The Role of Shadow Banking in Systemic Risk in the European Financial System*

Carlo Bellavite Pellegrini[a], Peter Cincinelli[b], Michele Meoli[c], Giovanni Urga[d,*]

[a]*Department of Political Economy and CSEA, Catholic University, Milan (Italy).*
[b]*Department of Management, University of Bergamo (Italy).*
[c]*Department of Management, Information and Production Engineering and CCSE, University of Bergamo (Italy).*
[d]*Faculty of Finance and Centre for Econometric Analysis, Bayes Business School (formerly Cass), London (UK).*

Abstract

We study how the characteristics of different financial institutions relate to systemic risk using the $\Delta CoVaR$ measure of Adrian and Brunnermeier (2016). We contrast traditional banks with shadow entities, such as Money Market Funds and Finance Services, using a sample of 476 European financial institutions between 2006 and 2015. We find that systemic risk increases significantly in the size of large financial institutions, particularly Money Market Funds, while it is insensitive to the size of Finance Services. We also find that Finance Services are particularly sensitive to proxies for market risk. For traditional banks, their reliance on short term wholesale funding is a key determinant of their contribution to systemic risk.

Keywords: Systemic Risk, Shadow Banking, Financial Crisis, CoVaR, Panel Data
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*Corresponding author
Email address: g.urga@city.ac.uk (Giovanni Urga)

1. Introduction

The 2008 financial crisis brought shadow banking to the forefront of scholars' attention because of its supposed contribution in exacerbating the global financial crisis. Before the crisis, the activities of shadow banking could be traced back to the prevalent originate-to-distribute banking model, which allowed the transfer of some balance sheet from the regulated to the unregulated part of the financial sector (Constâncio, 2012). During the financial crisis, the development of shadow banking may also be seen as a source of systemic risk, defined as the risk of threats to financial stability that impair the functioning of a large part of the financial system with significant adverse effects on the broader economy (De Bandt and Hartmann, 2000; Freixas et al., 2015). Pozsar et al. (2010, 2013) and Tucker (2010) report that the size of shadow banking shows a pattern of sudden increase before the outbreak of the global financial crisis, and that shadow banking has to be considered as one of the main determinants of financial systemic risk. Bernanke et al. (2011) document that shadow banking provides credit loans in a similar way to commercial banks, but without the same regulatory oversight, which can induce systemic risk. Gennaioli et al. (2013) study the relationship between shadow banking and systemic risk finding that shadow banking may help to withstand the systemic risk, but is vulnerable to crises and liquidity dry-ups when investors neglect tail risk. Colombo et al. (2016) emphasise that the propagation of a crisis shock reduces the ability of the financial system to offset future shocks. Nevertheless, while the shadow banking system has been largely discussed as a diversified system (Pozsar et al., 2010, 2013), also with respect to its different impacts on the 2009 financial crisis (Lysandrou and Nesvetailova, 2015), the role of the specific types of shadow entities on systemic risk has not been assessed yet. Our paper aims to fill this gap.

Over the last decade, several global systemic risk measures have been proposed (see Benoit et al., 2017) to explain systemic risk in terms of contagion, bank runs, liquidity and financial crises. In particular, the Marginal Expected Shortfall (MES) of Acharya et al. (2017), the SRISK of Brownlees and Engle (2016), and the $\Delta CoVaR$ of Adrian and Brunnermeier (2016) are the most central metrics in the systemic risk literature (Zhang et al., 2015; Benoit et al., 2017; Dičpinigaitienė and Novickytė, 2018; Grundke and Tuchscherer, 2019). In this study, we adopt the $\Delta CoVaR$ measure because it allows the generation of time-varying estimates of systemic risk contributions from individual financial institutions to the entire financial system. $\Delta CoVaR$ is a bilateral measure of downside risk that determines the expected loss of the financial system conditional on the Value at Risk (VaR) of an individual institution (López-Espinosa et al., 2015). Arsov et al. (2013) highlight that Adrian and Brunnermeier's $\Delta CoVaR$ is suited to assessing potential spillovers to inform policy makers about the systemic risk contribution of individual financial institutions and can be considered amongst the best performing near coincident indicators; Zhang et al. (2015) stress that only $\Delta CoVaR$ *"consistently adds predictive power to conventional early warning models"* (p. 1403).

In this paper, we study how the characteristics of different financial institutions relate to systemic risk. We contrast traditional banks with shadow entities. We identify traditional banks as those entities which take deposits or other repayable funds from the public and grant credits for their own account (European Union Regulation, 2013, p. 18). With respect to shadow entities, following the guidelines provided by the European Commission (2012), we identify two groups, namely Money Market Funds (MMFs, comprising investment funds or products with deposit-like characteristics which make them vulnerable to massive redemption) and Finance Services (FSs, providing credit or credit guarantees, or performing liquidity and/or maturity transformation without being regulated like a bank).

Our analysis is conducted using a sample of 476 European financial institutions, listed over the time period 2006:1-2015:4. In particular, we have 214 traditional banks and 262 shadow entities, with 183 MMFs and 79 FSs. We also study the impact of the different phases of the financial turmoil. To this end, we divide the sample into five subperiods: *"Pre Crisis"* (2006:1-2007:2), the *"Subprime Crisis"* (2007:3-2008:3), the *"Global Financial Crisis"* (2008:4-2010:2), the *"Sovereign Debt Crisis"* (2010:3-2012:4), and the *"Post Crisis Period"* (2013:1-2015:4).

The main findings of our study can be summarised as follows. Focusing on the *Size* variable, we find that large financial institutions (both traditional and shadow banks) contribute to systemic risk more than small entities. A one standard deviation increase in a large financial institution's size decreases its $\Delta CoVaR$ by 1.66 basis points in a quarter and thus increases its contribution to global financial fragility. However, shadow banking contributes more to systemic risk, in particular the impact of the *Size* variable is higher for MMFs: we estimate that one standard deviation increase in MMFs' size leads to a 3.14 basis points decrease in $\Delta CoVaR$ in a quarter. These findings support the argument that policy makers must pay attention to large financial institutions, and add credibility to the scope of the too-big-to-fail reforms such as the Global-Systemically Important Banks (G-SIBs) assessment and resolution frameworks (see for

example, Basel Committee on Banking Supervision (2013) and the FSB (2021)). For FSs, systemic risk is unaffected by their size. However, FSs are sensitive to proxies for market risks, such as *Market To Book Value* (*MTBV*) ratio, *Beta* and *Equity Returns Volatility* (*ERV*). This result can be explained by the composition of their balance sheets, which consist largely of risky assets, and short-term activities and collateralized borrowing. Though statistically significant, the impact of *MTBV* and *Beta* is marginal, while relevant is the contribution of *ERV*: an increase in *ERV* of one standard deviation leads to a 55.24 basis points decrease in $\Delta CoVaR$ and thus an increase in systemic risk. In addition, we find that systemic risk decreases in the level of *Leverage*, consistent with the fact that leverage decreases in stressed market periods such as a financial crisis and builds up prior to a financial crisis (Fostel and Geanakoplos, 2008). In particular, systemic risk increases in leverage of traditional banks, while decreases for shadow entities. We also find that *Short-Term Liability* ratio (*STL*) is an important balance sheet determinant of systemic risk for traditional banks. Banks with excessive *STL* ratio are typically more interconnected with other financial intermediaries holding the same asset classes and this increases the vulnerability not only of the interbank markets but of the entire financial system. For shadow entities, we find the opposite effect: an increase in their *STL* ratio of one standard deviation leads to a 6.46 basis points increase in $\Delta CoVaR$ or a decrease in systemic risk in a quarter, showing an important though moderate impact of shadow entities in engaging in credit transformation activities.

Our results are robust to several sensitivity checks, involving alternative measures of systemic risks, such as the *MES* by Acharya et al. (2017) and the *SRISK* of Brownlees and Engle (2016); the implementation of the Romano and Wolf (2005) adjusted p-values; the elimination from our dataset of both failed and rescued financial intermediaries and financial intermediaries belonging to PIIGS (Portugal, Ireland, Italy, Greece and Spain) countries; and, finally, controlling for endogeneity of regressors via the implementation of the GMM estimation method.

The remainder of the paper is organised as follows. In Section 2, we discuss the definition and rise of shadow banking. Section 3 presents the systemic risk measures and institution-specific variables used in this paper. Section 4 reports the main findings. Section 5 concludes and draws some policy implications.

2. The shadow banking system in Europe

2.1. Defining shadow banking

The existing literature provides several approaches to define and measure shadow banking. According to McCulley (2007) the term *"shadow banking"* is commonly understood to encompass the range of non-bank institutions that to various extents provide liquidity services, maturity mismatch or leverage. The FSB (2012, p. 3) proposes two definitions of shadow banking: a) the "broad definition" is: *"credit intermediation involving entities and activities outside the regular banking system"*; b) the "narrow definition" is:*"a system of credit intermediation that involves entities and activities outside the regular banking system, and raises systemic risk concerns, in particular by maturity/liquidity transformation, leverage and flawed credit risk transfer, and/or regulatory arbitrage concerns"*. The latter was subsequently modified to include *"entities and activities fully or partially outside the regular banking system, or non-bank credit intermediation in short"* (Financial Stability Board, 2014, p. 4). On the 22^{nd} October 2018, the FSB replaced the term *"shadow banking"* with *"non-bank financial intermediation"*. The motivation of this change in terminology relies on the intention to emphasise the forward-looking aspect of the FSB's work to enhance the resilience of non-bank financial intermediation, and to clarify the use of relevant technical terms. However, as the FSB argues in its report, *"the change in terminology does not affect the substance or coverage of the agreed monitoring framework and policy recommendations, which aim to address bank-like financial stability risks arising from non-bank financial intermediation (i.e., maturity/liquidity transformation, leverage and/or imperfect credit risk transfer)"* (Financial Stability Board, 2019, p. 9). Therefore, the "narrow definition" of shadow banking reflects the intermediation activities put in place by non-bank financial institutions and their susceptibility to facing risks in terms of maturity or liquidity transformation, credit or leverage. According to the FSB (2018), the shadow banking system encompasses the five economic functions summarised in Table 1. It is worth noticing that non-bank entities not involved in credit and liquidity intermediation (i.e., equity funds and closed-end funds) and entities that are consolidated into a banking group for prudential purposes (i.e., broker-dealers, finance companies' securitisation vehicles) are generally excluded from the shadow banking system.

Pozsar et al. (2010, 2013) provide the following shadow banking classification: a) *"internal shadow banking"* refers to activities that are conducted by subsidiaries of bank holding companies; b) *"external shadow banking"* refers

Table 1: The Shadow Banking System.

Economic Function (EF)	Shadow Entities
EF-1: Management of collective investment vehicles with features that make them susceptible to runs	Money Market Funds (MMFs), Fixed Income Funds, Mixed Funds, Credit Hedge Funds, Real Estate Funds
EF-2: Loan provision that is dependent on short-term funding or secured funding of assets	Finance Companies, Leasing Companies, Factoring Companies, Consumer Credit Companies
EF-3: Intermediation of market activities that is dependent on short-term funding or on secured funding of client assets	Investment firms that provide investment services (e.g., broker-dealers, etc. . .)
EF-4: Facilitation of credit creation	Credit insurance companies, financial guarantors, monolines
EF-5: Securitisation-based credit intermediation and funding of financial entities	Securitisation vehicles, structured finance vehicles, asset-backed securities

Source: Financial Stability Board (FSB), 2019.

to independent and regulated institutions conducting shadow banking activities which do not represent their primary business (i.e., stand-alone broker-dealers, independent wealth management institutions, credit hedge funds and finance companies); c) *"independent shadow banking"* refers to entities which are specialised in shadow banking (i.e., structured investment vehicles, stand-alone money market mutual funds, independent collateralised debt obligations, etc. . .); d) *"government-sponsored enterprise"* (GSE) refers to entities that, unlike traditional banks, are not funded by deposits but through capital markets where they issue short and long-term agency debt securities (e.g., Fannie Mae and Freddie Mac in the United States).

The existing literature stresses that: a) shadow banking would be intrinsically fragile (European Commission, 2012; Pozsar et al., 2010, 2013); b) a precise definition of the shadow banking system may be complex (Poschmann, 2012); and c) reserve and other regulatory requirements have induced shifts from bank loans to other sources of finance (Duca, 2014, 2016). With respect to the traditional banking system, shadow banking transforms risk and maturities without the presence of direct and explicit public sources of liquidity or any form of public deposit insurance (Adrian and Ashcraft, 2016).

2.2. Identifying shadow banking entities: MMFs and FSs

The identification of the shadow entities requires two steps. First of all, to be included as a shadow entity, a financial institution has to satisfy a) the guidelines provided by the European Commission in its Green Paper Shadow Banking (Brussels, 19/03/2012), b) the *"narrow definition"* of credit intermediation process[1]. As a second step, we carefully check the business descriptions available for each financial institution identified as "Finance Services" provided by Thomson Reuters Data Stream with the criteria provided by Pozsar et al. (2010, 2013). This procedure ensures that we include *"external"* and *"independent"* shadow banking entities, but exclude *"internal"* and *"GSE shadow entities"*. In our sample, the *"external"* entities are the FSs and the *"independent"* entities are the MMFs.

In what follows, we summarise the main features of MMFs, FSs and traditional banks according to the relevant European regulations.

2.2.1. Money Market Funds

According to Regulation 2017/1131 of the European Parliament and of the Council, MMFs provide short-term finance to financial institutions, corporations and governments. An MMF is set up as an Undertaking for Collective Investment in Transferable Securities (UCITS). This makes MMFs subject to: a) the requirements in UCITS legislation (Directive 85/611/EEC); and b) any supplementary regulations imposed in the fund's domicile. In accordance with the UCITS directives (Directive 85/611/EEC and later additions and amendments), MMFs are thereby regulated in terms of supervision, asset allocation and the separation, management and safekeeping of assets to ensure the highest level of investor protection.

From a financial standpoint, MMFs are engaged in maturity and liquidity transformation, and they are highly interconnected with banks. Their shares are very liquid, redeemable daily and have approximately the same features

[1]The shadow credit intermediation process is analogous to the process conducted by traditional banks. The main differences is that shadow banks conduct deposit-funded and hold-to-maturity lending operations via a more complex wholesale-funded and securitization-based lending process (Pozsar et al., 2010, 2013; European Banking Authority (EBA, 2014)).

of bank deposits. MMFs' assets are expected to have a short-term maturity, and even in the event of the maturity slightly exceeding that of their liabilities, MMFs are only marginally involved in maturity transformation. However, all MMFs attempt to maintain the value of the invested funds while offering liquidity and some interest payments. A detailed description of MMFs is reported in the Internet Appendix.

2.2.2. Finance Services

The EBA Report (2014) defines FSs as *"undertakings, other than credit institutions, which perform credit operations on a regular basis as their main activity and for their own account, within the limits of their licence. FSs may grant credits but are not allowed to receive refundable deposits from customers. These include credit card companies, consumer finance companies, mortgage loans companies, auto loans companies, leasing companies"* (EBA, 2014, p.74). FSs are financial entities focused on asset financing for households and non-financial corporations. Their typical activities include financial leasing, factoring, mortgage lending and consumer lending. Regulatory frameworks for FSs currently exist in some countries, despite having a residual characterisation, and a share of FSs' total assets end up being consolidated in banking groups. Based on the classification provided by Pozsar et al. (2010, 2013), we select stand-alone finance companies available on Thomson Reuters, which as the name suggests stand on their own and are not subsidiaries of any other corporate entity.

2.3. Traditional banks

As far as the traditional banks are concerned, we refer to "credit institutions" in the sense that: *"credit institution means an undertaking the business of which is to take deposits or other repayable funds from the public and to grant credits for its own account"* (European Union Regulation, 2013, p. 18). We select only listed banks included in the group "Banks" provided by the Thomson Reuters Data Stream.

2.4. Data description

Our analysis is conducted using 476 European financial institutions listed over the time period 2006:1-2015:4, belonging to all EU countries. The dataset contains 214 traditional banks and 262 shadow banking entities. In particular, our analysis covers two types of shadow banking entities (MMFs and FSs). A comprehensive list of the traditional banks, MMFs and FSs in our dataset is reported in the Internet Appendix.

Table 2 presents the yearly asset market value of the European financial institutions. On average, the traditional banks show an increasing path until 2008, when the great financial depression hit the European banking system. After that, and as a consequence of the deleveraging process conducted by banks' management, their asset value starts to decrease. A subsequent sharp increase is evident in 2013 and is sustained until 2015.

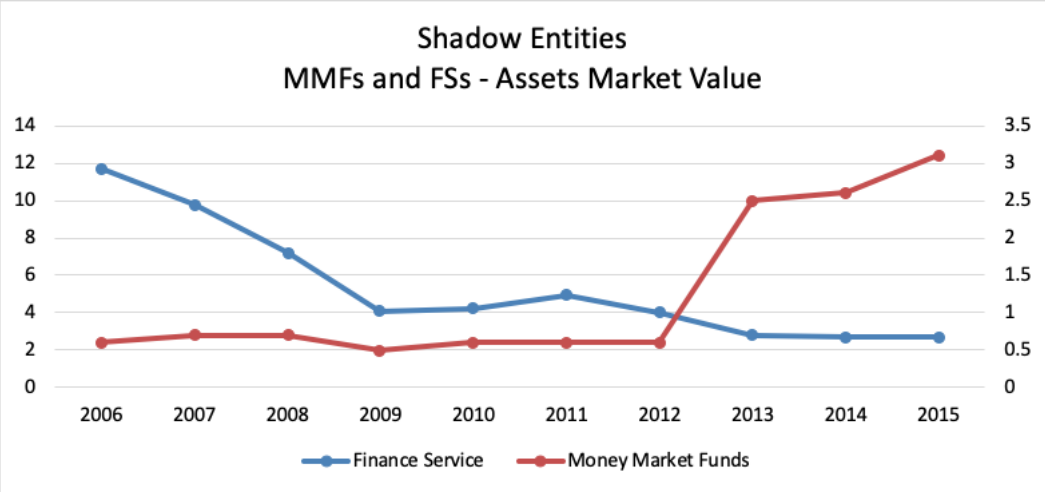
Table 2: European Financial Institutions: Asset Market Value (EUR bln).

Financial Institutions	**2006**	**2007**	**2008**	**2009**	**2010**
Traditional Banks	201.56	220.16	176.36	104.26	127.67
Finance Services	11.73	9.78	7.19	4.09	4.25
Money Market Funds	0.67	0.71	0.69	0.54	0.64
Total	**213.96**	**230.65**	**184.51**	**108.89**	**132.56**
	2011	**2012**	**2013**	**2014**	**2015**
Traditional Banks	118.42	103.9	384.76	379.97	404.5
Finance Services	4.97	4.01	2.81	2.68	2.76
Money Market Funds	0.66	0.66	2.5	2.68	3.17
Total	**124.05**	**108.57**	**390.07**	**385.33**	**410.43**

The table reports the yearly average of total asset market values.

As far as shadow entities are concerned, Figure 1 shows that FSs' asset market value on average decreases over the whole period, contrary to the positive trend of the MMFs, especially since 2012.

Figure 1: Asset Market Value of Shadow Entities (Euro bln) - Finance Services (left side) and Money Market Funds (right side) .



As argued by Bengtsson (2013), an explanation of this trend relies on the competitive returns that MMFs offer in comparison with ordinary bank accounts, and on the diversification opportunities available across securities and issuers. Diversification opportunities affect institutional investors since they are typically not covered by deposit guarantee schemes.

Table 3 reports a description of the relevant financial entities by country. The table shows sharp differences in institutional contexts across European countries. The largest number of traditional banks is in Denmark (42 banks), France (24), Italy (22), and Poland (18). In the UK, by contrast, we identify the largest number of MMFs (149) and FSs (28).

3. Measuring systemic risk

The identification of the different drivers of systemic risk has been a popular issue in the institutional and academic debate over the years since the global financial crisis. Systemic risk, by its nature, includes both a cross-sectional and a time dimension. The existing literature proposes measures which capture these two dimensions and different classifications are offered by Bisias et al. (2012), De Bandt et al. (2013) and Benoit et al. (2017). First of all, there are measures based on the single bank and on the system as a whole. Regarding the first group, the metrics rely on market data (e.g., equity returns or CDS spreads) or on balance sheet and regulatory data. With regard to the second group, there are indicators which captures the time dimension (e.g., the procyclicality of credit and asset prices, specifically housing) usually measured by credit/GDP, the change in credit/GDP, or the credit/GDP "gap". There are also measures of connectivity based on networks (graph theory) that focus on the cross-sectional dimension of risk only, whereby there are common failures and so-called "domino effects" sometimes caused by a common factor or by interconnected exposures.

Benoit et al. (2017) link the literature on systemic risk with the regulatory debate and provide two different ap-

Table 3: Sample Composition by Country and Type of Financial Intermediaries.

Eurozone										
	Type	**N.**		**Type**	**N.**		**Type**	**N.**		**Type**	**N.**
Austria	TBs	8	Belgium	TBs	3	Bulgaria	TBs	4	Cyprus	TBs	4
	MMFs	-		MMFs	6		MMFs	-		MMFs	13
	FSs	1		FSs	-		FSs	-		FSs	5
	Total	**9**		**Total**	**9**		**Total**	**4**		**Total**	**22**
Finland	TBs	4	France	TBs	24	Germany	TBs	11	Greece	TBs	12
	MMFs	1		MMFs	3		MMFs	4		MMFs	2
	FSs	2		FSs	9		FSs	24		FSs	-
	Total	**7**		**Total**	**36**		**Total**	**39**		**Total**	**14**
Ireland	TBs	3	Italy	TBs	22	Latvia	TBs	1	Lithuania	TBs	4
	MMFs	-		MMFs	1		MMFs	-		MMFs	-
	FSs	1		FSs	4		FSs	-		FSs	-
	Total	**4**		**Total**	**27**		**Total**	**1**		**Total**	**4**
Luxembourg	TBs	1	Malta	TBs	4	Netherlands	TBs	2	Portugal	TBs	5
	MMFs	-		MMFs	-		MMFs	4		MMFs	-
	FSs	2		FSs	-		FSs	1		FSs	-
	Total	**3**		**Total**	**4**		**Total**	**7**		**Total**	**5**
Slovakia	TBs	4	Slovenia	TBs	2	Spain	TBs	14	**Total**	**TBs**	**132**
	MMFs	-		MMFs	-		MMFs	-		**MMFs**	**34**
	FSs	-		FSs	-		FSs	2		**FSs**	**51**
	Total	**4**		**Total**	**2**		**Total**	**16**		**Total**	**217**
Non-Eurozone										
	Type	**N.**		**Type**	**N.**		**Type**	**N.**		**Type**	**N.**
Czech Republic	TBs	1	Denmark	TBs	42	Hungary	TBs	2	Poland	TBs	18
	MMFs	-		MMFs	-		MMFs	-		MMFs	-
	FSs	-		FSs	-		FSs	-		FSs	-
	Total	**1**		**Total**	**42**		**Total**	**2**		**Total**	**18**
Romania	TBs	2	Sweden	TBs	4	United Kingdom	TBs	13	**Total**	**TBs**	**82**
	MMFs	-		MMFs	-		MMFs	149		**MMFs**	**149**
	FSs	-		FSs	-		FSs	28		**FSs**	**28**
	Total	**2**		**Total**	**4**		**Total**	**190**		**Total**	**259**

The table reports the composition of the European Financial System: Traditional Banks (TBs), Money Market Funds (MMFs), and Finance Services (FSs) for each country. For Estonia, no data available for TBs, MMFs, and FSs over 2006:1–2015:4.

proaches, the *"source-specific approach"* and the *"global approach"*. Within the first approach, based on accounting data (i.e., data disclosed with a lag) or on data not in the public domain (e.g., interconnectedness, substitutability), authors propose methods to measure the various sources of systemic risk such as systemic risk-taking (Lehar, 2005; Acharya, 2009; De Nicolò and Lucchetta, 2011; Cai et al., 2018; He and Krishnamurthy, 2019); contagion between financial institutions (Allen et al., 2009; Afonso and Shin, 2011; Drehmann and Tarashev, 2011; Iyer and Peydro, 2011; Upper, 2011; Acharya and Merrouche, 2013; Acemoglu et al., 2015); and amplification mechanisms either within traditional banks or in the shadow banking system (Jobst, 2014; Greenwood et al., 2015).

The *"global approach"*, instead, considers a multi-channel approach to systemic risk providing several measures based on market data which can be gathered and freely computed in real time. In particular, the $\Delta CoVaR$ measure of Adrian and Brunnermeier (2016) and the Marginal Expected Shortfall (MES) of Acharya et al. (2017) are purely market-data-based measures. The SRISK of Brownlees and Engle (2016), aiming at capturing the (potential) undercapitalisation of an individual bank during a crisis affecting the whole financial system, combines market

and accounting data. These three measures are recognised as the most central metrics in the systemic risk literature (Bisias et al., 2012; De Bandt et al., 2013; Benoit et al., 2017; Abendschein and Grundke, 2018; Dičpinigaitienė and Novickytė, 2018; Grundke and Tuchscherer, 2019), and are employed in our empirical study.

Table 4 provides the definition and illustrates advantages and disadvantages of the systemic risk measures used in this paper.

Table 4: Δ*CoVaR*, MES, SRISK: Definition, Advantages, and Disadvantages.

N.	Indicator	Definition	Advantages	Disadvantages
1	**Δ*CoVaR* (Adrian and Brunnermeier, 2016)**	The Value at Risk of the financial system conditional on institutions being under distress. The Δ*CoVaR* of firm *i* is then defined as the difference between the VaR of the financial system conditional on this particular firm being in financial distress and the VaR of the financial system conditional on firm *i* being in its median state.	(i) Intuitive: it adopts a wide variety of data; (ii) Easy to implement with the possibility of frequent updates; (iii) As a near-coincident indicator, may also provide crucial warnings of an imminent crisis and compel authorities and systemic institutions to take action to mitigate the crisis.	(i) Depends on the choice of systemic state variables; the quantiles are estimate with linear regressions which may not accurately capture the underlying relationship; (ii) The proportionality coefficient between Δ*CoVaR* and VaR is firm-specific and implies that the most risky institutions (in terms of VaR) are not necessarily the most systemically risky ones (in terms of Δ*CoVaR*).
2	**MES (Acharya et al., 2017)**	The marginal contribution for a given banks to systemic risk which is defined as the amount the bank' equity drops below its target level set by regulators in case the banking sector is undercapitalized as a whole.	(i) Easy to implement with the possibility of frequent updates; (ii) As an ex ante indicator, it is useful to quantify the build-up of systemic risk for regulators.	(i) The systemic risk ranking of financial institutions based on MES is strictly equivalent to the ranking that would be produced by sorting them according to their betas; (ii) For a given financial institution, the time profile of its systemic risk measured by its MES may be different from the evolution of its systematic risk measured by its conditional beta.
3	**SRISK (Brownlees and Engle, 2016)**	The expected capital shortfall of a given financial institution, conditional on a crisis affecting the whole financial system. The SRISK extends the MES in order to take into account both the liabilities and the size of the financial institution.	(i) Possibility of frequent updates; (ii) As an ex ante indicator, it is useful to quantify the build-up of systemic risk for regulators.	(i) Accounting for market capitalization and liabilities in the definition of the systemic risk measure tends to increase the systemic risk score of large firms.

Source: Arsov et al. (2013) and Benoit et al. (2017).

3.1. Measuring systemic risk via CoVaR

While the Value at Risk (VaR) of an institution captures the risk of an individual entity in isolation, the CoVaR is an indicator of systemic risk that can be defined as the VaR of the financial system as a whole, conditional on another firm (or set of firms), exceeding its (their) firm specific VaR. VaR is defined as the threshold loss (in currency) that will not be exceeded at a given level of confidence. The $CoVaR_q^{system|C(X^i)}$ is the VaR of the financial system conditional on some event $C(X^i)$[2] at institution i and it is defined by the $q\%$ quantile of the conditional probability distribution:

$$Prob(X^{system|C(X^i)} \leq CoVaR_q^{system|C(X^i)}) = q\% \tag{1}$$

where X^i is the market-valued asset return of institution i, and X^{system} is the return of the portfolio, computed as the average of the X^is weighted by the lagged market value assets of the institutions in the portfolio. Adrian and Brunnermeier (2016) measure the contribution of each single institution to systemic risk by the Δ*CoVaR*, namely the difference between *CoVaR* conditional on the institution being in distress and *CoVaR* in the median state of the institution. Formally, the $\Delta CoVaR_q^i$, i.e. the contribution to systemic risk of institution i given the choice of quartile q, is defined as follows:

$$\Delta CoVaR_q^i = CoVaR_q^i - CoVaR_{50}^i = \hat{\beta}_q^i (VaR_q^i - VaR_{50}^i) \tag{2}$$

where q is always set to be 5%, so that $CoVaR^i$ identifies the system losses predicted on the 5% loss of institution i, while $\Delta CoVaR^i$ identifies the deterioration in losses at the system level, when the institution i moves from its median state to its 5% worst scenario. As far as the estimation method is concerned, quantile regressions (q) (Koenker and Bassett Jr, 1978) are employed to estimate the VaRs and CoVaRs (see Adrian and Brunnermeier, 2016). These measures are defined as time-varying, and in practice, in order to estimate the time-varying VaR_t and $CoVaR_t$, we include a set of state variables to capture the time variation in conditional moments of asset returns. We follow López-Espinosa et al. (2012) to take into account the peculiarities of the European institutional environment. The state

[2]Several definitions of $C(X^i)$ can be considered to define the distress of a financial institution. Adrian and Brunnermeir (2016) use a quantile regression approach, and consider a situation where the loss is equal to its VaR: $\Delta CoVaR_q^{system} = CoVaR_q^{system|X^i=VaR_q^i} - CoVaR_q^{system|X^i=VaR_{50}^i}$.

variables are as follows: *FTSE-volatility* is the weekly price of the FTSE 100 index as a volatility index; *Liquidity spread* is the liquidity spread calculated as the difference between the three month UK repo rate and the three month UK treasury bill; *T-Bill change* indicates the change in UK treasury bill three-month rate; *Y-Curve slope* represents the change in slope of the yield curve represented by the UK five-years minus the three-month rate; *Credit spread* indicates the change in credit spread represented by the difference between Baa corporate bonds and ten-year German government bonds; *Equity returns* indicates the weekly equity returns from the FTSE 100.

To obtain the time-varying VaR_t and $CoVaR_t$, we estimate the following quantile regressions on weekly data:

$$X_t^i = \alpha_q^i + \gamma_q^i \mathbf{M}_{t-1} + \varepsilon_{q,t}^i \tag{3a}$$

$$X_t^{system|i} = \alpha_q^{system|i} + \beta_q^{system|i} X_t^i + \gamma_q^{system|i} \mathbf{M}_{t-1} + \varepsilon_{q,t}^{system|i} \tag{3b}$$

where $\mathbf{M}_t$ includes the set of lagged state variables described above. We then use the predicted values from these regressions to obtain:

$$VaR_{q,t}^i = \hat{\alpha}_q^i + \hat{\gamma}_q^i \mathbf{M}_{t-1} \tag{4a}$$

$$CoVaR_{q,t}^i = \hat{\alpha}_q^{system|i} + \hat{\beta}_q^{system|i} VaR_{q,t}^i + \hat{\gamma}_q^{system|i} \mathbf{M}_{t-1} \tag{4b}$$

Table 5 provides summary statistics of the variables $\Delta CoVaR$, VaR, and CoVaR for the full sample and for the types of financial intermediaries considered in our sample. The frequency of $\Delta CoVaR$ is weekly and varies substantially across financial institutions and over time. In the Internet Appendix, we report the result of the quantile regression used to estimate our measures of systemic risk. The mean of $\Delta CoVaR$ equals -0.79%, which means that, on average, a distress at one institution is associated with an increase in the conditional VaR of the respective financial system by 0.79 weekly percentage points. Interestingly, the average $\Delta CoVaR$ is much higher for shadow entities, with an average of -1.2% (but up to -1.53% for MMFs), as compared to an average -0.17% for traditional banks. Note that $\Delta CoVaR_{i,t}$ is negative and therefore in all tables negative coefficients indicate increases in systemic risk, and vice versa. In the Internet Appendix, we report the correlation matrix between $\Delta CoVaR$ and the full set of state variables.

Table 5: Δ*CoVaR*, VaR, CoVaR: Summary statistics.

Type of Financial Intermediaries and Variables		Obs.	Mean	Min	Median	Max	Std. Dev
European Financial System	Δ*CoVaR* (%)	222,789	-0.79	-35.72	-0.46	8.94	1.29
	VaR (%)	222,789	-6.11	-127.54	-4.62	28.79	7.22
	CoVaR (%)	222,789	-6.32	-65.81	-6.03	3.69	2.89
Traditional Banks	Δ*CoVaR* (%)	89,818	-0.17	-15.13	-0.06	7.13	0.79
	VaR (%)	89,818	-9.00	-127.54	-7.34	19.21	7.85
	CoVaR (%)	89,818	-6.42	-56.49	-6.12	2.63	2.96
Shadow Banking Entities	Δ*CoVaR* (%)	132,971	-1.20	-35.72	-0.91	8.94	1.40
	VaR (%)	132,971	-4.15	-113.92	-1.92	28.79	6.02
	CoVaR (%)	132,971	-6.25	-65.81	-5.96	3.69	2.85
Money Market Funds	Δ*CoVaR* (%)	92,880	-1.53	-21.47	-1.33	8.94	1.45
	VaR (%)	92,880	-2.34	-113.92	-1.31	28.79	4.76
	CoVaR (%)	92,880	-6.19	-65.81	-5.90	3.69	2.84
Finance Services	Δ*CoVaR* (%)	40,091	-0.44	-35.72	-0.22	6.43	0.90
	VaR (%)	40,091	-8.36	-113.25	-6.74	10.92	6.52
	CoVaR (%)	40,091	-6.37	-55.82	-6.10	1.95	2.86

The table reports the number of observations (Obs.), mean, min, median and max values, and standard deviation (Std. Dev.), respectively, for the Δ*CoVar*, VaR and CoVaR in relation to the: a) European Financial System; b) traditional banks; c) shadow banking entities; d) Money Market Funds; e) Finance Services. The individual firm risk measures, VaR, are obtained by running 95%-quantile regressions of returns on the one-week lag of the market variables and by computing the predicted value of the regression. CoVaR is the predicted value from a 95%-quantile regression of the financial system equity losses on the institution equity losses and on the lagged state variables. Δ*CoVaR* is the difference between the CoVaR calculated from a 95%-quantile regression and the CoVaR calculated from a 50%-quantile regression. All quantities are expressed in units of weekly percent returns.

3.2. ΔCoVaR patterns in Europe

Figure 2 reports the mean of European financial intermediaries' Δ*CoVaR*, showing a significant trough during the financial crisis. The contribution to systemic risk by all financial intermediaries was low to non-existent until 2007 when the mean of Δ*CoVaR* increased dramatically. Systemic events, which occurred from September 2008 onwards (e.g., the Lehman bankruptcy and the rescue of the American International Group - AIG), show a relevant impact on the real economy. The distress of several financial institutions determined distress to the full financial system, which could not function normally. After the crisis, the average Δ*CoVaR* of financial intermediaries decreased again, showing that the average contribution of intermediaries to systemic risk was again limited. In addition, Figure 3 reports the Δ*CoVaR* for the traditional banks and the shadow banking system. The measure for the shadow entities is always lower over the whole period suggesting the presence of higher systemic risk.

Figure 2: Δ*CoVaR* - European Financial System.

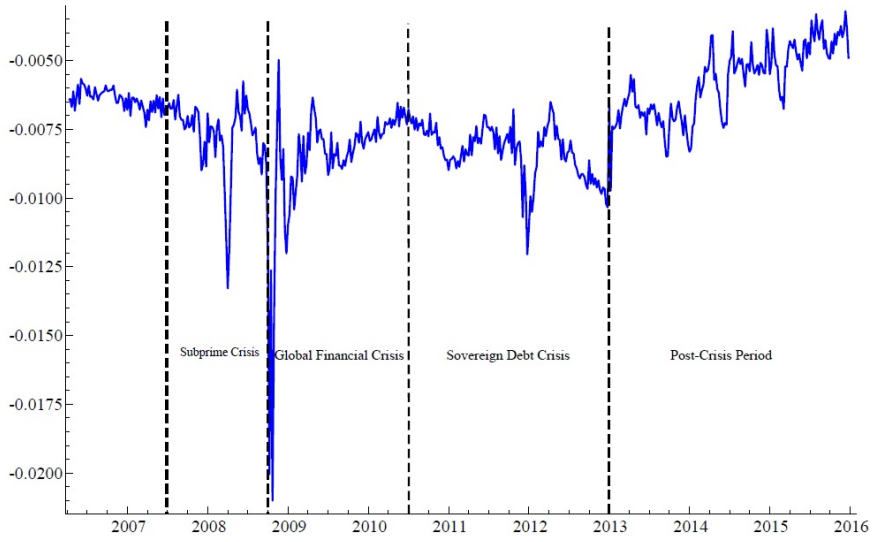


Figure 3: Δ*CoVaR* - Traditional Banks vs. Shadow Entities.

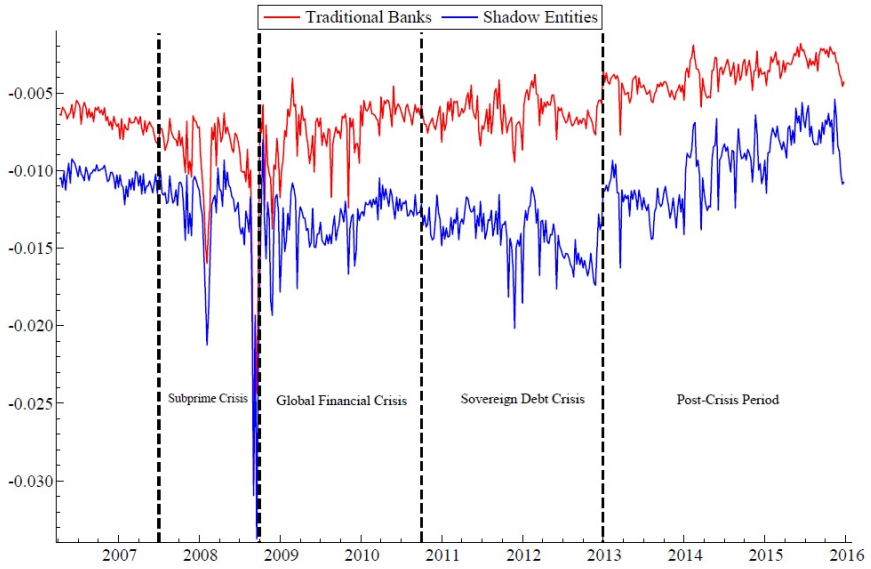
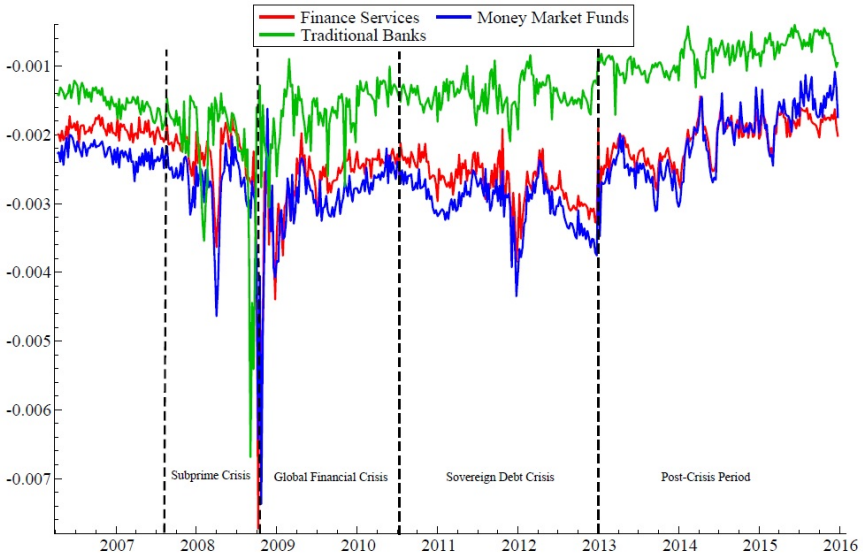


Figure 4 reports the values of Δ*CoVaR* calculated separately for MMFs, FSs and traditional banks. We observe how MMFs have contributed more to systemic risk than FSs. The worsening of financial stability during the third quarter of 2007 may be explained by the amount of loss incurred by MMFs: according to Lipper FMI (see Bengtsson, 2013), that loss amounted to EUR 29bln, representing 20.8% of total assets under management for investor redemptions. Moreover, in spring 2008, distress affected the MMFs. In particular, the interbank and wholesale funding markets dries up following the bail out of Bear Stearns by the Federal Reserve (Bengtsson, 2013). Although financial

market stress then decreased during summer 2008, due to monetary policy and a wide range of other central bank activities, problems with the two channels of funding subsequently returned with full force, culminating in the fallout of Lehman Brothers on 15^{th} September 2008, with the shock triggered in particular through credit and money markets. Following this event, the MMFs entered a deep freeze.

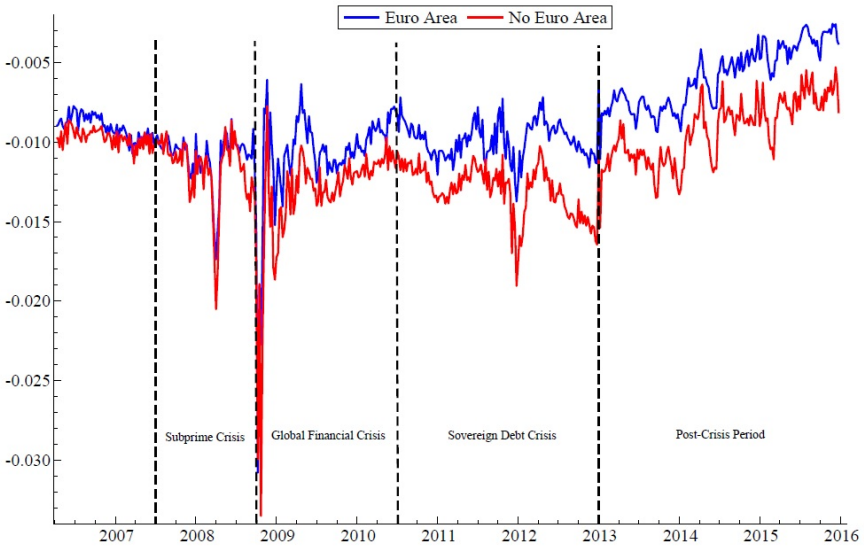
Figure 5 reports the $\Delta CoVaR$ for Euro and non-Euro countries. It is worth noticing that starting in 2013, the European Central Bank (ECB) implements a more aggressive combination of large-scale asset purchases, negative interest rates, and starts to target credit supply policies[3]. Figure 5 also shows that the $\Delta CoVaR$ measure decreases and systemic risk is damped down after such interventions. One possible explanation is that monetary easing during the crisis led to increasing stock prices, and investors considered that returns would be less volatile relative to the financial system (Wright, 2012; Rogers et al., 2014; Haitsma et al., 2016). In particular, Eksi et al. (2017) find that investors rebalance their portfolios towards equity after selling Treasury securities to the Fed during its large scale asset purchases.

Figure 4: $\Delta CoVaR$ - Traditional Banks, Money Market Funds and Finance Services.



[3]In June 2014, the ECB announced the first Targeted Long-Term Refinancing Operations (TLTROs), and, on 22^{nd} January 2015, the Governing Council decided that asset purchases should be expanded to include a secondary markets public sector asset purchase program. In addition, on 24^{th} April 2013, the Bank of England (BoE) and the HM Treasury, complementary to Quantitative Easing, extended the funding for lending scheme in order to increase incentive both for banks and for non-banking providers of credit to expand their lending to households and private non-financial corporates, by providing funds at cheaper rates. Moreover, in response to mounting pressures in bank funding markets and to alleviate dollar-based liquidity issues caused in large part by MMFs unwillingness to roll over their bank commercial paper and other short-term liabilities, the Fed provided dollar liquidity swap line with ECB, Swiss National Bank and BoE.

Figure 5: Δ*CoVaR* - European Financial System: Euro and No Euro areas.



We also conduct a comparison among failed, not failed, and rescued banks[4]. Figure 6 shows the Δ*CoVaR* of each bank classification. The major contribution to systemic risk comes from failed banks (the red line associated with the failed banks is nearly flat after 2013 because, being insolvent, they do not have share prices), as opposed to rescued banks (blue line). The "not failed" banks (green line) contribute even more to systemic risk than the other two groups, and continued to weigh on the financial system even in the post crisis period.

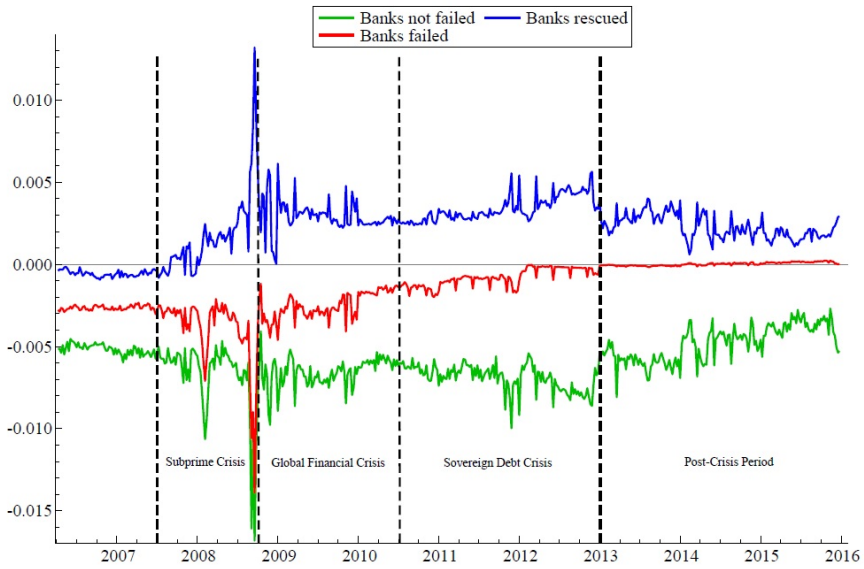
The smaller contribution to systemic risk from the rescued banks is emphasised during the time period spanning from 2008 to the end of 2009, when European governments intervene to prevent the near-collapse of several large banks (e.g., Northern Rock in February 2008, Anglo Irish in September 2008, Lloyds and Royal Bank of Scotland in October 2008).

3.3. Accounting and financial variables as determinants of ΔCoVaR

Following Adrian and Brunnermeier (2016) and López-Espinosa et al. (2012), we collect the following accounting and financial variables: $Size_{i,t-1}$ is the total assets of financial institution i at quarter (*t-1*); $Leverage_{i,t-1}$ is the total assets to equity ratio of financial institution i at quarter (*t-1*). This ratio is a proxy for the level of solvency of a financial institution; $MTBV_{i,t-1}$ is the *Market To Book Value* ratio of financial institution i at quarter (*t-1*). This ratio

[4] A bank is failed when it is unable to meet its obligations to depositors and other creditors. Not failed banks are either those rescued or operating without any intervention by the supervisor. Rescued banks are those subject to a number of interventions such as recapitalization, guarantees, nationalization, state liquidity scheme, nationalized and liquidated, in administration. European governments bailed-out several traditional banks and our sample includes several of them. Namely, Dexia required three bailouts totalling more than EUR 15bln from France, Belgium and Luxembourg; KBC Group received EUR 7bln in 2008 and 2009, half from the Belgian state, the rest from the northern region of Flanders; Commerzbank, the German's second-largest bank, required EUR 18.2bln; Greece pumped EUR 25bln into its banks and, thus owning at the end of the financial crisis, 66% of Alpha Bank, 35% of Eurobank and 67% of Piraeus Bank; in Ireland, EUR 4.8bln were pumped into the Bank of Ireland and EUR 20.7bln into Allied Irish Banks; the Dutch government paid more than EUR 40 bln to rescue the domestic banking sector, nationalising ABN Amro; in Portugal, Millennium BCP received EUR 3bln, BPI EUR 1.3bln, the smaller bank BANIF EUR 400bln and Caixa Geral de Depositor EUR 1.65bln; Bankia, Spain's fourth-biggest lender, needed EUR 22.4bln in bailout funds; finally, the total amount pumped in the UK banking sector was 66 billion pounds in 2008 (£ 20.5bln into Lloyds, £ 45.8 bln into Royal Bank of Scotland and nationalised Northern Rock).

Figure 6: ΔCoVaR - Failed, Not Failed and Rescued European Traditional Banks.



captures both opportunities for growth and systemic risk due to potential asset pricing misalignments; $STL_{i,t-1}$ is the *Short-Term Liability* ratio which captures the relative level of short-term wholesale funding, as the total short-term debt minus cash to total liabilities ratio of financial institution i at quarter (*t-1*). Short-term debt includes repo, bank overdrafts, short-term debt and borrowing, the short-term portion of long-term borrowing due to other banks (including to the central bank) or any other financial institutions, discounted bills, call money, purchased federal funds, and securities sold but where the proceeds from the sale have not yet been received. If a lot of large relevant firms have a similar (high) STL ratio, a "shock" event might give rise to joint fire sales of their assets (enabling them to generate cash when short-term liabilities cannot be rolled over), and this would generate systemic risk. In addition, according to, for instance, López-Espinosa et al. (2012) the STL ratio can be a proxy of interconnectedness (see FSB (2020, p. 45) for more details); $Beta_{i,t-1}$ is the equity market beta for financial institution i at quarter (*t-1*), calculated as the ratio between the covariance of the equity security on the market and the variance in the market; $ERV_{i,t-1}$, is the Equity Returns Volatility, calculated as the standard deviation of the daily equity returns for financial institution i at quarter (*t-1*).

Table 6 provides summary statistics for the accounting and financial variables. First, we compare accounting and financial variables between traditional banks and shadow banking entities. Size and leverage are larger for traditional banks than for shadow banking entities. In particular, on average, leverage is roughly five times larger for traditional banks though, when we consider FSs only, the ratio is around two times larger. The median value of leverage for traditional banks is 13.343, while for the whole sample of shadow banking entities it is 1.167. In relation to *MTBV*, the average value is around 1.217 for all entities, while the median value is less than one, respectively at 0.875 for traditional banks and 0.914 for the whole sample of shadow banking entities, though the FSs show a value slightly greater than one. If we focus on the *STL* ratio, there is evidence of a relevant difference between all entities. For traditional banks the average value is 0.115, while among shadow banking entities the mean values are -3.168 for FSs and -4.558 for MMFs, respectively.

Table 7 reports the correlation matrix between the variables. The correlations do not show any extremely high value. The possibility of multicollinearity among the explanatory variables is also tested using the Variance Inflation Factors (VIFs). The maximum VIF that results from any of the models is 2.53, which is far below the generally employed cut-off of 10, and the average value of the model is not considerably larger than 1 (Chatterjee and Hadi, 2015). The average value is below 2 in all models. Therefore, the results show that multicollinearity is a moderate

Table 6: Accounting and Financial Variables: Summary Statistics.

Type of financial intermediaries and variables		Obs.	Mean	Median	Min	Max	Std. Dev
European Financial System	Size (ln)	18,088	11.350	12.530	0.000	21.771	6.138
	Leverage	13,751	8.827	4.056	1.001	78.587	11.498
	MTBV	14,712	1.217	0.909	-3.973	12.896	1.301
	Short-Term Liability ratio	14,172	-2.105	0.016	-60.903	0.893	8.960
	Beta	14,593	0.634	0.578	-5.930	6.324	0.969
	ERV	14,727	2.50	1.60	0.000	32.00	3.60
Traditional Banks	Size (ln)	8,132	13.805	15.497	0.000	21.771	6.314
	Leverage	6,073	16.194	13.343	1.331	78.587	12.023
	MTBV	6,963	1.133	0.875	-3.973	7.062	1.322
	Short-Term Liability ratio	6,667	0.115	0.104	-1.286	0.741	0.253
	Beta	7,021	0.721	0.676	-5.930	6.324	1.312
	ERV	6,843	2.90	2.00	0.000	27.80	3.70
Shadow Banking Entities	Size (ln)	9,956	9.345	11.194	0.000	18.143	5.192
	Leverage	7,678	2.999	1.167	1.001	72.275	6.749
	MTBV	7,749	1.292	0.914	0.010	12.896	1.276
	Short-Term Liability ratio	7,505	-4.077	-0.199	-60.903	0.893	11.971
	Beta	7,572	0.553	0.537	-0.622	2.087	0.446
	ERV	7,884	2.22	1.30	0.000	32.00	3.50
Money Market Funds	Size (ln)	6,954	8.619	11.134	0.000	16.484	5.502
	Leverage	4,963	1.540	1.112	1.001	15.753	1.760
	MTBV	5,024	1.082	0.900	0.109	5.870	0.819
	Short-Term Liability ratio	4,910	-4.558	-0.261	-60.903	0.893	12.717
	Beta	4,902	0.565	0.579	-0.181	1.651	0.376
	ERV	5,061	1.40	1.20	0.10	6.30	0.90
Finance Services	Size (ln)	3,002	11.026	11.339	0.000	18.143	3.905
	Leverage	2,715	5.667	1.890	1.002	72.275	10.591
	MTBV	2,725	1.680	1.150	0.010	12.896	1.779
	Short-Term Liability ratio	2,595	-3.168	-0.128	-55.587	0.715	10.355
	Beta	2,670	0.529	0.458	-0.622	2.087	0.551
	ERV	2,823	3.60	1.70	0.000	32.00	5.40

The table reports the number of observations (Obs.), mean, median, min and max values, and standard deviation (Std. Dev.), respectively, of accounting and financial variables, in relation to the European Financial System split up into traditional banks, Money Market Funds, and Finance Services, calculated over the full period 2006:1-2015:4. *Size* is the natural logarithm of total assets; *Leverage* is the total assets to equity ratio; *MTBV* is the Market To Book Value ratio; *Short-Term Liability* ratio captures the relative level of short-term wholesale funding as the total short-term debt minus cash to total liabilities ratio; *Beta* is the equity market beta, calculated as the ratio between the covariance of the equity security on the market and the variance in the market; *ERV* is the Equity Returns Volatility, calculated as the standard deviation of the daily equity returns for financial institution.

concern. In the Internet Appendix, we report the correlation matrix between each of two alternative measures of systemic risk (*MES* and *SRISK*) and the full set of accounting and financial variables.

4. Empirical Results

In this section, we report the results of our regression analysis where the systemic risk measure $\Delta CoVaR$ is estimated as a function of accounting and financial variables. In order to match the time frequency of the corporate variables that are only available quarterly, the weekly estimates of $\Delta CoVaR$ are aggregated (summed) by quarter (as in

Table 7: Accounting and Financial Variables: Correlation Matrix. Dependent variable: $\Delta CoVaR$.

Correlation Matrix	Δ***CoVaR***	$\Delta CoVaR_{t-1}$	$VaR\ 95_{t-1}$	$Size_{t-1}$	$Leverage_{t-1}$	$MTBV_{t-1}$	STL_{t-1}	$Beta_{t-1}$	ERV_{t-1}
Δ***CoVaR***	1								
$\Delta CoVaR_{t-1}$	0.9651*	1							
$VaR\ 95_{t-1}$	-0.3446*	-0.3421*	1						
$Size_{t-1}$	0.2289*	0.2498*	-0.2104*	1					
$Leverage_{t-1}$	0.3797*	0.3781*	-0.3407*	0.6474*	1				
$MTBV_{t-1}$	0.1393*	0.1392*	-0.0075	0.0470*	0.0811*	1			
STL_{t-1}	0.0968*	0.0941*	-0.0816*	0.2279*	0.1704*	0.0762*	1		
$Beta_{t-1}$	0.1238*	0.1228*	-0.0831*	0.2943*	0.2256*	-0.0406*	0.0523*	1	
ERV_{t-1}	0.1588*	0.1546*	-0.2204*	0.0669*	0.2838*	0.0328*	0.0836*	0.1512*	1
VIF	**1.51**	**1.43**	**1.37**	**2.53**	**2.05**	**1.04**	**1.09**	**1.38**	**1.19**

The table reports the correlations among variables from 2006:1 to 2015:4. $Size_{t-1}$ is the total assets at quarter (*t-1*); $Leverage_{t-1}$ is the total assets to equity ratio at quarter (*t-1*); $MTBV_{t-1}$ is the Market To Book Value ratio at quarter (*t-1*); STL_{t-1} is the Short-Term Liability ratio which captures the relative level of short-term wholesale funding as the total short-term debt minus cash to total liabilities ratio at quarter (*t-1*); $Beta_{t-1}$ is the equity market beta at quarter (*t-1*), calculated as the ratio between the covariance of the equity security on the market and the variance in the market; ERV_{t-1} is the Equity Returns Volatility, calculated as the standard deviation of the daily equity returns at quarter (*t-1*). VIF is the Variance Inflation Factor and is used to detect collinearity of the regressors. * denotes the statistical significance at 5% level.

López-Espinosa et al. 2012; Adrian and Brunnermeier, 2016). Our general unrestricted regression model with fixed effects is:

$$\begin{aligned}\Delta CoVaR_{i,t} =& \beta_0 + \beta_1 \Delta CoVaR_{i,t-1} + \beta_2 VaR_{i,t-1} + \beta_3 Size_{i,t-1} + \beta_4 Leverage_{i,t-1} + \\ &+ \beta_5 MTBV_{i,t-1} + \beta_6 STL_{i,t-1} + \beta_7 Beta_{i,t-1} + \beta_8 ERV_{i,t-1} + \\ &+ \sum_{i=1}^{476} Financial\ Intermediaries_i + [\sum_{t=2006:1}^{2015:4} Time_t] or [\sum_{t=1}^{4} Regimes_t] + \varepsilon_{i,t}\end{aligned} \tag{5}$$

where *Financial Intermediaries* is a set of dummies capturing fixed effects for each institution (traditional vs shadow bank); *Time* is a set of time dummies capturing fixed effects for each quarter; *Regimes* is a set of four dummy variables (replacing *Time* in some specifications), capturing fixed effects for the five sub-periods identified in our analysis, namely the Subprime Crisis over the period 2007:3-2008:3 (*Regime 1*), the European Great Financial Depression over the period 2008:4-2010:2 (*Regime 2*), the Sovereign Debt Crisis over the period 2010:3-2012:4 (*Regime 3*), and the Post Crisis Period over 2013:1-2015:4 (*Regime 4*), with the Pre Crisis as our reference case. In each of the tables below, we report the results of the following specifications: [i] represents the benchmark specification using accounting and financial variables and time dummies; [ii] includes accounting and financial variables and replaces time dummies with the four regimes; and [iii] includes accounting and financial variables, time dummies and the interaction of explanatory variables with the four regime dummies[5].

Moreover, we identify the marginal effect of each variable for shadow entities with respect to traditional banks. Therefore, first we repeat our analysis by controlling the sample for traditional banks and shadow entities; second, we disentangle the marginal effects for MMFs and FSs. Therefore, we introduce a dummy for shadow entities, which we interact with all accounting and financial variables. As further step, this dummy is split into MMFs (a dummy variable equal to 1 for MMFs, and 0 elsewhere) and FSs (a dummy variable equal to 1 for FSs and 0 elsewhere). Given that our estimate of $\Delta CoVaR$ refers to the whole financial system, comprising traditional banks and shadow entities, disentangling the effects of shadow entities from the effects of traditional banks allows us to identify the marginal impact of each group on the change in systemic risk, when the impact of the other (one or two) group(s) is taken as the reference case.

[5]Specification [iii] includes six accounting and finance variables, the lagged $\Delta CoVaR$, the lagged VaR, the dummies for each of the four regimes, and a constant, plus interactions of the accounting and finance variable with each regime.

4.1. Systemic risk of the entire European financial system

Table 8 reports the results considering the full sample of the 476 financial institutions, both traditional banks and shadow entities. It is worth noticing that a decline (increase) in the $\Delta CoVaR$ represents an increase (decrease) in systemic risk, and that the negative coefficients in all tables indicate increases of systemic risk, and viceversa.

As far as specifications [ii] and [iii] are concerned, there is clear evidence that *Size* is significantly associated with systemic risk, confirming the results in López-Espinosa et al. (2012), Adrian and Brunnermeier (2016), and Bostandzic and Weiß (2018). Our results suggest that an increase in log asset size of one standard deviation (6.138 in Table 6 for the entire financial system) and the coefficient in specification [iii] of -0.0027 implies a 1.66 basis points decrease in the $\Delta CoVaR$ or (equivalently) an increase in systemic risk. In addition, for specification [ii], the negative and statistically significant coefficients associated with the dummy variables for three financial regimes clearly indicate the increased financial instability in the European financial system during the three crisis periods. However, in specification [iii], when we interact the four dummies with the *Size* variable, the coefficient associated with each regime becomes positive and statistically significant.

Next, we focus on the relation between *Leverage* and systemic risk. In specifications [i], [ii], and [iii], we can see that systemic risk decreases in the leverage. The first possible explanation is related to the leverage cycle. According to Fostel and Geanakoplos (2008), leverage falls during stressed market situations and builds up prior to a financial crisis. We note that leverage levels were 8.6%, 8.7%, 8.4% during the three regimes characterized by the financial crisis but rocketed to an average of 10% in the final regime (*Post Crisis*), which could be considered a new upswing in the leverage cycle. In addition, we also note that the leverage of shadow entities is lower relative to traditional banks. From Table 6, traditional banks have on average nearly 5.4 times the leverage of the shadow banking entities.

The coefficient of *Beta* is negative and statistically significant in specification [iii]. However, when we control for the four regimes, the *Beta* coefficient becomes positive and statistically significant during the first and third crises. In accordance with Sarin and Summers (2016), the *Beta* coefficient helps us to understand how bank risk has evolved over time in relation to the effects of regulatory changes implemented during and in the aftermath of the crisis.

4.2. Systemic risk and shadow banking, and MMFs and FSs separately

Table 9 reports the results of the regressions for shadow entities. Specification [i] reports the coefficients for the full sample and the marginal effects from the shadow banks as a whole, while specifications [ii] and [iii] report the marginal effects from MMFs and FSs, respectively.

4.2.1. Shadow banking

With respect to specification [i], there is clear evidence that the larger the shadow entities are, the higher is their contribution to systemic risk. Our results suggest that an increase in log asset size of one standard deviation (5.192 in Table 6 for the shadow banking entities) and the coefficient in specification [i] of -0.0049 would imply a 2.54 basis points decrease in the $\Delta CoVaR$ in a quarter or (equivalently) an increase in systemic risk. This result reflects the capacity of the shadow banking system to operate on a large scale. According to the IMF GFSR (2014), shadow banking tends to flourish in presence of tight bank regulations, large amounts of liquidity, low real interest rates and yield spreads, and investors who are looking for higher returns, and when there is a considerable demand for assets coming from insurance companies and pension funds.

We find that traditional banks' *MTBV* ratio contributes more to systemic risk relative to shadow entities. One possible explanation is that to counter funding and capital-related pressures[6], banks may be expected to reduce assets in order to improve their capital or liquidity positions, or both. These measures are, in general, comparatively costly and difficult to implement within a short time span, especially in periods of distress, causing asset pricing misalignments and thus increasing systemic risk (European Central Bank, 2012).

Regarding *STL* ratio, we find that it is a reliable balance sheet determinant of traditional banks' contribution to systemic risk. Banks, with their excessive *STL* ratio, are more interconnected with other financial intermediaries holding the same asset classes. This feature can increase the vulnerability not only of the interbank markets, but

[6]From regulators and supervisors such as the Basel III framework (the global systemically important banks), and the European Banking Authority (EU-wide stress tests and recent recapitalization exercise).

Table 8: Determinants of Systemic Risk - Baseline Model and Marginal Effects for the European Financial System.

Dependent Variable: $\Delta CoVaR$	**[i]**	**[ii]**	**[iii]**	**Marginal effects**			
				Regime 1	**Regime 2**	**Regime 3**	**Regime 4**
$\Delta CoVaR_{t-1}$	0.7072***	0.7002***	0.6944***	0.0336**	-0.0458	0.0300	-0.1054***
	(0.0141)	(0.0145)	(0.0350)	(0.0144)	(0.0307)	(0.0261)	(0.0262)
$VaR95_{t-1}$	0.0002	-0.0011	0.0139***	-0.0016	-0.0167***	-0.0116***	-0.0131***
	(0.0012)	(0.0012)	(0.0034)	(0.0025)	(0.0039)	(0.0035)	(0.0035)
$Size_{t-1}$	0.0002	-0.0012*	-0.0027***	0.0007*	0.0017**	0.0011**	0.0018***
	(0.0006)	(0.0006)	(0.0008)	(0.0004)	(0.0008)	(0.0006)	(0.0005)
$Leverage_{t-1}$	0.0001**	0.0002**	0.0002**	0.0000	0.0000	0.0000	0.0000
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
$MTBV_{t-1}$	0.0005	-0.0004	0.0004	-0.0001	0.0000	0.0000	-0.0008
	(0.0005)	(0.0005)	(0.0006)	(0.0005)	(0.0001)	(0.0001)	(0.0008)
STL_{t-1}	0.0001	0.0001	0.0001	-0.0001	-0.0001	0.0000	-0.0001
	(0.0001)	(0.0001)	(0.0002)	(0.0001)	(0.0002)	(0.0002)	(0.0002)
$Beta_{t-1}$	0.0011	0.001	-0.0049**	0.0058***	0.004	0.0074**	0.0031
	(0.0009)	(0.0009)	(0.0022)	(0.0016)	(0.0034)	(0.0024)	(0.0023)
ERV_{t-1}	0.0045	0.0174	0.0193	0.0088	-0.0039	-0.0116	-0.0270
	(0.0183)	(0.0188)	(0.0225)	(0.0311)	(0.0031)	(0.0086)	(0.0456)
Regime 1		-0.0050***	-0.0140**				
		(0.0010)	(0.0058)				
Regime 2		-0.0073**	-0.0498***				
		(0.0025)	(0.0124)				
Regime 3		-0.0103***	-0.0326***				
		(0.0021)	(0.0093)				
Regime 4		-0.0038**	-0.0393***				
		(0.0019)	(0.0088)				
Constant	-0.0286***	-0.0098	0.0226*				
	(0.0082)	(0.0091)	(0.0123)				
Time Dummies	YES	NO	NO				
Crisis Dummies	NO	YES	YES				
Fixed effects	YES	YES	YES				
N. Obs.	12,930	12,930	12,511				
R^2 *Adjusted*	0.50	0.49	0.49				

The table reports regressions using alternative specifications. The dependent variable is $\Delta CoVaR$. $Size_{i,t-1}$ is the total assets of financial institution i at quarter (*t-1*); $Leverage_{i,t-1}$ is the total assets to equity ratio of financial institution i at quarter (*t-1*); $MTBV_{i,t-1}$ is the Market To Book Value ratio of financial institution i at quarter (*t-1*); $STL_{i,t-1}$ is the Short-Term Liability ratio which captures the relative level of short-term wholesale funding as the total short-term debt minus cash to total liabilities ratio of financial institution i at quarter (*t-1*); $Beta_{i,t-1}$ is the equity market beta for financial institution i at quarter (*t-1*), calculated as the ratio between the covariance of the equity security on the market and the variance in the market; $ERV_{i,t-1}$, is the Equity Returns Volatility, calculated as the standard deviation of the daily equity returns for financial institution i at quarter (*t-1*). *Regime 1* captures the Subprime Crisis over the period 2007:3-2008:3; *Regime 2* captures the European Great Financial Depression over the period 2008:4-2010:2; *Regime 3* captures the Sovereign Debt Crisis over the period 2010:3-2012:4; *Regime 4* captures the Post Crisis Period over 2013:1-2015:4. [i] is the benchmark specification using accounting and financial variables and time dummies. [ii] includes accounting and financial variables and replaces time dummies with the four regimes. [iii] includes accounting and financial variables, time dummies and the interaction of explanatory variables with the four regime dummies. Standard errors are reported in parentheses.
Sample period: 2006:1-2015:4. *, **, *** denote the 10%, 5% and 1% significance level, respectively.

eventually of the entire financial system. For shadow entities, instead, we find that an increase in the *STL* ratio of one standard deviation (11.971 in Table 6 for the Shadow Banking Entities) and the coefficient in specification [i] of 0.0054 leads to a 6.46 basis points increase in $\Delta CoVaR$ in a quarter or (equivalently) a decrease in systemic risk. This result reflects the moderate role of shadow entities in engaging in liquidity transformation activities. In contrast, traditional banks, being heavily dependent on short-term borrowing, contribute decisively to higher systemic risk. During a crisis, the interbank market usually dries up and short-term borrowing decreases. Moreover, some components of long-term debt may increase, in particular positions in long-term debt interest rate swaps which appear as liabilities typically increase. Similar results have been found in Lopez-Espinosa et al. (2012), Adrian and Brunnermeier (2016), and Acharya et al. (2017). According to Raddatz (2010) and Beltratti and Stulz (2012), banks with a high dependence on wholesale funding are more fragile and experience strong decreases in their share price and volatility during a financial crisis.

4.2.2. MMFs and FSs.

Specifications [ii] and [iii] in Table 9 present the results considering MMFs and FSs separately. The new evidence relies on the role played by the size of MMFs. We estimate that an increase in MMFs' size of one standard deviation (5.502 in Table 6 for the Money Market Funds) and the coefficient in specification [ii] of -0.0057 would imply a 3.14 decrease in $\Delta CoVaR$ and thus an increase in systemic risk. Collectively, many small MMFs added together, not individual ones with large amounts of assets, increase systemic risk. Moreover, the importance of growth in MMFs' size also depends on the growth of institutional investors such as insurance companies and pension funds, which possibly reflects the demand for these shadow banking services (IMF, 2014). As far as FSs are concerned, there is no evidence of any impact of size on systemic risk.

The coefficient of the *Leverage* variable is positive and statistically significant, confirming that shadow entities decrease systemic risk relative to traditional banks. The low level of debt characterizing shadow entities mainly applies to MMFs' (see Table 6: FSs have on average nearly 3.7 times the leverage of MMFs). FSs, instead, in trading securities on their own account or on behalf of customers, are usually more highly leveraged than MMFs through the use of short-term secured lending arrangements (e.g., repos).

We find that the *STL* ratio is never significant at any of the standard confidence levels when we consider MMFs and FSs separately, implying that this variable does not give additional information, although MMFs' main risk is a "*run*" risk (i.e., from redemptions). One possible explanation is that immediate redemptions are considered to be mainly relevant for MMFs with Constant Net Asset Value (CNAV) relative to MMFs with Variable Net Asset Value (VNAV). See for example: Baba et al. (2009), Gorton et al. (2010), McCabe (2010), FSB (2011), ESRB (2012), and ESRB (2019). A detailed description of CNAV and VNAV for MMFs is reported in the Internet Appendix. In this paper, we only use MMFs with VNAV. The *MTBV* ratio of MMFs reflects how their are vulnerable to investor runs in conditions of financial distress, which may eventually increase the vulnerability of the whole financial system. In particular, one possible explanation is that MMFs with VNAV may reduce the specific risks associated with a CNAV and the effects of a credit event (ESRB, 2019). An MMF with a VNAV model may reduce the shareholder's incentive to run when a money market fund has experienced a modest loss; and may also provide price transparency to investors by improving their understanding of the risks relative to these funds and their difference compared to bank deposits. In this case, it may therefore change investor expectations, whereby MMFs are viewed as less vulnerable to losses and the potential for a run is reduced, when a fund lives up to those expectations. Even small losses may cause a run on an MMF which could spill over to other MMFs. The "*first-mover advantage*", created by using amortized cost accounting, may be reduced by forcing shareholders to redeem at a NAV that reflects current losses, thus reducing the transfer of losses to the remaining shareholders. Another explanation is based on the fluctuations that occurred during the summer of 2011 in the value of European VNAV MMFs, reflecting changing market conditions and increased volatility. According to ESRB (2019), despite these fluctuations, there was little impact on redemptions and thus on the financial system, which suggests that investors accept temporary variations (including negative ones) in the NAV of their funds.

FSs, instead, are more sensitive to *MTBV*. A possible explanation may be found in the composition of their balance sheets, which consist largely of risky assets, while a substantial portion of the liability side consists of short-term and collateralised borrowing. Increases in leverage may correspond to increases in risk-taking. Thus, one would expect more volatility, a higher probability of a major stock price decline, riskier debt, higher yields on preferred stock, and higher expected returns on common stock.

Regarding FSs, we also look at their *Beta* which helps us understand how their contribution to systemic risk has evolved. In particular, credits provided by FSs are often securitized, with demand depending on credit risk and yields offered. Thus, they may be subject to rollover risk in the form of early amortization triggers, which may be particularly acute during periods of market stress, when collateral values fall and haircuts increase on counterparty risk concerns. Finally, we also find that FSs are more sensitive to *ERV*, which may eventually increase the vulnerability of the whole financial system. According to our estimates in specification [iii], an increase in *ERV* of one standard deviation (5.4 in Table 6 for the FSs) would imply a 55.24 basis points decrease in $\Delta CoVaR$ and thus an increase in systemic risk at the 1-quarter horizon.

Table 9: Determinants of Systemic Risk - Baseline Model and Marginal Effects for MMFs and FSs.

Dependent Variable: $\Delta CoVaR$	**Marginal effects for Shadow Banks [i]**		**Marginal effects for MMFs [ii]**		**Marginal effects for FSs [iii]**	
$\Delta CoVaR_{t-1}$	0.6462***	0.0565**	0.6575***	0.0544*	0.7047***	-0.0501
	(0.0143)	(0.0216)	(0.0287)	(0.0315)	(0.0132)	(0.0588)
$VaR95_{t-1}$	-0.0002	0.0010	-0.0017	0.0053	-0.0008	0.0014
	(0.0008)	(0.0014)	(0.0011)	(0.0037)	(0.0016)	(0.0021)
$Size_{t-1}$	0.0011	-0.0049***	-0.0001	-0.0057**	-0.0013	-0.0005
	(0.0008)	(0.0014)	(0.0009)	(0.0023)	(0.0008)	(0.0015)
$Leverage_{t-1}$	0.0001	0.0002**	0.0002**	0.0003	0.0002**	0.0001
	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0001)	(0.0002)
$MTBV_{t-1}$	-0.0027***	0.0034***	-0.0014**	0.0027*	-0.0003	-0.0000***
	(0.0008)	(0.0009)	(0.0006)	(0.0015)	(0.0005)	(0.0000)
STL_{t-1}	-0.0053*	0.0054*	0.0004	-0.0003	0.0000	0.0004
	(0.0029)	(0.0029)	(0.0003)	(0.0003)	(0.0001)	(0.0003)
$Beta_{t-1}$	0.0016*	-0.0026	0.0006	0.0015	0.0018	-0.0049**
	(0.0009)	(0.0018)	(0.0009)	(0.0033)	(0.0011)	(0.0021)
ERV_{t-1}	0.0765**	-0.0872**	0.0049	0.0909	0.0726**	-0.1023**
	(0.0302)	(0.0390)	(0.0193)	(0.0726)	(0.0312)	(0.0372)
Regime 1	-0.0053***		-0.0048***		-0.0050***	
	(0.0011)		(0.0010)		(0.0010)	
Regime 2	-0.0082**		-0.0080**		-0.0077**	
	(0.0025)		(0.0024)		(0.0025)	
Regime 3	-0.0115***		-0.0104***		-0.0104***	
	(0.0022)		(0.0021)		(0.0021)	
Regime 4	-0.0071***		-0.0051**		-0.0042**	
	(0.0019)		(0.0020)		(0.0018)	
Constant	-0.0071		-0.0007		-0.0083	
	(0.0105)		(0.0120)		(0.0107)	
Time Dummies	NO		NO		NO	
Crisis Dummies	YES		YES		YES	
Fixed effects	YES		YES		YES	
N. Obs.	12,874		12,925		12,925	
R^2 *Adjusted*	0.5071		0.4945		0.4937	

The table reports regressions using alternative specifications. The dependent variable is $\Delta CoVaR$. $Size_{i,t-1}$ is the total assets of financial institution i at quarter (*t-1*); $Leverage_{i,t-1}$ is the total assets to equity ratio of financial institution i at quarter (*t-1*); $MTBV_{i,t-1}$ is the Market To Book Value ratio of financial institution i at quarter (*t-1*); $STL_{i,t-1}$ is the Short-Term Liability ratio which captures the relative level of short-term wholesale funding as the total short-term debt minus cash to total liabilities ratio of financial institution i at quarter (*t-1*); $Beta_{i,t-1}$ is the equity market beta for financial institution i at quarter (*t-1*), calculated as the ratio between the covariance of the equity security on the market and the variance in the market; $ERV_{i,t-1}$, is the Equity Returns Volatility, calculated as the standard deviation of the daily equity returns for financial institution i at quarter (*t-1*). *Regime 1* captures the Subprime Crisis over the period 2007:3-2008:3; *Regime 2* captures the European Great Financial Depression over the period 2008:4-2010:2; *Regime 3* captures the Sovereign Debt Crisis over the period 2010:3-2012:4; *Regime 4* captures the Post Crisis Period over 2013:1-2015:4. Specification [i] refers to the marginal effects for the all shadow banking system; [ii] is the benchmark specification for MMFs; [iii] is the benchmark specification for FSs. Standard errors are reported in parentheses. Sample period: 2006:1-2015:4. *, **, *** denote the 10%, 5% and 1% significance level, respectively.

5. Conclusions

In this paper, we studied the role of both traditional banks and shadow entities (MMFs and FSs) in systemic risk in Europe. We conducted an extensive empirical analysis where $\Delta CoVaR$ is estimated as a function of accounting and financial variables. We used a dataset of 476 listed financial institutions consisting of 214 traditional banks and 261 shadow entities (183 MMFs and 79 FSs), over the period 2006:1-2015:4. We found that systemic risk increased significantly in the size of large financial institutions, in particular of large MMFs, while it was insensitive to the size of FSs. FSs, instead, were more sensitive to proxies for market risk, *MTBV*, *Beta* and *ERV*. In addition, systemic risk increases in the *Leverage* of traditional banks, while decreases for shadow entities. We also found that *STL* ratio is an important balance sheet determinant of increased systemic risk for traditional banks, while the use of short-term liabilities by MMFs and FSs mitigated systemic risk. Our results also confirmed an increase in systemic risk in the European financial system during crisis periods in particular in the sovereign debt crisis.

Our results are robust to several sensitivity checks, as we report in the Internet Appendix, involving alternative measures of systemic risks, such as *MES* and *SRISK*; the implementation of the Romano and Wolf (2005) adjusted p-values to evaluate the relevance of the regressors using alternative measures of systemic risks; the elimination from our dataset of both failed and rescued financial intermediaries and financial intermediaries belonging to PIIGS countries; and, finally, controlling for endogeneity of regressors via the implementation of the GMM estimation method.

The main findings in this paper have a number of policy implications and give rise to suggestions for further

research. First, our paper highlights that size plays a crucial role in systemic risk and hence confirms the too-big-to-fail hypothesis, a long-standing policy issue that has been emphasized by financial crises, when the government intervened to prevent the near-collapse of several large firms. Second, our results highlight the need for the simultaneous supervision of traditional and shadow banks. We found that large MMFs play a major role in the creation of systemic risk, and are expected to be the target of supervision measures. Future research is need to support regulators to better understand how the leverage of the different entities affects systemic risk and to establish leverage ratios that are in line with the identified risks. Finally, shadow banking entities go beyond the MMFs and FSs considered in this paper and thus it will be interesting to evaluate the impact of shadow entities on systemic risk when a richer dataset is available. We leave these interesting developments to future research.

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Internet Appendix

Appendix A Sensitivity analysis

In this section, we provide evidence of the robustness of our findings. We replace $\Delta CoVaR$ with alternative measures of systemic risk *(A.1)*; we validate our results with Romano and Wolf (2005) adjusted p-value *(A.2)*; we replicate our analyses after excluding failed or rescued financial intermediaries *(A.3)* or financial institutions belonging to PIIGS countries *(A.4)*; finally, we address potential endogeneity issues using the Generalized Methods of Moments *(A.5)*.

A.1 Alternative measures of systemic risk

As an alternative to $\Delta CoVaR$, we consider two alternative systemic risk measures such the *MES* by Acharya et al. (2017) and the *SRISK* of Brownlees and Engle (2016). The *MES* measures the exposure to systemic risk of a financial institution as the average of global market returns during the 5% worst days of financial institution i for each financial institution i and each quarter t. This measure is defined as $MES_{i,t} = \frac{\partial ES_{m,t}}{\partial w_{i,t}} = \mathbb{E}_{t-1}(r_{i,t}|r_{m,t} < \alpha)$. ES is the Expected Shortfall, i.e., the expected loss of a financial institution, conditional on the loss being greater than the VaR calculated at a given level of 1-α; $w_{i,t}$ is the equity market value of each financial institution. As for $\Delta CoVar$, $MES_{i,t}$ is negative and therefore in all tables negative coefficients indicate increases of systemic risk, and viceversa. The *SRISK* measures the expected capital shortage faced by a financial institution during a period of system distress when the financial market declines substantially and it is calculated as $SRISK_{i,t} = [0; \kappa D_{i,t} - (1-\kappa)W_{i,t}(1 - LRMES_{i,t})]$, where κ is the prudential capital ratio of 8%, $D_{i,t}$ is the book value of the debt and $W_{i,t}$ is the market value of the equity of each financial institution. For all measures ($\Delta CoVaR$, *MES* and *SRISK*) we use α=5% significance level and approximations as in the original studies. We constructed *SRISK* using data over the period March 2006 to December 2015. Then, we compute *SRISK* using the values for *MES* over the five periods and precisely: from 2006:2 to 2007:2 as *"ex ante crisis period"*; from 2007:3 to 2008:3 as *"subprime crisis"*; from 2008:4 to 2010:2 as *"global financial crisis"*; from 2010:3 to 2012:4 as *"sovereign debt crisis"*; from 2013:1 to 2015:4 as *"post crisis period"*. Regarding the *SRISK*' coefficients, we include both positive values (Acharya et al., 2013) and negative values (Laeven et al., 2016), allowing *SRISK* to take on negative values, with a view that highly capitalised banks, with substantial large buffers, can easily absorb systemic shocks and consequently subtracting systemic risk from the entire financial system. For the purpose of our analysis, we also winsorized both *MES* and *SRISK* at their 1^{st} and 99^{th} percentiles to remove the influence of outliers.

Thus, Equation (5) can be rewritten to allow as dependent variable the other two systemic risk indicators, namely $SRisk_{i,t}$ as either $MES_{i,t}$ or $SRISK_{i,t}$ respectively:

$$\begin{aligned} SRisk_{i,t} =& \beta_0 + \beta_1 Size_{i,t-1} + \beta_2 Leverage_{i,t-1} + \beta_3 MTBV_{i,t-1} + \beta_4 STL_{i,t-1} + \\ &+ \beta_5 Beta_{i,t-1} + \beta_6 ERV_{i,t-1} + \sum_{i=1}^{476} Financial\ Intermediaries_i + \\ &+ [\sum_{t=2006:1}^{2015:4} Time_t] or [\sum_{t=1}^{4} Regimes_t] + \varepsilon_{i,t} \end{aligned} \tag{6}$$

Both *MES* and *SRISK* are regressed against the lagged values of the accounting and financial variables as in (6) above. Tables A1 and A2 report the full set of results. For the entire financial system, the *Size* is a significant predictor for the *MES* though with the statistical significance of its coefficients lower, while it is strongly significant during the sovereign debt crisis (Regime 3) for both the *MES* and *SRISK* measures of systemic risk. When we consider the two groups of shadow entities, with reference to the *Size* variable, the contribution to systemic risk is statistically significant for both types of shadow entities and for MMFs when the dependent variable is *SRISK* and for the two types (individually) with the *MES* measure. With reference to the *MTBV* variable, it is positively related to systemic risk for both shadow entities together, but not separately, for the *SRISK* measure, is additionally significant for the FSs category using the *MES* measure of systemic risk.

Table A1: Determinants of Systemic Risk - Baseline Model and Marginal Effects for European Financial System

(a) Dependent Variable: Marginal Expected Shortfall (MES).

Dependent Variable: MES	**[i]**	**[ii]**	**[iii]**	**Marginal effects**			
				Regime 1	**Regime 2**	**Regime 3**	**Regime 4**
$Size_{t-1}$	-0.0703**	-0.0660**	-0.1099*	0.0282	-0.0105	0.0617***	0.0514
	(0.0317)	(0.0305)	(0.0615)	(0.0171)	(0.0237)	(0.0157)	(0.0547)
$Leverage_{t-1}$	-0.0026	-0.0029	-0.0034	-0.0002	-0.0007	0.0007	-0.0043
	(0.0022)	(0.0021)	(0.0034)	(0.0027)	(0.0009)	(0.0008)	(0.0080)
$MTBV_{t-1}$	0.0501	0.0528	0.0957	-0.0456	0.0003	-0.0043*	-0.0294
	(0.0479)	(0.0489)	(0.0620)	(0.0433)	(0.0015)	(0.0025)	(0.0461)
STL_{t-1}	-0.0018	-0.0018	-0.0012	-0.0004	0.0044	0.0006	0.0002
	(0.0014)	(0.0014)	(0.0016)	(0.0016)	(0.0042)	(0.0018)	(0.0031)
$Beta_{t-1}$	-0.0975	-0.0993	-0.0879	0.0738	-0.0741	0.026	-0.1939
	(0.1029)	(0.1045)	(0.0798)	(0.0785)	(0.1731)	(0.0756)	(0.1710)
ERV_{t-1}	0.2341	0.2992	1.9148	-4.3041	0.4504*	-1.1498	-4.0395
	(2.0954)	(2.0991)	(4.2163)	(3.2589)	(0.2391)	(1.6364)	(5.3841)
Regime 1		-0.1969***	-0.4679**				
		(0.0352)	(0.1885)				
Regime 2		-0.1394*	0.0394				
		(0.0818)	(0.3954)				
Regime 3		0.0339	-0.7775***				
		(0.0429)	(0.1802)				
Regime 4		0.0353	-0.346				
		(0.0661)	(0.5622)				
Constant	0.9803**	0.9193**	1.4299*				
	(0.4436)	(0.4265)	(0.7609)				
Time Dummies	YES	NO	NO				
Crisis Dummies	NO	YES	YES				
Fixed effects	YES	YES	YES				
N. Obs.	12,930	12,930	12,511				
R^2 *Adjusted*	0.009	0.013	0.033				

(b) Dependent Variable: SRISK.

Dependent Variable: SRISK	**[i]**	**[ii]**	**[iii]**	**Marginal effects**			
				Regime 1	**Regime 2**	**Regime 3**	**Regime 4**
$Size_{t-1}$	0.1606	0.1437	0.1261	0.021	-0.0313	-0.5791***	-0.0655
	(0.1228)	(0.1205)	(0.1761)	(0.1026)	(0.1116)	(0.0870)	(0.1269)
$Leverage_{t-1}$	0.0325*	0.0346**	0.0442**	-0.0058	-0.0028	0.0005	0.0710*
	(0.0172)	(0.0172)	(0.0191)	(0.0261)	(0.0074)	(0.0035)	(0.0416)
$MTBV_{t-1}$	0.143	0.1312	-0.0845	0.3185**	-0.0111**	0.0039	-0.1001
	(0.1156)	(0.1151)	(0.1491)	(0.1386)	(0.0053)	(0.0125)	(0.2385)
STL_{t-1}	0.0059	0.0057	-0.0011	-0.0151	-0.0039	0.0019	-0.0045
	(0.0076)	(0.0075)	(0.0111)	(0.0131)	(0.0132)	(0.0123)	(0.0195)
$Beta_{t-1}$	0.0246	0.0299	-0.1983	0.1782	1.4276**	-0.4838	0.5572
	(0.2003)	(0.1995)	(0.2847)	(0.4146)	(0.5702)	(0.3978)	(0.4915)
ERV_{t-1}	9.7972*	9.6306*	10.3811	18.0478***	-3.8136***	-0.3101	-5.9862
	(5.4427)	(5.3463)	(6.9346)	(4.0980)	(0.8872)	(3.8203)	(11.3777)
Regime 1		1.3674***	0.0527				
		(0.2075)	(1.2430)				
Regime 2		0.8685**	0.4043				
		(0.2698)	(1.4498)				
Regime 3		-1.0482***	6.8376***				
		(0.2333)	(1.0803)				
Regime 4		0.2249	-0.1859				
		(0.3123)	(1.7915)				
Constant	-2.5202	-2.2801	-1.577				
	(1.7373)	(1.7069)	(2.4010)				
Time Dummies	YES	NO	NO				
Crisis Dummies	NO	YES	YES				
Fixed effects	YES	YES	YES				
N. Obs.	12,904	12,904	12,486				
R^2 *Adjusted*	0.066	0.084	0.201				

The tables report regressions using alternative specifications. $Size_{i,t-1}$ is the total assets of financial institution i at quarter (*t-1*); $Leverage_{i,t-1}$ is the total assets to equity ratio of financial institution i at quarter (*t-1*); $MTBV_{i,t-1}$ is the Market To Book Value ratio of financial institution i at quarter (*t-1*); $STL_{i,t-1}$ is the Short-Term Liability ratio which captures the relative level of short-term wholesale funding as the total short-term debt minus cash to total liabilities ratio of financial institution i at quarter (*t-1*); $Beta_{i,t-1}$ is the equity market beta for financial institution i at quarter (*t-1*), calculated as the ratio between the covariance of the equity security on the market and the variance in the market; $ERV_{i,t-1}$, is the Equity Returns Volatility, calculated as the standard deviation of the daily equity returns for financial institution i at quarter (*t-1*). *Regime 1* captures the Subprime Crisis over the period 2007:3-2008:3; *Regime 2* captures the European Great Financial Depression over the period 2008:4-2010:2; *Regime 3* captures the Sovereign Debt Crisis over the period 2010:3-2012:4; *Regime 4* captures the Post Crisis Period over 2013:1-2015:4. [i] is the benchmark specification using accounting and financial variables and time dummies. [ii] includes accounting and financial variables and replaces time dummies with the four regimes. [iii] includes accounting and financial variables, time dummies and the interaction of explanatory variables with the four regime dummies. Standard errors are reported in parentheses. Sample period: 2006:1-2015:4. *, **, *** denote the 10%, 5% and 1% significance level, respectively.

Table A2: Determinants of Systemic Risk - Baseline Model and Marginal Effects for MMFs and FSs.

(a) Dependent Variable: Marginal Expected Shortfall (MES).

Dependent Variable: MES	**Marginal effects for Shadow Banks [i]**		**Marginal effects for MMFs [ii]**		**Marginal effects for FSs [iii]**	
$Size_{t-1}$	-0.1297*	0.0811	-0.0989**	0.0873	-0.1081**	0.032
	(0.0663)	(0.0610)	(0.0500)	(0.0666)	(0.0518)	(0.0773)
$Leverage_{t-1}$	0.0003	-0.004	-0.0026	-0.0027	-0.0023	0.0024
	(0.0035)	(0.0047)	(0.0024)	(0.0056)	(0.0029)	(0.0062)
$MTBV_{t-1}$	0.0084	0.0634	0.078	-0.0646	0.0451	-0.0001**
	(0.0379)	(0.0586)	(0.0679)	(0.0677)	(0.0459)	0.00
STL_{t-1}	-0.0801	0.0781	-0.0005	-0.0014	-0.0018*	0.0016
	(0.1082)	(0.1082)	(0.0048)	(0.0049)	(0.0010)	(0.0055)
$Beta_{t-1}$	0.0171	-0.2287	-0.1306	0.17	0.0301	-0.4219
	(0.0300)	(0.2267)	(0.1294)	(0.1413)	(0.0263)	(0.3841)
ERV_{t-1}	-4.1098	6.2354	0.7803	-3.1471	-3.9842*	7.2374
	(2.5022)	(4.1448)	(2.5197)	(4.0170)	(2.2228)	(4.4348)
Regime 1	-0.2108***		-0.1872***		-0.1893***	
	(0.0389)		(0.0352)		(0.0355)	
Regime 2	-0.1589**		-0.1173		-0.1262	
	(0.0665)		(0.0984)		(0.0851)	
Regime 3	0.0048		0.0479		0.0305	
	(0.0411)		(0.0503)		(0.0421)	
Regime 4	0.0173		0.0805		0.043	
	(0.0568)		(0.0938)		(0.0662)	
Constant	1.3007**		0.9690**		1.4413**	
	(0.6308)		(0.4572)		(0.6721)	
Time Dummies	NO		NO		NO	
Crisis Dummies	YES		YES		YES	
Fixed effects	YES		YES		YES	
N. Obs.	12,874		12,925		12,925	
R^2 *Adjusted*	0.020		0.015		0.022	

(b) Dependent variable: SRISK.

Dependent Variable: SRISK	**Marginal effects for Shadow Banks [i]**		**Marginal effects for MMFs [ii]**		**Marginal effects for FSs [iii]**	
$Size_{t-1}$	0.1158	0.1085	0.1219	0.1221	0.2521	-0.1811
	(0.2183)	(0.2903)	(0.1791)	(0.2718)	(0.1639)	(0.3577)
$Leverage_{t-1}$	0.0323	0.0004	0.0354*	0.0062	0.0355*	-0.0165
	(0.0243)	(0.0312)	(0.0185)	(0.0399)	(0.0213)	(0.0339)
$MTBV_{t-1}$	0.5866**	-0.6763**	0.181	-0.2521	0.1502	0.0001
	(0.2152)	(0.2489)	(0.1426)	(0.2952)	(0.1165)	(0.0001)
STL_{t-1}	1.2414	-1.2364	-0.0101	0.0196	0.0104	-0.0209
	(0.9265)	(0.9265)	(0.0198)	(0.0211)	(0.0075)	(0.0208)
$Beta_{t-1}$	0.1173	-0.2769	0.1283	-0.5048	-0.0199	0.0052
	(0.2511)	(0.3677)	(0.2353)	(0.3236)	(0.2080)	(0.4821)
ERV_{t-1}	20.8159**	-14.376	9.2707	2.6026	16.6925**	-12.437
	(7.0074)	(10.1919)	(5.8883)	(13.7975)	(6.0632)	(10.5035)
Regime 1	1.4010***		1.3500***		1.3526***	
	(0.2116)		(0.2059)		(0.2078)	
Regime 2	0.9808***		0.8635**		0.8443**	
	(0.2722)		(0.2765)		(0.2719)	
Regime 3	-0.9194***		-1.0581***		-1.0498***	
	(0.2323)		(0.2313)		(0.2334)	
Regime 4	0.406		0.244		0.1428	
	(0.3595)		(0.3338)		(0.3295)	
Constant	-2.8877		-2.4412		-3.4314	
	(2.1030)		(1.9515)		(2.1014)	
Time Dummies	NO		NO		NO	
Crisis Dummies	YES		YES		YES	
Fixed effects	YES		YES		YES	
N. Obs.	12,848		12,899		12,899	
R^2 *Adjusted*	0.091		0.085		0.086	

The tables report regressions using alternative specifications. $Size_{i,t-1}$ is the total assets of financial institution *i* at quarter (*t-1*); $Leverage_{i,t-1}$ is the total assets to equity ratio of financial institution *i* at quarter (*t-1*); $MTBV_{i,t-1}$ is the Market To Book Value ratio of financial institution *i* at quarter (*t-1*); $STL_{i,t-1}$ is the Short-Term Liability ratio which captures the relative level of short-term wholesale funding as the total short-term debt minus cash to total liabilities ratio of financial institution *i* at quarter (*t-1*); $Beta_{i,t-1}$ is the equity market beta for financial institution *i* at quarter (*t-1*), calculated as the ratio between the covariance of the equity security on the market and the variance in the market; $ERV_{i,t-1}$, is the Equity Returns Volatility, calculated as the standard deviation of the daily equity returns for financial institution *i* at quarter (*t-1*). *Regime 1* captures the Subprime Crisis over the period 2007:3-2008:3; *Regime 2* captures the European Great Financial Depression over the period 2008:4-2010:2; *Regime 3* captures the Sovereign Debt Crisis over the period 2010:3-2012:4; *Regime 4* captures the Post Crisis Period over 2013:1-2015:4. Specification [i] refers to the marginal effects for the all shadow banking system; [ii] is the benchmark specification for MMFs; [iii] is the benchmark specification for FSs. Standard errors are reported in parentheses.
Sample period: 2006:1-2015:4.
*, **, *** denote the 10%, 5% and 1% significance level, respectively.

A.2 The Romano and Wolf (2005) adjusted p-values

To validate the relevance of accounting and financial variables on $\Delta CoVaR$, we also calculated the Romano and Wolf (2005) adjusted p-value. In the light of the presence of a large number of variables in all our specifications, the level of p-values may be too lenient potentially leading to spurious (Type I) significance of the coefficient. Therefore, we provide an analysis based on Romano and Wolf, which uses resampling methods, such as the bootstrap, to control for the probability of rejecting at least one true null hypothesis in the Family Wise Error Rate (FWER) of hypotheses under test. The procedure is noteworthy given that in addition to controlling the FWER, it also offers more power (i.e., the ability to correctly reject false null hypotheses) compared to earlier multiple hypothesis correction procedures such as Bonferroni (1936) and Holm (1979). We conduct the test for the baseline regression model, for the marginal effects for shadow entities, and for both FSs and MMFs requesting 1,000 bootstrap repetitions. The results are reported in Table A3, which confirm our main findings. The only exception is for the ERV variable, where the Romano and Wolf p-values are much lower (specification [i] for the Baseline Model and Shadow Entities), and significant (specifications [ii] and [iii] for MMFs and FSs, respectively).

Table A3: Romano and Wolf (2005) Adjusted p-value – Baseline Model, Marginal Effects for Financial Crises, and between MMFs and FSs. Dependent Variable: $\Delta CoVaR$.

Baseline Model - Specification [iii] Table 8		
Variables	**Model p-value**	**Romano-Wolf p-value**
$\Delta CoVaR_{t-1}$	0.000	0.010
$VaR95_{t-1}$	0.000	0.010
$Size_{t-1}$	0.001	0.010
$Leverage_{t-1}$	0.034	0.020
$MTBV_{t-1}$	0.538	0.396
STL_{t-1}	0.554	0.277
$Beta_{t-1}$	0.025	0.010
ERV_{t-1}	0.391	0.228
Regime 1	0.016	0.010
Regime 2	0.000	0.010
Regime 3	0.001	0.010
Regime 4	0.000	0.010
Regime 1		
$\Delta CoVaR_{t-1}$	0.020	0.010
$VaR95_{t-1}$	0.505	0.455
$Size_{t-1}$	0.082	0.010
$Leverage_{t-1}$	0.528	0.386
$MTBV_{t-1}$	0.823	0.743
STL_{t-1}	0.598	0.525
$Beta_{t-1}$	0.000	0.010
ERV_{t-1}	0.777	0.574
Regime 2		
$\Delta CoVaR_{t-1}$	0.137	0.020
$VaR95_{t-1}$	0.000	0.010
$Size_{t-1}$	0.028	0.010
$Leverage_{t-1}$	0.509	0.337
$MTBV_{t-1}$	0.893	0.832
STL_{t-1}	0.537	0.545
$Beta_{t-1}$	0.242	0.069
ERV_{t-1}	0.209	0.040
Regime 3		
$\Delta CoVaR_{t-1}$	0.252	0.040
$VaR95_{t-1}$	0.001	0.010
$Size_{t-1}$	0.048	0.010
$Leverage_{t-1}$	0.750	0.733
$MTBV_{t-1}$	0.630	0.495
STL_{t-1}	0.843	0.832
$Beta_{t-1}$	0.002	0.010
ERV_{t-1}	0.181	0.030
Regime 4		
$\Delta CoVaR_{t-1}$	0.000	0.010
$VaR95_{t-1}$	0.000	0.010
$Size_{t-1}$	0.001	0.010
$Leverage_{t-1}$	0.742	0.673
$MTBV_{t-1}$	0.344	0.238
STL_{t-1}	0.541	0.307
$Beta_{t-1}$	0.174	0.020
ERV_{t-1}	0.554	0.337

Baseline Model and Shadow Entities - Specification [i] Table 9		
Variables	**Model p-value**	**Romano-Wolf p-value**
$\Delta CoVaR_{t-1}$	0.000	0.001
$VaR95_{t-1}$	0.379	0.296
$Size_{t-1}$	0.159	0.012
$Leverage_{t-1}$	0.208	0.071
$MTBV_{t-1}$	0.002	0.001
STL_{t-1}	0.031	0.001
$Beta_{t-1}$	0.067	0.007
ERV_{t-1}	0.078	0.004
Regime 1	0.000	0.001
Regime 2	0.001	0.001
Regime 3	0.000	0.001
Regime 4	0.000	0.001
$\Delta CoVaR_{t-1}$*Shadow	0.020	0.011
$VaR95_{t-1}$*Shadow	0.230	0.130
$Size_{t-1}$*Shadow	0.001	0.001
$Leverage_{t-1}$*Shadow	0.061	0.017
$MTBV_{t-1}$*Shadow	0.000	0.001
STL_{t-1}*Shadow	0.029	0.001
$Beta_{t-1}$*Shadow	0.276	0.106
ERV_{t-1}*Shadow	0.088	0.011
Money Market Funds - Specification [ii] Table 9		
$\Delta CoVaR_{t-1}$	0.000	0.001
$VaR95_{t-1}$	0.146	0.083
$Size_{t-1}$	0.925	0.881
$Leverage_{t-1}$	0.022	0.005
$MTBV_{t-1}$	0.026	0.001
STL_{t-1}	0.252	0.175
$Beta_{t-1}$	0.469	0.259
ERV_{t-1}	0.799	0.683
Regime 1	0.000	0.001
Regime 2	0.001	0.001
Regime 3	0.000	0.001
Regime 4	0.013	0.001
$\Delta CoVaR_{t-1}$*MMFs	0.085	0.080
$VaR95_{t-1}$*MMFs	0.148	0.076
$Size_{t-1}$*MMFs	0.014	0.001
$Leverage_{t-1}$*MMFs	0.133	0.056
$MTBV_{t-1}$*MMFs	0.080	0.018
STL_{t-1}*MMFs	0.276	0.161
$Beta_{t-1}$*MMFs	0.640	0.487
ERV_{t-1}*MMFs	0.211	0.046
Finance Services - Specification [iii] Table 9		
$\Delta CoVaR_{t-1}$	0.000	0.001
$VaR95_{t-1}$	0.615	0.521
$Size_{t-1}$	0.122	0.013
$Leverage_{t-1}$	0.019	0.002
$MTBV_{t-1}$	0.644	0.473
STL_{t-1}	0.992	0.986
$Beta_{t-1}$	0.101	0.017
ERV_{t-1}	0.021	0.003
Regime 1	0.000	0.001
Regime 2	0.002	0.001
Regime 3	0.000	0.001
Regime 4	0.020	0.001
$\Delta CoVaR_{t-1}$*FSs	0.395	0.534
$VaR95_{t-1}$*FSs	0.494	0.453
$Size_{t-1}$*FSs	0.756	0.711
$Leverage_{t-1}$*FSs	0.576	0.463
$MTBV_{t-1}$*FSs	0.001	0.024
STL_{t-1}*FSs	0.261	0.183
$Beta_{t-1}$*FSs	0.017	0.001
ERV_{t-1}*FSs	0.006	0.002

A.3 Failed or rescued financial intermediaries

We replicate our analyses after excluding the financial intermediaries failed or rescued during the time period considered. In particular, we identified 59 financial institutions, of which 17 traditional banks required to be rescued, 36 traditional banks failed entirely, and 6 shadow entities failed too (3 MMFs and 3 FSs). The results reported in Table A4 are in line with our main findings, though Size variable is weakened for Regimes 1-3 relative to the original results and the *ERV* variable is now significant for Regimes 2 and 3.

Table A4: Determinants of Systemic Risk for Not Failed or Rescued Financial Intermediaries.

Dependent Variable: $\Delta CoVaR$	**[i]**	**[ii]**	**[iii]**	**Marginal effects**			
				Regime 1	**Regime 2**	**Regime 3**	**Regime 4**
$\Delta CoVaR_{t-1}$	0.7035***	0.6969***	0.6913***	0.0311**	-0.0476	0.029	-0.1064***
	(0.0143)	(0.0149)	(0.0357)	(0.0146)	(0.0316)	(0.0269)	(0.0277)
$Var95_{t-1}$	0.0009	-0.0004	0.0220***	-0.0064**	-0.0240***	-0.0187***	-0.0207***
	(0.0009)	(0.0009)	(0.0049)	(0.0029)	(0.0055)	(0.0047)	(0.0049)
$Size_{t-1}$	0.0001	-0.0014*	-0.0027**	0.0003	0.0008	0.0006	0.0015**
	(0.0007)	(0.0007)	(0.0009)	(0.0004)	(0.0009)	(0.0006)	(0.0006)
$Leverage_{t-1}$	0.0001**	0.0002**	0.0002**	0.0000	0.0001	0.0000	0.0000
	(0.0001)	(0.0001)	(0.0001)	(0.0000)	(0.0001)	(0.0000)	(0.0001)
$MTBV_{t-1}$	0.0002	-0.0010*	0.0003	0.0000	0.0000	0.0000	-0.0014
	(0.0005)	(0.0006)	(0.0006)	(0.0005)	(0.0000)	(0.0000)	(0.0008)
STL_{t-1}	0.0001	0.0001	0.0001	-0.0001	-0.0001	-0.0001	-0.0002
	(0.0001)	(0.0001)	(0.0002)	(0.0001)	(0.0002)	(0.0002)	(0.0002)
$Beta_{t-1}$	0.001	0.0008	-0.0063**	0.0068***	0.0062	0.0088**	0.0041
	(0.0010)	(0.0011)	(0.0024)	(0.0018)	(0.0040)	(0.0027)	(0.0026)
ERV_{t-1}	-0.0043	0.0115	0.0301	0.004	-0.0182*	-0.0205**	-0.0495
	(0.0178)	(0.0186)	(0.0185)	(0.0312)	(0.0104)	(0.0083)	(0.0529)
Regime 1		-0.0054***	-0.0127**				
		(0.0011)	(0.0060)				
Regime 2		-0.0077**	-0.0434**				
		(0.0027)	(0.0145)				
Regime 3		-0.0113***	-0.0308**				
		(0.0023)	(0.0105)				
Regime 4		-0.0041**	-0.0400***				
		(0.0020)	(0.0103)				
Constant	-0.0291**	-0.0089	0.0242*				
	(0.0093)	(0.0101)	(0.0131)				
Time Dummies	YES	NO	NO				
Crisis Dummies	NO	YES	YES				
Fixed effects	YES	YES	YES				
N. Obs.	11,704	11,704	11,343				
R^2 *Adjusted*	0.50	0.49	0.49				

The table reports regressions using alternative specifications. The dependent variable is $\Delta CoVaR$. $Size_{i,t-1}$ is the total assets of financial institution i at quarter (*t-1*); $Leverage_{i,t-1}$ is the total assets to equity ratio of financial institution i at quarter (*t-1*); $MTBV_{i,t-1}$ is the Market To Book Value ratio of financial institution i at quarter (*t-1*); $STL_{i,t-1}$ is the Short-Term Liability ratio which captures the relative level of short-term wholesale funding as the total short-term debt minus cash to total liabilities ratio of financial institution i at quarter (*t-1*); $Beta_{i,t-1}$ is the equity market beta for financial institution i at quarter (*t-1*), calculated as the ratio between the covariance of the equity security on the market and the variance in the market; $ERV_{i,t-1}$, is the Equity Return Volatility, calculated as the standard deviation of the daily equity returns for financial institution i at quarter (*t-1*). *Regime 1* captures the Subprime Crisis over the period 2007:3-2008:3; *Regime 2* captures the European Great Financial Depression over the period 2008:4-2010:2; *Regime 3* captures the Sovereign Debt Crisis over the period 2010:3-2012:4; *Regime 4* captures the Post Crisis Period over 2013:1-2015:4. [i] is the benchmark specification using accounting and financial variables and time dummies. [ii] includes accounting and financial variables and replaces time dummies with the four regimes. [iii] includes accounting and financial variables, time dummies and the interaction of explanatory variables with the four regimes. Standard errors are reported in parentheses.
Sample period: 2006:1-2015:4.
*, **, *** denote the 10%, 5% and 1% significance level, respectively.

A.4 Financial institutions not belonging to PIIGS countries

We replicate our analyses after excluding traditional banks and shadow entitles belonging to the so-called PIIGS (Portugal, Ireland, Italy, Greece and Spain) countries. The countries generated a good deal of financial distress in the harmonization of the Eurozone leading ECB to adopt non-conventional monetary policies to stabilize the European Financial System. The results reported in Table A5 confirms our main findings, the only exception being that the *Leverage* variable is no longer significant in specifications [i] and [iii].

Table A5: Determinants of Systemic Risk of the European Financial System, PIIGS Countries Excluded.

Dependent Variable: $\Delta CoVaR$	**[i]**	**[ii]**	**[iii]**	**Marginal effects**			
				Regime 1	**Regime 2**	**Regime 3**	**Regime 4**
$\Delta CoVaR_{t-1}$	0.7085***	0.6999***	0.7008***	0.0304**	-0.0525*	0.0246	-0.1112***
	(0.0145)	(0.0151)	(0.0353)	(0.0147)	(0.0314)	(0.0267)	(0.0274)
$VaR95_{t-1}$	-0.0014	-0.0024	0.0150***	-0.0025	-0.0190***	-0.0134**	-0.0156***
	(0.0016)	(0.0015)	(0.0044)	(0.0031)	(0.0049)	(0.0044)	(0.0044)
$Size_{t-1}$	0.0005	-0.0012	-0.0025**	0.0006	0.0007	0.0007	0.0016**
	(0.0007)	(0.0008)	(0.0009)	(0.0004)	(0.0010)	(0.0006)	(0.0006)
$Leverage_{t-1}$	0.0001	0.0002**	0.0002	0.0000	0.0001	0.0000	0.0000
	(0.0001)	(0.0001)	(0.0001)	0.00	(0.0001)	0.00	(0.0001)
$MTBV_{t-1}$	0.0009	-0.0002	0.0000	-0.0001	0.0000	0.0000	-0.0004
	(0.0006)	(0.0006)	(0.0007)	(0.0005)	(0.0000)	(0.0000)	(0.0009)
STL_{t-1}	0.0001	0.0001	0.0001	-0.0001	-0.0003	-0.0001	-0.0002
	(0.0001)	(0.0001)	(0.0002)	(0.0001)	(0.0003)	(0.0002)	(0.0002)
$Beta_{t-1}$	0.0007	0.0007	-0.0054**	0.0060**	0.006	0.0091***	0.0035
	(0.0010)	(0.0011)	(0.0024)	(0.0018)	(0.0039)	(0.0027)	(0.0025)
ERV_{t-1}	-0.0033	0.0171	0.0299	0.0025	-0.0141	-0.0192	-0.0399
	(0.0199)	(0.0208)	(0.0251)	(0.0319)	(0.0101)	(0.0120)	(0.0490)
Regime 1		-0.0062***	-0.0140**				
		(0.0012)	(0.0063)				
Regime 2		-0.0086**	-0.0420**				
		(0.0028)	(0.0144)				
Regime 3		-0.0120***	-0.0304**				
		(0.0024)	(0.0102)				
Regime 4		-0.0042**	-0.0414***				
		(0.0021)	(0.0102)				
Constant	-0.0388***	-0.0162	0.015				
	(0.0094)	(0.0103)	(0.0135)				
Time Dummies	YES	NO	NO				
Crisis Dummies	NO	YES	YES				
Fixed effects	YES	YES	YES				
N. Obs.	11,077	11,077	10,724				
R^2 *Adjusted*	0.50	0.49	0.49				

The table reports regressions using alternative specifications. The dependent variable is $\Delta CoVaR$. $Size_{i,t-1}$ is the total assets of financial institution i at quarter (*t-1*); $Leverage_{i,t-1}$ is the total assets to equity ratio of financial institution i at quarter (*t-1*); $MTBV_{i,t-1}$ is the Market To Book Value ratio of financial institution i at quarter (*t-1*); $STL_{i,t-1}$ is the Short-Term Liability ratio which captures the relative level of short-term wholesale funding as the total short-term debt minus cash to total liabilities ratio of financial institution i at quarter (*t-1*); $Beta_{i,t-1}$ is the equity market beta for financial institution i at quarter (*t-1*), calculated as the ratio between the covariance of the equity security on the market and the variance in the market; $ERV_{i,t-1}$, is the Equity Return Volatility, calculated as the standard deviation of the daily equity returns for financial institution i at quarter (*t-1*). *Regime 1* captures the Subprime Crisis over the period 2007:3-2008:3; *Regime 2* captures the European Great Financial Depression over the period 2008:4-2010:2; *Regime 3* captures the Sovereign Debt Crisis over the period 2010:3-2012:4; *Regime 4* captures the Post Crisis Period over 2013:1-2015:4. [i] is the benchmark specification using accounting and financial variables and time dummies. [ii] includes accounting and financial variables and replaces time dummies with the four regimes. [iii] includes accounting and financial variables, time dummies and the interaction of explanatory variables with the four regimes. Standard errors are reported in parentheses.
Sample period: 2006:1-2015:4.
*, **, *** denote the 10%, 5% and 1% significance level, respectively.

A.5 Estimation techniques

In order to check for endogeneity of the regressors, we estimate our models using the Generalized Method of Moments (GMM) estimator, instrumenting all regressors. Tables A6 and A7 report the results. The Size variable becomes weaker for the entire financial system, but when we consider the two groups of shadow entities, it remains statistically significant only for MMFs, whereas the size of FSs still remains not significance. The results also confirm the detrimental role of the Short-Term Liability ratio for shadow entities. With reference to the *ERV* variable, it raises systemic risk for FSs and is additionally significant for the MMFs category.

Table A6: Determinants of Systemic Risk for the European Financial System – GMM.

Dependent Variable: $\Delta CoVaR$	**[i]**	**[ii]**	**[iii]**	**Marginal effects**			
				Regime 1	**Regime 2**	**Regime 3**	**Regime 4**
$\Delta CoVaR_{t-1}$	0.9497***	0.9189***	6.9565***	-3.2216*	-5.7050***	-6.2211***	-6.4031***
	(0.0615)	(0.0501)	(1.4435)	(1.9447)	(1.2873)	(1.4332)	(1.5079)
$VaR95_{t-1}$	0.0006	0.0017	0.4092***	-0.2284	-0.4331***	-0.4432***	-0.4002***
	(0.0021)	(0.0021)	(0.0913)	(0.2056)	(0.0890)	(0.0908)	(0.0970)
$Size_{t-1}$	0.0020	-0.0015	0.0201	-0.1001	-0.0335	0.0098	-0.0168
	(0.0018)	(0.0018)	(0.0250)	(0.1633)	(0.0792)	(0.0593)	(0.0605)
$Leverage_{t-1}$	0.0000	0.0001	-0.0042	0.0103	0.0000	0.0002	0.0040
	(0.0002)	(0.0002)	(0.0028)	(0.0110)	(0.0006)	(0.0003)	(0.0029)
$MTBV_{t-1}$	0.0010	-0.0027	-0.0227	0.0182	0.0001	0.0006	0.0237
	(0.0017)	(0.0016)	(0.0225)	(0.0206)	(0.0004)	(0.0006)	(0.0235)
STL_{t-1}	-0.0002	-0.0001	-0.0040	0.0081	0.0039	0.0035	0.0042
	(0.0001)	(0.0001)	(0.0075)	(0.0138)	(0.0070)	(0.0071)	(0.0076)
$Beta_{t-1}$	0.0031	0.0032*	0.0644	0.0288	-0.0506	-0.0637*	-0.0476
	(0.0019)	(0.0019)	(0.0456)	(0.1819)	(0.0429)	(0.0394)	(0.0470)
ERV_{t-1}	0.0467	0.1289***	-0.0861	-0.4373	0.0166	0.1723	-0.0222
	(0.0457)	(0.0440)	(0.4110)	(0.7437)	(0.0984)	(0.2010)	(0.4945)
Regime 1		-0.0006	0.9516				
		(0.0031)	(2.5608)				
Regime 2		-0.0532***	-0.3089				
		(0.0043)	(1.1810)				
Regime 3		-0.0631***	-0.9822				
		(0.0053)	(0.9329)				
Regime 4		-0.0526***	-0.6226				
		(0.0067)	(0.9492)				
Constant	-0.1879	0.0358	0.3506				
	(0.0278)	(0.0291)	(0.9954)				
Lagged dependent variables	YES	YES	YES				
Time Dummies	YES	NO	NO				
Crisis Dummies	NO	YES	YES				
Fixed effects	YES	YES	YES				
N. Obs.	12,369	12,369	11,907				
Sargan Test	0.52	0.18	0.92				

The table reports the results of regressions using a dynamic panel data with Arellano-Bond estimator. The dependent variable is $\Delta CoVaR$. $Size_{i,t-1}$ is the total assets of financial institution i at quarter (*t-1*); $Leverage_{i,t-1}$ is the total assets to equity ratio of financial institution i at quarter (*t-1*); $MTBV_{i,t-1}$ is the Market To Book Value ratio of financial institution i at quarter (*t-1*); $STL_{i,t-1}$ is the Short-Term Liability ratio which captures the relative level of short-term wholesale funding as the total short-term debt minus cash to total liabilities ratio of financial institution i at quarter (*t-1*); $Beta_{i,t-1}$ is the equity market beta for financial institution i at quarter (*t-1*), calculated as the ratio between the covariance of the equity security on the market and the variance in the market; $ERV_{i,t-1}$, is the Equity Returns Volatility, calculated as the standard deviation of the daily equity returns for financial institution i at quarter (*t-1*). *Regime 1* captures the Subprime Crisis over the period 2007:3-2008:3; *Regime 2* captures the European Great Financial Depression over the period 2008:4-2010:2; *Regime 3* captures the Sovereign Debt Crisis over the period 2010:3-2012:4; *Regime 4* captures the Post Crisis Period over 2013:1-2015:4. Sargan test reports the p-value of the overidentifying restrictions. [i] is the benchmark specification using accounting and financial variables and time dummies. [ii] includes accounting and financial variables and replaces time dummies with the four regimes. [iii] includes accounting and financial variables, time dummies and the interaction of explanatory variables with the four regimes. Standard errors are reported in parentheses. Sample period: 2006:1-2015:4. *, **, *** denote the 10%, 5% and 1% significance level, respectively.

Table A7: Determinants of Systemic Risk - Baseline Model and Marginal Effects for Shadow Entities (MMFs and FSs). GMM estimates.

Dependent Variable: $\Delta CoVaR$	**Marginal effects for Shadow Banks [i]**		**Marginal effects for MMFs [ii]**		**Marginal effects for FSs [iii]**	
$\Delta CoVaR_{t-1}$	1.9720***	-2.0561***	1.0065***	-1.0732***	2.0327***	-2.179304***
	(0.2308)	(0.2316)	(0.0656)	(0.0668)	(0.3117)	(0.3220)
$VaR95_{t-1}$	-0.0037*	0.0004	-0.0117***	0.0004	-0.0350***	0.0353***
	(0.0022)	(0.0041)	(0.0018)	(0.0060)	(0.0059)	(0.0094)
$Size_{t-1}$	0.0026	-0.0071*	0.0033	-0.0108**	-0.0013	-0.0014
	(0.0027)	(0.0039)	(0.0021)	(0.0049)	(0.0040)	(0.0079)
$Leverage_{t-1}$	0.0002	0.0000	0.0001	-0.0009	-0.0001	0.0003
	(0.0002)	(0.0004)	(0.0002)	(0.0010)	(0.0004)	(0.0007)
$MTBV_{t-1}$	-0.0056**	0.0072**	-0.0025*	0.0087**	0.0001	0.0001
	(0.0026)	(0.0033)	(0.0015)	(0.0039)	(0.0027)	(0.0002)
STL_{t-1}	-0.0521***	0.0522***	0.0001	-0.0001	0.0003	-0.0002
	(0.0111)	(0.0111)	(0.0002)	(0.0002)	(0.0002)	(0.0005)
$Beta_{t-1}$	0.0098***	-0.0063*	0.0054***	0.0051	0.0072**	-0.0102
	(0.0024)	(0.0038)	(0.0017)	(0.0044)	(0.0035)	(0.0079)
ERV_{t-1}	0.2342***	-0.2443***	0.0777*	-0.2208**	0.5564***	-0.5336***
	(0.0595)	(0.0800)	(0.0375)	(0.1095)	(0.1153)	(0.1558)
Regime 1	-0.0020		-0.0022		0.0006	
	(0.0028)		(0.0025)		(0.0048)	
Regime 2	-0.0554***		-0.0539***		-0.0568***	
	(0.0039)		(0.0035)		(0.0069)	
Regime 3	-0.0590***		-0.0565***		-0.0765***	
	(0.0048)		(0.0043)		(0.0090)	
Regime 4	-0.0570***		-0.0552***		-0.0686***	
	(0.0066)		(0.0059)		(0.0112)	
Constant	0.0314		0.0144		0.1104*	
	(0.0324)		(0.0269)		(0.0568)	
Lagged dependent variable	YES		YES		YES	
Time Dummies	NO		NO		NO	
Crisis Dummies	YES		YES		YES	
Fixed effects	YES		YES		YES	
N. Obs.	12,364		12,364		12,364	
Sargan Test	0.42		0.24		0.29	

The table reports the results of regressions using alternative specifications. The dependent variable is $\Delta CoVaR$. $Size_{i,t-1}$ is the total assets of financial institution i at quarter (t-1); $Leverage_{i,t-1}$ is the total assets to equity ratio of financial institution i at quarter (t-1); $MTBV_{i,t-1}$ is the Market To Book Value ratio of financial institution i at quarter (t-1); $STL_{i,t-1}$ is the Short-Term Liability ratio which captures the relative level of short-term wholesale funding as the total short-term debt minus cash to total liabilities ratio of financial institution i at quarter (t-1); $Beta_{i,t-1}$ is the equity market beta for financial institution i at quarter (t-1), calculated as the ratio between the covariance of the equity security on the market and the variance in the market; $ERV_{i,t-1}$, is the Equity Returns Volatility, calculated as the standard deviation of the daily equity returns for financial institution i at quarter (t-1). *Regime 1* captures the Subprime Crisis over the period 2007:3-2008:3; *Regime 2* captures the European Great Financial Depression over the period 2008:4-2010:2; *Regime 3* captures the Sovereign Debt Crisis over the period 2010:3-2012:4; *Regime 4* captures the Post Crisis Period over 2013:1-2015:4. Sargan test reports the p-value of the overidentifying restrictions. Specification [i] refers to the marginal effects for the all shadow banking system; [ii] is the benchmark specification for MMFs; [iii] is the benchmark specification for FSs. Standard errors are reported in parentheses. Sample period: 2006:1-2015:4. *, **, *** denote the 10%, 5% and 1% significance level, respectively.

Appendix B List of Financial Institutions

Table B1: Traditional Banks.

Traditional Banks	Country
BK.FUR TIROL UND VBG.; BKS BANK; ERSTE GROUP BANK; OBERBANK; OEST.VOLKSBANKEN PC.; RAIFFEISEN BANK INTL. VOLKSBANK VBG.PC.; VORARLBERG HYPOBANK PC	Austria
DEXIA; KBC ANCORA; KBC GROUP CB BGN.AMER.CR.BK.; CB CENTRAL COOP.BANK	Belgium
CB CORPORATE COML.BANK; CIBANK	Bulgaria
BANK OF CYPRUS; CYPRUS POPULAR BANK; HELLENIC BANK; USB BANK	Cyprus
KOMERCNI BANKA	Czech Republic
AARHUS LOKALBANK; AMAGERBANKEN; BANKNORDIK; DANSKE; ANDELSKASSERS BK.; DANSKE BANK; DIBA BANK; DJURSLANDS BANK; FIONIA HOLDING; FORSTAEDERNES BANK; GRONLANDSBANKEN; HVIDBJERG BANK; JYSKE BANK; KREDITBANKEN; LAN & SPAR BANK; LOKALBANKEN I NORD; LOLLANDS BANK; MAX BANK; MONS BANK; MORSO BANK; NORDFYNS BANK; NORRESUNDBY BANK; OSTJYDSK BANK; RINGKJOBING BANK; RINGKJOBING LANDBOBANK; ROSKILDE BANK; SALLING BANK; SELSKABET; SKAELSKOR BANK; SKJERN BANK; SPAR NORD BANK; SPARBANK; SPAREKASSEN FAABORG; SPAREKASSEN HIMLD; SPAREKASSEN HVETBO; SPAREKASSEN LOLLAND; SVENDBORG SPAREKASSE; SYDBANK; TOTALBANKEN; VESTFYNS BANK; VESTJYSK BANK; VINDERUP BANK; VORDINGBORG BANK.	Denmark
AKTIA 'A'; ALANDSBANKEN 'A'; POHJOLA PANKKI A.	Finland
BANQUE REUNION; BANQUE TARNEAUD; BNP PARIBAS; CIC 'A'; CR.AGR.ALPES PROVENCES; CR.AGRICOLE MORBIHAN; CRCAM; AQUITAINE; CRCAM ATLANTIQUE VENDEE; CRCAM ILLE-VIL.CCI; CRCAM LANGUED CCI; CRCAM NORD DE FRANCE CCI; CRCAM; NORMANDIE SEINE; CREDIT AGR.CENTRE LOIRE; CREDIT AGR.ILE DE FRANCE; CREDIT AGR.LOIRE-H-LOIRE; CREDIT AGR.MIDI (3EME); CREDIT AGR.TOULOUSE; CREDIT AGR.TOURAINE; CREDIT AGRICOLE; CREDIT AGRICOLE BRIE PICARDIE; CREDIT AGRICOLE OISE; CREDIT FONCIER DE MOCO; TIXIS; SOCIETE GENERALE.	France
BAYER.HYPO-UND-VBK.; COMMERZBANK; DEPFA BANK; TAKEOVER; DEUTSCHE BANK; DEUTSCHE POSTBANK; EUROHYPO; FIB FFUR.INVESTMENTBANK; IKB DEUTSCHE INDSTRBK.; LANDESBANK BL.HLDG.; MERKUR BANK; OLDENBURGISCHE LB.; QUIRIN BANK.	Germany
AGRI.BANK OF GREECE; ALPHA BANK; ATTICA BANK; BANK OF PIRAEUS; EMPORIKI BK.OF GREECE; EUROBANK ERGASIAS S A; GENERAL BANK OF GREECE; MARFIN EGTIA BANK; TIOL BK.OF GREECE; PROTON BANK; T BANK; TT HELLENIC POSTBANK.	Greece
INTER-EUROPA BANK; OTP BANK.	Hungary
ALLIED IRISH BANKS; ANG.IR.BK.; BANK OF IRELAND.	Ireland
BANCA CARIGE; BANCA FINT EURAMERICA; BANCA MONTE DEI PASCHI; BANCA POPOLARE DI MILANO; BANCA POPOLARE INTRA; BANCA PPO.DI SONDRIO; BANCA PPO.DI SPOLETO; BANCA PPO.EMILIA ROMAG; BANCA PPO.ETRURIA LAZIO; BANCO DI SARDEG RSP; BANCO POPOLARE; BCA.PICCOLO CDT.VALTELL; BNC.DI DESIO E DELB.; CREDITO BERGAMASCO; CREDITO EMILIANO; INTESA SANPAOLO; IW BANK; MEDIOBANCA BC.FIN; MELIORBANCA; RETI BANCARIE HOLDING; UNICREDIT; UNIONE DI BANCHE ITALIANE.	Italy
LATVIJAS KRAJBANKA	Latvia
BANKAS SNORAS; NORD LB LIETUVA; SIAULIU BANKAS; UKIO BANKAS	Lithuania
ESPIRITO SANTO FINL.GP.	Luxemburg
BANK OF VALLETTA; FIMBANK; HSBC BANK MALTA; LOMBARD BANK	Malta
ABN AMRO HOLDING; VAN LANSCHOT	Netherlands
ALIOR BANK; BANK BPH; BANK GSPK.ZYWNOSCIOWEJ; BANK MILLENNIUM; BANK POLSKA KASA OPIEKI; BANK ZACHODNI WBK; BNP PARIBAS BANK POLSKA; BOS; BRE BANK; DZPOLSKA; GETIN HOLDING; GETIN NOBLE BANK; GETINOBLE BANK; HANDLOWY; ING BANK SLASKI BSK; KREDYT BANK; NORDEA BANK POLSKA; PKO BANK.	Poland
BANCO BPI; BANCO COMR.PORTUGUES 'R'; BANCO ESPIRITO; SANTO; BANIF-SGPS; FINIBANCO.	Portugal
BANCA COMERCIALA CARPATICA; BANCA TRANSILVANIA CLUJ.	Romania
OTP BANKA SLOVENSKO; PRIMA BANKA SLOVENSKO 2; TATRA BANKA; VSEOBEC UVEROVA BANKA.	Slovakia
ABANKA VIPA; NOVA KREDIT BANKA MARIBOR.	Slovenia
BANCA CIVICA; BANCO DE ANDALUCIA; BANCO DE SABADELL; BANCO DE VALENCIA; BANCO ESPANOL DE CREDITO; BANCO GUIPUZCOANO; BANCO PASTOR; BANCO POPULAR ESPANOL; BANCO SANTANDER; BANKIA; BANKINTER 'R'; BBV.ARGENTARIA; CAIXABANK; CAJA DE AHORROS DEL MEDITERRANEO.	Spain
NORDEA BANK; SEB 'A'; SVENSKA HANDBKN.'A'; SWEDBANK 'A'.	Sweden
ARCHIAL GROUP; BANK OF GEORGIA HDG.; BARCLAYS; BCB HOLDINGS; BRADFORD & BINGLEY; EUROPEAN ISLAMIC INV.BK.; HSBC HDG. (ORD $0.50); ISLAMIC BANK OF BRITAIN; LLOYDS BANKING GROUP; NORTHERN ROCK; ROYAL BANK OF SCTL.GP.; SECURE TRUST BANK; STANDARD CHARTERED.	United Kingdom

B.1 European MMFs - Background

Since the global financial crisis, MMFs have determined a regulatory revolution, with an EU political agreement to dictate specific prudential requirements from 2018 onwards. (See Regulation 2017/1131 of the European Parliament and of the Council of 14^{th} June 2017 on Money Market Funds.) Total assets in the Euro area MMFs is continuing to grow, despite not satisfying returns and volatility in 2016. The financial crisis in 2008 has shown that MMFs are vulnerable to investor runs in conditions of financial distress. Both EU and US regulators have adopted comparable approaches to strengthen MMFs. In US, the collapse of Lehman Brothers on September 15^{th}, 2008 triggered large withdrawals by institutional investors from prime MMFs. Since US MMFs market their shares at a stable price of one dollar (i.e., they are Constant Net Asset Value), the massive redemptions from them exacerbated and aggravated a severe funding shortage in US short-term credit markets, in particular for Asset Backed Commercial Paper (ABCP), Commercial Papers (CPs) issuers, as MMFs had to shed assets quickly. To address some of these vulnerabilities, in 2014, the Securities and Exchange Commissions (SEC) amended the Rule 2a-7, which brought a fundamental change in US MMFs: starting in 2016, institutional prime and institutional municipal MMFs had to change to Variable Net Asset Value, based on mark-to-market valuation. In Europe, the European Commission proposed, in September 2013, a new regulation based on the recommendations outlined by the European Systemic Risk Board (ESRB) in December 2012. In particular, the Commission recommended that the relevant Union legislation requires MMFs to have a fluctuating (i.e., variable) net asset value. The new regulation has been reached by the European Parliament and the European Council in June 14^{th}, 2017. Unfortunately, the measures chosen to contain an investor run are very different in the EU and US markets.

In relation to the accounting techniques, European MMFs offer their shares at a Constant Net Asset Value (CNAV) or a Variable Net Asset Value (VNAV) also called floating NAV. In the US, instead, all MMFs are valued according to CNAV. CNAV refers to funds which use amortised cost accounting to value all of their assets, while VNAV refers to funds which use mark-to-market accounting to value their assets. Still, the MMFs industry is geographically concentrated, with 41% of euro area MMFs assets domiciled in Ireland, 30% in France and 26% in Luxembourg. (EU Shadow Banking Monitor, European Systemic Risk Board, May 2017, page 21.). Irish based MMFs are similar to the US type, therefore they are valued according to CNAV. However, in our dataset there are no MMFs belonging to Ireland. The CNAV of MMFs accounts for roughly half of the EU's total assets under management, and their shares are mostly denominated in USD (over 50%) and GBP (around 30%). In light of this evidence, we collected only listed MMFs with VNAV. First of all, and according to the Regulation 2017/1131 of the European Parliament, in order to reflect the actual value of assets, the use of mark-to-market should be the preferred method of valuation. One other motivation is related to the European context. Different approaches, in assessing the MMFs' net asset value, fail to address their vulnerabilities to money markets in the Union and fail to mitigate contagion risks, thereby endangering the functioning and the stability of the financial market, as emphasised by the financial crisis. A common set of rules could provide a high level of protection both for the investor and for the financial stability as a whole. In the absence of a homogeneous set of rules on MMFs, different measures might continue to be adopted at national level and would continue to determine significant distortions of competition coming from significant differences in investment protection. Moreover, differences in portfolio composition, eligible assets, maturity, liquidity, diversification and quality of issuers and money market instruments create different levels of investor protection because of the different levels of risk related to the investment proposition associated with an MMFs. The adoption of a homogeneous set of rules would avoid contagion of the short-term funding market which undermine the stability of the Union's financial market.

The Table B2 reports the list of MMFs used in the empirical analysis.

Table B2: Money Market Funds.

Money Market Funds	Country
ACKERMANS & VAN HAAREN; BREDERODE SA; QUEST FOR GROWTH; RHJ INTRETIOL; SOFI; GBL.	Belgium
DEMETRA; FINIKAS AMMOCHOSTOU; ACTIBOND GROWTH; APOLLO; CYTRUSTEES; ELMA; EXELIXI INVESTMENT; HARVEST CAPITAL; INTERFUND INVESTMENT; JUPITER PORTFOLIO INV; KARYES INV; REGALLIA; TRIAI.	Cyprus
NORVESTIA	Finland
UNION FINCIERE DE FRANCE; IDI SCA; SIPAREX CROISSANCE.	France
AEOLIAN INVESTMENT FUND; ANDROMEDA.	Greece
DVB BANK; HCI CAPITAL; PEH WERTPAPIER; VALUE MANAGEMENT & RESEARCH	Germany
AZIMUT.	Italy
VALUE; ROBECO; ROLINCO; RORENTO.	Netherlands
ABERDEEN ASSET MGMT; ASHCOURT ROWAN DEAD; BREWIN DOLPHIN; BROOKS MACDOLD GRP; FIRST PROPERTY; LIONTRUST ASSET MGT; MATTIOLI WOODS PLC; MITON GROUP PLC; RATHBONE BROTHERS; ABERDEEN ASIAN SMALL; ABERDEEN JAPAN; ABERDEEN NEW DAWN; ABERDEEN NEW THAI; ABERDEEN UK; ABERFORTH SMALLER CO; ALLIANCE TRUST PLC; ALTERTIVE ASSET OP; ARTEMIS ALPHA; ASIAN TOTAL RETURN; ATHELNEY TRUST PLC; AURORA INVESTMENT TR; BAILLIE GIFFORD JAPA; BAILLIE GIFFORD SHIN; BANKERS INVESTMENT; BARING EMERGING EURO; BARONSMEAD VCT 2 PLC; BLACKROCK COM; BLACKROCK EMERGING; BLACKROCK GREATER; BLACKROCK INCOME; BLACKROCK SMALLER CO; BLACKROCK THROG; BLACKROCK WORLD; BLACKSTAR GROUP; BLUE PLANET; BRITISH ASSETS TRUST; BRITISH EMPIRE SECUR; BRUNNER INVESTMENT; CALEDONIA INVESTMENT; CAPITAL GEARING; CAYENNE TRUST PLC CHELVERTON GROWTH; CITY MERCHANTS HIGH; CITY TURAL; CITY OF LONDON INVES; DUNEDIN INCOME GRWTH; DUNEDIN SMALLER COS; EDINBURGH DRAGON; EDINBURGH INVESTMENT; EDINBURGH WORLDWIDE; EP GLOBAL OPP; F&C CAPITAL; FIDELITY ASIAN VALUE; FIDELITY EUROPEAN; FIDELITY JAPANESE; FIDELITY SPECIAL; FINSBURY GROWTH; GRAPHITE ENTERPRISE; GRESHAM HOUSE PLC; HANSA TRUST PLC; HENDERSON EUROTRUST; HENDERSON EUROP; HENDERSON GLOB; HENDERSON HIGH INC; HENDERSON OPP; HENDERSON SMALLER; HERALD INVEST TRUST; IMPAX ENVIRONMENTAL; INTERN'L BIOTECHNOLO; INVESCO ASIA TRUST; INVESTMENT CO PLC; JPMORGAN AMERICAN; JPMORGAN ASIAN; JPMORGAN CHINESE; JPMORGAN CLAVER; JPMORGAN EMERGING; JPMORGAN EUROPEAN SMALL; JPMORGAN EUROPEAN; JPMORGAN INDIAN; JPMORGAN JAPAN; JPMORGAN JAP; JPMORGAN OVERSEAS; JPMORGAN RUSSIAN; JPMORGAN SMALLER; JPMORGAN US SMALL; JUPITER DIVIDEND; JUPITER EUROPEAN; JUPITER PRIMADO; JUPITER SECOND SPLIT; JUPITER US SMALLER; KEYSTONE INVESTMENT; LAW DEBENTURE CORP; LINSELL TRAIN INV; LONDON & ST LAWRENCE; LOWLAND INVESTMENT; MAJEDIE INVESTMENTS; MANCH&LONDON INV TR; MARTIN CURRIE GLB.PRTF; MARTIN CURRIE PACIFIC; MERCANTILE INV; MERCHANTS TRUST PLC; MID WYND INTL; SENECA GLOBAL; MONKS INV. TST. PLC; MONTARO EUROPEAN; MURRAY INCOME TRUST; MURRAY INTERTIOL; NEW INDIA INVEST; NEW STAR INV; THE NORTH AMERICAN; NORTH ATLANTIC SMALL; PACIFIC ASSETS TRUST; PACIFIC HORIZON; PERPETUAL INC & GR; PERSOL ASSETS TR; POLAR CAPITAL; PREMIER ENERGY; ALLIANZ TECHNOLOGY; RENN UNIVERSAL; RIT CAPITAL PARTNERS; SCHRODER ASIAPACIFIC; SCHRODER INCOME; SCHRODER JAPAN; SCOTTISH AMERICAN; SCOTTISH INVEST TR; SCOTTISH MORTGAGE; SCOTTISH ORIENTAL; HUME CAPITAL SECURITIES; SHIRES INCOME PLC; SMALL COMPANIES; STANDARD LIFE; STANDARD LIFE EQUITY; SVM UK EMERGING; TEMPLE BAR INVESTMNT; TEMPLETON EMERGING; ESTABLISHMENT; THE EUROPEAN; INDEPENDENT INV TR; TIGER RESOURCE; TR EUROPEAN GROWTH; TR PROPERTY INV; THREADNEEDLE; TROY INCOME; VALUE & INCOME TRUST; WITAN INVESTMENT; WITAN PACIFIC; THE WORLD TRUST FUND; WORLDWIDE HEALTHCARE; BLACKROCK NEW ENERGY.	United Kingdom

Table B3: Finance Services.

Finance Services	Country
QINO FLAGSHIP	Austria
A.L. PROCHOICE GROUP; CPI HOLDINGS PUBLIC; ELLIS; LAIKI CAPITAL PUBLIC; SFS GROUP.	Cyprus
CAPMAN OYJ; EQ OYJ.	Finland
ABC ARBITRAGE; AVENIR FINCE; BOURSE DIRECT; GLOBAL INVESTMENT; COMPAGNIE MAROCAINE; PARIS ORLEANS; SOFRAGI; VIEL ET CIE; WENDEL.	France
IFG GROUP PLC	Ireland
ALBIS LEASING; ALLERTHAL-WERKE; ARAGON AG; BAADER BANK; BERLINER EFFEKTENGESELLSCHAFT; COMDIRECT BANK; DAB BANK; EUWAX; GREENWICH BETEILIGUNGEN; HAMBURGER GETREIDE-LAGERHAUS; HEIDELBERGER; HESSE NEWMAN; KREMLIN; SPARTA; HSBC TRINKAUS & BURKHARDT; LLOYD FONDS; MLP; MWB FAIRTRADE; SCHNIGGE; SINO; VALORA EFFEKTEN HANDEL; VESTCORP; WUESTENROT & WUERTT.; CJ VOGEL FUR BETEILIGUNGEN.	Germany
DEA CAPITAL; INVESTIMENTI E SVILUPPO; MITTEL; TAMBURI	Italy
IDB HOLDINGS; LUXEMPART.	Luxemburg
BINCKBANK.	Netherlands
DIMIA CAPITAL PRIVADO; CIA. DE INVERSIONES.	Spain
CAMELLIA PLC; CHARLES STANLEY; CITY OF LONDON GR; CLOSE BROTHERS PLC; CRAVEN HOUSE; DANIEL STEWART SEC; DRAGANFLY INV LTD; EUROPEAN WE; FAIRPOINT; FISKE PLC; ICAP PLC; IG GROUP HLDGS; IMPACT HOLDINGS (UK); IMPAX ASSET; INSETCO; INTERMEDIATE CAPITAL; LEGENDARY; LONDON CAPITAL GRP; NUMIS CORP PLC; PANMURE GORDON; PARAGON GROUP; PRIVATE & COMMERCIAL; PROVIDENT FINCIAL; S & U PLC; W.H. IRELAND GROUP; WALKER CRIPS GROUP; WESTERN SELECTION; JPMORGAN MID CAP.	United Kingdom

Appendix C Correlation Matrices and Quantile Regression Results

Table C1: Quantile Regressions: Results.

Dependent Variable	$\mathbf{X}_t^i$	$\mathbf{X}_t^{system\|i}$
FTSE-Volatility$_{i,t-1}$	0.0508	-0.4850***
	(0.0671)	(0.0275)
Liquidity Spread$_{i,t-1}$	0.0868***	0.0679***
	(0.0066)	(0.0016)
T-Bill Change$_{i,t-1}$	-0.0221**	-0.0404***
	(0.0084)	(0.0087)
Y-Curve Slope$_{i,t-1}$	0.0075***	0.0191***
	(0.0007)	(0.0005)
Credit Spread$_{i,t-1}$	0.0046***	0.0013***
	(0.0004)	(0.0002)
Equity Returns$_{i,t-1}$	-0.0807	0.3588***
	(0.0703)	(0.0282)
$X_{i,t}$		0.0293***
		(0.0024)
Constant	0.0499***	0.0333***
	(0.0010)	(0.0004)
N. Obs.	221,893	221,893
Pseudo-R^2	0.0043	0.10

The table reports the estimated coefficients and Pseudo-R^2 in the 5% quantile regressions on financial institution returns and on European Financial System returns, using FTSE-Volatility, Liquidity Spread, T-Bill Change, Y-Curve Slope, Credit Spread, Equity Returns. The regressions are based on weekly data over the time period 2006:1-2015:4. Standard errors are reported in parentheses.

Table C2: State Variables: Correlation Matrix. Dependent variable: $\Delta CoVaR$.

Correlation Matrix	Δ***CoVaR***	*FTSE-volatility*	*Liquidity spread*	*T-Bill change*	*Y-Curve slope*	*Credit Spread*	*Equity Returns*
Δ***CoVaR***	1						
FTSE-volatility	-0.0092*	1					
Liquidity spread	-0.1249*	-0.0631*	1				
T-Bill change	0.0455*	0.0611*	-0.1240*	1			
Y-Curve slope	-0.0508*	0.0118*	0.1391*	0.0308*	1		
Credit Spread	0.0414*	0.0046*	0.0411*	-0.0936*	0.0533*	1	
Equity Returns	-0.0106*	0.9725*	-0.0562*	0.0336*	0.0219*	-0.0014	1

The table reports the correlations among state variables on weekly data from 2006 to 2015. The state variables are: *FTSE-volatility*: is the weekly price of the index of the FTSE 100 as a volatility index; *Liquidity spread*: is the liquidity spread calculated as the difference between the three month UK repo-rate and the three month UK T bill; *T-Bill change*: indicates the change in UK treasury bill 3 month rate; *Y-Curve slope*: indicates the change in slope of the yield curve represented by UK 5-years minus three-month interest rate on government bonds; *Credit Spread*: indicates the change in credit spread represented by the difference between BBB corporate bonds and the ten year German government bonds; *Equity returns*: indicates the weekly equity returns from the FTSE 100. * denotes the statistical significance at 5% level.

Table C3: Accounting and Financial Variables: Correlation Matrix. Dependent variables: *MES* and *SRISK*.

Correlation Matrix	***MES***	***SRISK***	*Size*	*Leverage*	*MTBV*	*STL*	*Beta*	*ERV*
MES - SRISK	1	1						
Size	-0.0439*	0.1425*	1					
Leverage	0.0340*	0.1161*	0.6474*	1				
MTBV	0.0173*	0.0228*	0.0470*	0.0811*	1			
STL	0.0083	0.0239*	0.2279*	0.1704*	0.0762*	1		
Beta	-0.0223*	0.0237*	0.2943*	0.2256*	-0.0406*	0.0523*	1	
ERV	0.0169*	0.0816*	0.0669*	0.2838*	0.0328*	0.0836*	0.1512*	1
VIF	**1.47**	**1.47**	**2.32**	**1.92**	**1.02**	**1.09**	**1.34**	**1.12**

The table reports the correlations among variables from 2006:1 to 2015:4. The dependent variables are *MES* and *SRISK*. $Size_{t-1}$ is the total assets at quarter (*t-1*); $Leverage_{t-1}$ is the total assets to equity ratio at quarter (*t-1*); $MTBV_{t-1}$ is the Market To Book Value ratio at quarter (*t-1*); STL_{t-1} is the Short-Term Liability ratio which captures the relative level of short-term wholesale funding as the total short-term debt minus cash to total liabilities ratio at quarter (*t-1*); $Beta_{t-1}$ is the equity market beta at quarter (*t-1*), calculated as the ratio between the covariance of the equity security on the market and the variance in the market; ERV_{t-1} is the Equity Returns Volatility, calculated as the standard deviation of the daily equity returns at quarter (*t-1*). VIF is the Variance Inflation Factor and it is used to detect collinearity. * denotes the statistical significance at 5% level.