42	2.42	Eurostat
P	crisis	Banking crisis dummy, ESRB (0 – no crisis, 1 – crisis)	0	1	0	0.39	ESRB
Q	reg	Regulation index (normalized to EA12 average)	-1.61	2.18	-0.43	0.90	Cerutti et al. (2017)
R	fdi	Financial development index	0.48	1	0.74	0.09	IMF
S	capital	Ratio of Tier 1 and Tier 2 capital to risk-weighted assets	0.41	1.27	0.78	0.13	Bloomberg
T	npl	Non-performing loans to total gross loans	-1.03	1.67	0.46	0.51	Bloomberg
U	roa	Net income to total assets	-8.52	6.20	0.38	1.12	Bloomberg
V	liquidity	Liquid assets to total assets (liquid asset ratio)	-80.77	48.02	-0.56	10.61	Bloomberg

Note: Variables are in annualized growth rates (except for interest rates, MCI, regulation index, and dummy variables, which are left in levels).

Figure A1: Traditional and Shadow Loans in the Euro Area



Source: ECB/Eurosystem data.

Appendix B: Monetary Conditions Index Estimation Procedure

There are a number of approaches that allow a large number of time series to be combined into a single composite index. In the case of the indicator presented in this paper, I use a factor model estimate. The logic behind factor analysis is that the common motion of selected time series can be explained by a few indirectly measurable components (factors). The aim of factor analysis is to identify the number of statistically significant factors and to estimate the values of each of the factors for all the monitored objects, i.e., to describe the objects using estimated factors. Consider an n-dimensional vector of stationary observable variables $X = (X_1, \ldots, X_n)'$ that are linearly dependent on an m-dimensional vector of originally unobservable factors $F = (F_1, \ldots, F_m)$. The baseline factor model then takes the following form:

$$X_t = \Lambda F_t + \varepsilon_t, \text{ where } F_t = \sum_{i=1}^{p} A_i F_{t-i} + u_t, \qquad \text{(B1)}$$

where Λ is a matrix of factor loadings, A_i is a matrix of autoregression coefficients for p lags and ε_t, u_t are i.i.d. Gaussian error terms. I use the maximum likelihood method to estimate the factor model. While more complicated to calculate, the maximum likelihood method, unlike the principal components method, makes it possible to test whether the number of common factors selected is sufficient. The optimal number of factors to estimate is primarily based on parallel analysis. The optimal number of lags is chosen based on the Schwarz information criterion. For my data, the results of statistical tests prefer a factor model with three estimated factors and one lag. The robustness and sensitivity analysis of the selected model specification for calculating the MCI was performed with respect to the number of lags used, the number of factors estimated, the estimation period, and the variables included in the estimation.

Table B1 summarizes the set of 14 variables that reflect the monetary conditions in the euro area. The variables in the blocks were treated as follows: (i) interest rates enter the estimation in levels; (ii) monetary aggregates are expressed in year-on-year change and in reciprocal values (switched sign) so that an increase corresponds to a monetary tightening, as for interest rates; (iii) ECB balance sheet items are expressed in year-on year change with a negative sign for all these variables; and (iv) the exchange rate is transformed into year-on-year change with the sign left unchanged.

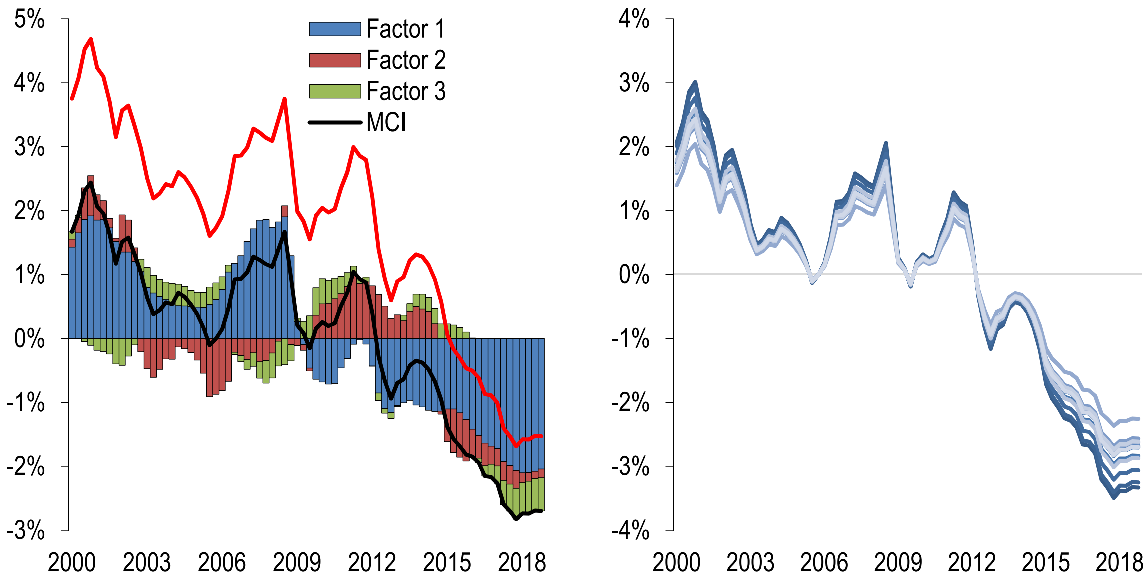
Table B1: Dataset Used to Extract the Factor Loadings

Blocks	Variable
Interest rates	Main refinancing operations rate (EMPRATE) Inter-bank rates (EURIBOR) with maturities of 3 and 12 months (EMIBOR) Yields on government bonds with maturities of 5 and 10 years (EMGBOND) Overnight index swap (OIS)
Monetary aggregates	M1, M2, and M3 (EMM1NEG, EMM2NEG, EMM3NEG)
ECB balance sheet items	Total assets (EMASTOTNEG) Securities held for monetary policy purposes (EMECASMNEG) Long-term refinancing operations (EMALTRONEG) Currency in circulation (EMECLBCNEG) Liabilities of ECB to euro area MFIs related to monetary operations (EMECLEMNEG)
Exchange rate	Nominal exchange rate of US dollar against euro

Note: The data covers the period from January 1999 to December 2018 and was extracted from the Thomson database (time series codes are given in brackets), except for the nominal exchange rate, which is taken from the ECB database.

To save space, I do not report all the robustness checks performed; they are available upon request. Figure B1 (left-hand graph) shows the relative contribution of each of the estimated factors to the final index. The figure also plots the MCI as normalized using the mean and standard deviation of the 3-month EURIBOR. The right-hand graph shows results of a simulation exercise in which the index was estimated multiple times, each time with one variable excluded from the input data set. This approach is very similar to the more formal bootstrapping proposed by Gospodinov and Ng (2013).

Figure B1: Monetary Conditions Index for the Euro Area



Note: In order to calculate the synthetic indicator, I weight the sum of the three factors (with weights given by the percentage of the overall data variability explained by each factor, i.e., 44%, 34%, and 22%).

Appendix C: Regulation Index Normalization Procedure

The regulation index is calculated using information from the cross-country database of Cerutti et al. (2017). The database focuses on both microprudential and macroprudential policy actions, such as changes to general capital requirements, sector-specific capital requirements, concentration limits, reserve requirements, interbank exposure limits, and loan-to-value ratio limits. The dataset covers 64 countries and covers the 2000 Q1 to 2014 Q4 period. I extended the dataset past 2014 using information from the MacroPrudential Policies Evaluation Database (MaPPED), described in detail in Budnik and Kleibl (2018) and policy reports collected by the ESRB. MaPPED contains information on policy instruments which are either genuinely macroprudential or are essentially microprudential but likely to have a significant impact on the whole banking system.

Note that the database does not gauge the intensity of measures, as all measures are coded as dummy variables. However, this is disconcerting given my interest in regulatory arbitrage, as more binding measures are expected to generate stronger incentives to move towards the shadow banking system. Moreover, to capture cross-country regulatory arbitrage, I normalize the regulation index as follows:

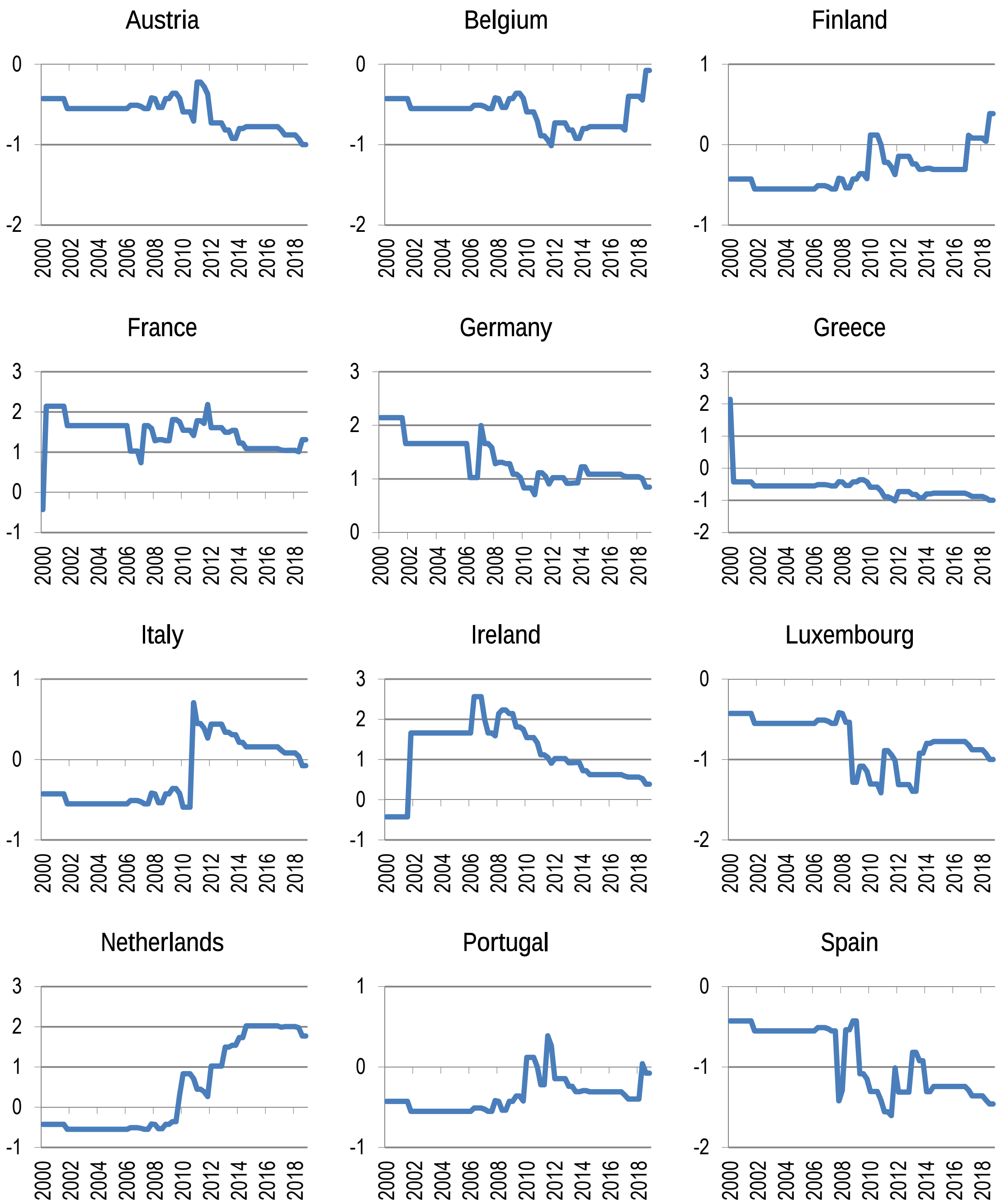
$$reg_{it}^{norm} = \frac{reg_{it} - \overline{E}(reg_{EA12,t})}{std(reg_{EA12,t})}, \quad \text{(C1)}$$

where i denotes the individual country and EA12 the whole sample. My reference group of countries consists of the EA12 countries. By doing so, I can derive a metric that not only captures the regulatory and supervisory situation in a given country, but also reflects the situation in the rest of the system. The mean and standard deviation are computed at each point in time:

$$std(reg_{EA12,t}) = \sqrt{\frac{1}{(n-1)} \sum_{i=1}^{n} \left(reg_i - \overline{E}(reg_i)\right)^2} \quad \text{(C2)}$$

$$E(reg_{EA12,t}) = \frac{1}{n} \sum_{i=1}^{n} reg_i \quad \text{(C3)}$$

Figure C1: Scaled Regulation Indexes for Individual Countries in the Sample



Note: Figures depict the z-score scaled index for each country. Since I use the mean and std. dev. for EA12 countries as a benchmark, positive/negative values imply that capital regulation stringency is below/above the average level.

Appendix D: Dating of Financial Crises in European Countries

Table D1: Dating of Crises According to the ESRB Database

Country	Country code	Event	Start date	End of crisis management date
Austria	AT	1	2007 Q4	2016 Q1
Belgium	BE	1	2007 Q4	2012 Q4
Finland	FI	0	-	-
France	FR	1	2008 Q2	2009 Q4
Germany	DE	1	2001 Q1	2003 Q4
		2	2007 Q3	2013 Q2
Greece	GR	1	2010 Q2	ongoing
Ireland	IE	1	2008 Q3	2013 Q4
Italy	IT	1	2011 Q3	2013 Q4
Luxembourg	LU	1	2008 Q1	2010 Q3
Netherlands	NL	1	2008 Q1	2013 Q1
Portugal	PT	1	2008 Q3	2015 Q4
Spain	ES	1	2009 Q1	2013 Q4

Appendix E: Robustness Checks

Table E1: Baseline Model Estimation Using the Bootstrap-Based Bias-Corrected (BBBC) Estimator

Explanatory variables	Traditional banks	Shadow banks	Other financial intermediaries	Investment funds	Traditional banks	Shadow banks
	(**Δ** total assets)				**Δ** outstanding loans	
Lagged dependent variable	0.814***	0.775***	0.776***	0.772***	0.844***	0.831***
	(0.022)	(0.038)	(0.039)	(0.046)	(0.019)	(0.020)
MCI	-0.722**	0.453	1.135*	-0.280	-1.259***	1.472***
	(0.366)	(0.520)	(0.551)	(0.330)	(0.122)	(0.353)
MCI x lowrates	0.362	-0.995	-0.684**	-1.680***	-0.259	0.207
	(0.226)	(0.628)	(0.312)	(0.466)	(0.436)	(0.272)
MCI x crisis	-0.317	-0.139	-0.285	-0.815**	-0.436	-0.024
	(0.371)	(0.401)	(1.354)	(0.405)	(0.323)	(0.394)
Traditional banking		-0.025	-0.406***	-0.406***		0.012
		(0.044)	(0.079)	(0.079)		(0.047)
Regulation index	-0.098*	0.082*	0.700	0.022	-0.010	0.170
	(0.047)	(0.050)	(0.729)	(0.239)	(0.058)	(0.241)
Macro-finance controls (4)	yes	yes	yes	yes	yes	yes
Country fixed effects	yes	yes	yes	yes	yes	yes
No. of obs.	818	825	825	825	818	825

Note: Results from dynamic panel regression. Macro-finance controls contain real GDP growth, institutional cash pools growth, the term spread and the financial development index. Bootstrapped standard errors reported in parentheses. Statistical significance at the 1%, 5%, and 10% level is indicated by ***, **, and *, respectively.

Table E2: Baseline Model Estimation Using the Natural Rate of Interest as the Threshold Variable

Explanatory variables	Traditional banks	Shadow banks	Other financial intermediaries	Investment funds	Traditional banks	Shadow banks
	(**Δ** total assets)				**Δ** outstanding loans	
Lagged dependent variable	0.424***	0.306***	0.416***	0.368***	0.264***	0.304***
	(0.065)	(0.028)	(0.027)	(0.027)	(0.052)	(0.056)
MCI	-1.452**	0.378	0.787**	-1.180	-2.745***	0.626*
	(0.628)	(0.543)	(0.373)	(1.295)	(0.537)	(0.359)
MCI x lowrates	0.180*	0.466	-0.388	-0.660**	0.267	0.611
	(0.108)	(0.539)	(0.653)	(0.277)	(0.169)	(0.700)
MCI x crisis	-0.359	-0.484*	0.797	0.412	0.387	-0.248
	(0.326)	(0.263)	(1.232)	(0.357)	(0.777)	(0.656)
Traditional banking		-0.050	0.666***	-0.329*		
		(0.086)	(0.130)	(0.171)		
Regulation index	-0.180***	0.168**	0.269*	0.068	-0.094*	0.067
	(0.055)	(0.067)	(0.132)	(0.216)	(0.050)	(0.124)
Macro-finance controls (4)	yes	yes	yes	yes	yes	yes
Country fixed effects	yes	yes	yes	yes	yes	yes
MCI long-run effect	-2.520**	0.545	1.347**	-1.865	-3.729***	0.899
	(1.174)	(0.767)	(0.635)	(2.027)	(0.748)	(0.562)
MCI long-run effect in low interest rates	0.312	0.672	-0.664	-1.043**	0.362	0.878
	(0.203)	(0.806)	(1.118)	(0.426)	(0.232)	(1.125)
No. of obs.	818	825	825	825	818	825

Note: See Table 4.

Table E3: Baseline Model Estimation Using the Interest Margin as the Threshold Variable

Explanatory variables	Traditional banks	Shadow banks	Other financial intermediaries	Investment funds	Traditional banks	Shadow banks
	(**Δ** total assets)				**Δ** outstanding loans	
Lagged dependent variable	0.417***	0.310***	0.471***	0.376***	0.259***	0.328***
	(0.064)	(0.027)	(0.025)	(0.025)	(0.052)	(0.057)
MCI	-1.302**	0.591	1.340***	-2.147	-2.639***	1.649**
	(0.550)	(0.481)	(0.384)	(1.731)	(0.533)	(0.736)
MCI x lowmargin	-0.404	-0.035	-1.338**	-1.231*	0.128	0.645
	(0.309)	(0.529)	(0.595)	(0.656)	(0.326)	(0.904)
MCI x crisis	-0.395	-0.543**	-2.819**	0.655	0.267	-0.427
	(0.323)	(0.266)	(1.151)	(0.464)	(0.341)	(0.616)
Traditional banking		-0.053	0.211*	-0.338**		
		(0.086)	(0.119)	(0.159)		
Regulation index	-0.183***	0.159**	0.301*	0.053	-0.087*	0.385**
	(0.057)	0.068)	(0.148)	(0.086)	(0.051)	(0.150)
Macro-finance controls (4)	yes	yes	yes	yes	yes	yes
Country fixed effects	yes	yes	yes	yes	yes	yes
MCI long-run effect	-2.231**	0.856	2.535***	-3.438	-3.563***	2.454***
	(1.001)	(0.675)	(0.714)	(2.771)	(0.730)	(0.934)
MCI long-run effect in low interest rates	-0.692	-0.050	-2.529**	-1.972*	0.172	0.959
	(0.544)	(0.768)	(1.121)	(1.069)	(0.439)	(0.785)
	0.218	0.357	0.098	0.081	0.357	0.205
No. of obs.	0.305	0.374	0.241	0.280	0.451	0.274

Note: See Table 4.

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