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Systemic risk in non financial companies: Does governance matter?

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ABSTRACT

The paper investigates the impact of four key corporate governance mechanisms - board, audit, compensation and ownership, and anti-takeover provisions - on the exposure and contribution to systemic risk of >400 US non-financial companies (NFCs) listed in S&P500 from 2005 to 2020. Our results show that in NFCs, unlike in banks, good corporate governance practices constrain both systemic risk exposure and contribution. We find a complementary effect between internal corporate governance mechanisms in reducing both the contribution and the exposure to systemic risk, and a substitution effect between internal and external governance practices in constraining the exposure of NFCs to systemic risk. Moreover, strong corporate governance practices are shown to constrain systemic risk both in steady-state conditions and in times of distress.

1. Introduction

In the aftermath of the global financial crisis (GFC) of 2008, regulators, politicians and academics identified flaws in corporate governance practices as one of the main causes of the crisis (Basel Committee on Banking Supervision, 2010; Board of Governors of the Federal Reserve System, 2010; Srivastav & Hagendorff, 2016). After 2008, seemingly isolated risks spread across increasingly closely interconnected financial systems (Shi, Sun, & Jiang, 2022) and policy debate began about whether major banks had become both too big and too interconnected to fail. This led to the definition of Systemically Important Financial Institutions and the introduction of the Dodd-Frank Act in the US and Basel III in Europe. However, these regulations are not applied to non-financial companies (NFCs), even though after the GFC some big industrial enterprises, including Chrysler, Ford, and General Motors, received US government emergency loans on the basis of systemic risk and the need to stave off a larger crisis.

There are various reasons for believing that NFCs, like banks, are also potentially systemically important. First, close intra-sector links of NFCs through trade credit and supply and production chains can transmit adverse shocks throughout the system, thus creating a potential systemic crisis. Second, because NFCs are connected to financial companies through their financing and investment activities, big shocks on NFCs can also cause fragility in the financial system (Dungey, Flavin, O'Connor, & Wosser, 2022; Poledna, Hinteregger, & Thurner, 2018). The third reason is that today big-tech firms, such as Google, Amazon, Facebook, and Apple, are playing an increasingly important role in providing financial services. All this explains the bi-directional contagion between financial and non-financial companies when adverse shocks occur (Dungey, Flavin, & Lagoa-Varela, 2020; Dungey & Gajurel, 2015).

Although systemic risk in financial companies has already been closely investigated (Brunnermeier, Dong, & Palia, 2020; Stolbov & Shchepeleva, 2020; Weiß, Neumann, & Bostandzic, 2014), few studies so far have focused on NFCs. These papers show that NFCs are also systemically risky and identify the main firm economic and financial characteristics associated with systemic risk (Dungey et al., 2022; Zhu, Mao, Huang, Lin, & Niu, 2020). Only one of the papers, Dungey et al. (2022), considers corporate governance quality, measured by a global corporate governance score aggregating several internal and external governance practices. We believe however that a synthetic measure of governance is not suitable for this analysis, as the different dimensions of corporate governance could impact differently on the exposure and contribution of NFCs to systemic risk.

Our paper aims to overcome this limit by empirically investigating whether the systemic risk of US NFCs is affected by internal and external corporate governance practices, i.e., board, audit, compensation and ownership, and Anti-Takeover Provisions (ATPs). Specifically, we test the impact of different corporate governance mechanisms on both exposure and contribution to systemic risk, on a sample of 409 US NFCs over the period 2005–2020. We also investigate whether these practices are substitutes or complementary in influencing systemic risk and whether the "governance effect" is significant in both steady state and crisis periods.

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We extend prior literature from different points of view. First, to our knowledge, this paper is the first to study the impact of specific internal and external corporate governance practices on NFCs' risk exposure and contribution to systemic risk. Second, we investigate whether the different aspects of corporate governance are substitutes or complementary in affecting systemic risk of NFCs. In this way, our analysis extends previous studies on the interaction of different corporate governance mechanisms in affecting firm risk. Finally, we enrich previous literature on corporate governance in crisis periods by exploring whether corporate governance mechanisms influence systemic risk in steady-state conditions and in times of distress, considering three crisis periods.

From the corporate governance perspective, our focus on the US is particularly interesting as the country is characterized by a common law system which, according to previous literature (Mmselmi, 2020), could amplify the impact of corporate governance quality on systemic risk. As suggested by La Porta, Florencio, Andrei, and Robert (1998), bank financing mainly follows the stakeholder model in civil law countries, whereas it follows the shareholder model, based on the financial market economy, in common law countries such as the US and the UK. In common law countries, boards of directors may thus be more shareholder-friendly and, in order to improve firm profitability, more willing to increase the level of risk-taking than those in civil law countries. Moreover, in the last twenty years the continued development of financial engineering has encouraged speculation in short-term trading gains rather than in long-term profits, and if speculator shareholders outnumber other shareholders, the level of excessive risk may be higher. As this is the case for several US companies, US laws on the governance of financial markets need to be more stringent than in other countries and, for this reason, the government should perhaps be required to evaluate the introduction of new policies to prevent the spread of systemic risk among NFCs.

The remainder of the paper is organized as follows. Section 2 presents the literature review and formulates the hypotheses. Section 3 describes the sample and the variables used in the empirical analysis. Sections 4 and 5 report the methods and our empirical results, respectively. Section 6 shows our additional analyses and robustness checks. Finally, the last section summarizes the findings and concludes the paper.

2. Literature review and hypothesis development

Although it has been proved that the broader economy is a driver of systemic risk, in the last ten years academic attention has focused on the study of systemic risk in financial companies (Brunnermeier et al., 2020; Chu, Deng, & Xia, 2020; Stolbov & Shchepeleva, 2020; Weiß et al., 2014), and comparatively few papers have focused on NFCs. These show however that NFCs are systemically risky in the USA (Anginer, Demirguc-Kunt, Huizinga, & Ma, 2018, Dungey et al., 2022, Dungey, Luciani, & Veredas, 2018, Naeem, Karim, & Tiwari, 2022), in Europe (Poledna et al., 2018; Van Cauwenberge, Vancauteren, Braekers, & Vandemaele, 2019) and in China (Zhu et al., 2020). Specifically analyzing a network of Austrian firms, Poledna et al. (2018) find that about 29% of total systemic risk is attributable to interbank linkages, with the remainder emanating from bank-NFC and inter-NFC relationships.

Moreover, Zhu et al. (2020) and Dungey et al. (2022) find evidence of a link between systemic risk and some firm economic and financial characteristics, i.e., size, level of indebtedness, liquidity, profitability, level of globalization, firm age, and trade credit.

Among the few previous studies on systemic risk in NFCs, only Dungey et al. (2022) consider corporate governance as a variable potentially impacting on this kind of risk. They measure the corporate governance quality of US firms using the aggregate (global) Refinitiv ESG corporate governance scores and show that good corporate governance influences neither the exposure nor the contribution to systemic risk. Aggregate corporate governance measures have widely been used in the banking literature to capture both internal and external governance practices or the strength of board monitoring and oversight, and therefore to test the impact of corporate governance quality on systemic risks in financial companies (Iqbal, Strobl, & Vähämaa, 2015; Battaglia & Gallo, 2017[1, 2, 3, 4 and 5]; Anginer et al., 2018; Mmselmi, 2020; Addo, Hussain, & Iqbal, 2021). Although these global scores have the advantage of being synthetic, they have significant limitations in capturing the different dimensions of governance (Andries and Nistor, 2016;Addo et al., 2021; Battaglia & Gallo, 2017). Corporate governance is in fact a multidimensional construct, combining many practices which can be very different (Aggarwal, Erel, Ferreira, & Matos, 2011; Bebchuk, Cohen, & Ferrell, 2009; Gompers, Ishii, & Metrick, 2003). Individual governance mechanisms have a specific effectiveness in terms of organizational dynamics, and previous literature shows that their impact on performance outcomes and firm risks is also different (Filatotchev & Nakajima, 2010).

For this reason, some previous studies discourage the use of aggregate indicators, and disaggregate corporate governance in order to take account of different components, such as internal risk management mechanisms (Andries and Nistor, 2016) and board quality (Addo et al., 2021; Battaglia & Gallo, 2017). Moreover, recent studies (Avramov, Cheng, Lioui, & Tarelli, 2021; Berg, Kölbel, & Rigobon, 2022) on ESG ratings uncertainty, i.e., the lack of consistency of ESG ratings provided by different rating agencies, show that this inconsistency is particularly pronounced for governance ratings. Therefore, to date there are no shared aggregate measures to globally estimate corporate governance quality, and using disaggregated variables seem the most reasonable choice.

Despite some limitations related to small sample size, short periods, and the use of aggregate governance indicators, all previous studies show that financial institutions with stronger global corporate governance structures and shareholder-friendly board of directors are associated with higher levels of systemic risk, especially in common law countries (Mmselmi, 2020). This counterintuitive evidence has been explained by the fact that banks with shareholder-friendly boards took on more risks at the onset of the GFC (Beltratti & Stulz, 2012), encouraged by the moral hazard problems related to the benefit of explicit state guarantees in the form of risk-insensitive deposit insurance, and by potential implicit guarantees in the form of liquidity and additional regulatory capital (Anginer et al., 2018).

Previous literature shows that good corporate governance encourages rather than constrains excessive risk-taking among banks, but we question whether the same is true for NFCs. Unlike financial companies, NFCs cannot in fact rely on the safety nets of additional regulatory capital and deposit insurance systems, and they are also subject to stricter stakeholder control (Mehran, Morrison, & Shapiro, 2011). Moreover, previous literature shows that weak corporate governance mechanisms in NFCs are related to high levels of default risk (Li, Crook, Andreeva, & Tang, 2021), leading to financial instability (Ballester, González-Urteaga, & Martínez, 2020). We therefore assume that in well-governed NFCs, effective board oversight, together with other internal and external governance mechanisms, encourages management to act in the best interests of all stakeholders and not only shareholders (Shleifer & Vishny, 1997), and this discourages excessive risk-taking (Wu, Peng, Shan, & Zhang, 2020), thus reducing systemic risk.

In order to consider the multidimensional nature of corporate governance, we measure its quality by means of single attributes. Given the multiplicity of variables used in previous studies (Aggarwal, Erel, Stulz, & Williamson, 2009; Bebchuk et al., 2009; Gompers et al., 2003; Schnyder, 2012), we focus on practices covering the key governance categories identified by Aggarwal et al. (2011): board, audit, compensation and ownership, and ATPs. We follow the approach suggested by Aggarwal et al. (2011) for two reasons: in order to anchor this research to previous literature, and to place it into the field studying the interaction between the external governance instrument of ATPs and internal

governance measures (Drobetz & Momtaz, 2020; Lee & Chung, 2016). We believe in fact that board, audit, compensation and ownership, and ATPs, both jointly and stand-alone, could play a specific role in affecting systemic risk of NFCs, as detailed in the hypotheses below.

The board of directors is the most important internal governance mechanism in a firm (Iqbal et al., 2015). It has in fact the final responsibility for the functioning of the firm (Bhagat & Bolton, 2008; Jensen, 1993), so corporate risk-taking depends, among other factors, on the quality of monitoring and decision-making by the board of directors (Ferrero-Ferrero, Fernandez-Izquierdo, & Munoz-Torres, 2012).In this study, we analyze the impact on systemic risk of board strength, proxied by four main board quality characteristics: board size, board independence, board meeting frequency and board attendance.

With regard to board size, although an individual director's incentive to acquire information and monitor managers is low on large boards (Jensen, 1993), they are shown to facilitate manager supervision considering more human capital to advise managers (Andres & Vallelado, 2008) and to take fewer extreme decisions, since more effort is required to reach consensus in a large than a small group (Cheng, 2008). In this regard, we might expect that large board of directors reduces risk-taking in NFCs (Cheng, 2008; Mathew, Ibrahim, & Archbold, 2017; Nakano & Nguyen, 2012; Tai, Laib, & Yang, 2020), and therefore also their systemic risk. Moreover, the presence of a significant percentage of independent directors on boards is shown to monitor managers more effectively and constrain excessive risk-taking in NFCs (Borokhovich, Brunarski, Crutchley, & Simkins, 2004; Djerbi & Anis, 2015; Tai et al., 2020; Younas, Klein, Trabert, & Zwergel, 2019), as independent directors value maintaining their reputation in the directorship market (Bhagat & Black, 2002; Fama & Jensen, 1983). Moreover, independent directors are more sensitive to the regulatory compliance and will take more conservative and prudent action to avoid default (Phatan, 2009). Furthermore, board meeting frequency (Vafeas, 1999) and attendance of board members at these meetings (Di Vito & Trottier, 2021) are found to be effective mechanisms for monitoring executive behavior and excessive executive risk-taking. A higher number of board meetings and higher board meeting attendance are often advocated by regulators as ways of enhancing board effectiveness in public companies (Ji, Talavera, & Yin, 2020). Board meetings in fact strengthen cohesion and interactions between directors (Forbes & Milliken, 1999), providing them with more information about the firm (Lipton & Lorsch, 1992). From this point of view, the more frequent and better attended the meetings, the better the monitoring and control (Ji et al., 2020). This should lead to prudent actions to avoid default, thus reducing firm exposure and contribution to systemic risk. Therefore, we assume that:

H1. *Stronger boards on NFCs reduce their contribution and exposure to systemic risk.*

Prior literature has also explored the role of audit committees, their existence, financial expertise and members' independence as a corporate governance mechanism. Specifically, the independence of the audit committee improves monitoring (Bronson, Carcello, Hollingsworth, & Neal, 2009), decreases the possibility of fraud (Abbott, Parker, & Peters, 2004; Beasley & Salterio, 2001) and is thus shown to reduce risk-taking activities in NFCs (Carcello, Hermanson, & Ye, 2011; Dionne & Triki, 2005; Tai et al., 2020; Wan Mohammad, Nik Salleh, & Wan Yusoff, 2022). Therefore, we assume that:

H2. *High-quality audit in NFCs reduces their contribution and exposure to systemic risk.*

Among corporate governance mechanisms useful to align manager and shareholder interests, incentive-based compensation contracts are also shown to be effective, especially when monitoring costs are high, as in widely held US firms. Extant literature demonstrates that compensation plans which include long-term incentives and involve shareholders in the definition of management compensation discourage short-termism (Bebchuk & Fried, 2010; Edmans, Fang, & Huang, 2022; Larcker, 1983). Previous studies show that a higher proportion of variable and long-term incentives tend to reduce firm risk-taking (Wright, Kroll, Krug, & Pettus, 2007), so management team members receiving these incentives are expected to be more conservative, prudent, and careful to avoid default, thus reducing the exposure and contribution of NFCs to systemic risk. We therefore hypothesize that:

H3. *High-quality compensation plans in NFCs reduce their exposure and contribution to systemic risk.*

Another branch of literature argues that impediments to the efficient functioning of the market for corporate control, such as an external governance mechanism in the form of ATPs, may facilitate managers to make value-destroying investments. Classical theory suggests in fact that the threat of takeover reduces agency costs because it increases the probability that poorly performing agents will be dismissed (Drobetz & Momtaz, 2020). Previous literature shows therefore that ATPs reduce firm value and increase risk-taking in NFCs (Bebchuk et al., 2009; Gompers et al., 2003; Humphery-Jenner & Powell, 2011). Hence, ATPs could incentivize managers to make high-risk and value-destroying investments, thus increasing firm exposure and contribution to systemic risk. We therefore assume that:

H4. *ATPs in NFCs increase their contribution and exposure to systemic risk.*

We also investigate whether and how internal (board, audit, compensation and ownership) and external (ATPs) corporate governance mechanisms are substitutes or complementary in affecting the systemic risk of NFCs. In fact, firms usually employ several governance practices, or governance bundles, simultaneously, and their choice is the result of company decisions about resource allocation. The issue of whether various governance mechanisms have substitution or complementary roles is currently much debated in the literature. On the one hand, different governance practices may work jointly to reduce agency problems, and the presence of one practice may strengthen another. Mutually enhancing effects have in fact been found in NFCs between strong internal governance mechanisms and market for corporate control, and the absence of ATPs (Lee & Chung, 2016). On the other hand, governance practices may act as substitutes if one mechanism replaces another to increase shareholders' wealth (Hussain, Rigoni, & Orij, 2018; Sihag & Rijsdijk, 2019). Specifically, Drobetz and Momtaz (2020) show that ATPs may increase firm value in NFCs when internal corporate governance is sufficiently strong. So far only Addo et al. (2021) have investigated the combined effect of different governance mechanisms in affecting the level of systemic risk, and they focus only on the banking sector. They show that the systemic risk of large banks is higher when both external and internal corporate governance mechanisms complement each other. The role of various board-level governance mechanisms in determining the systemic risk of NFCs has not yet been investigated. Therefore, we test the following two competing hypotheses:

H5. *Internal corporate governance mechanisms and ATPs are complementary in reducing the exposure and the contribution to systemic risk of NFCs.*

H6. *Internal corporate governance mechanisms and ATPs are substitutes in reducing the exposure and the contribution to systemic risk of NFCs.*

Our analysis also led us to explore whether strong corporate governance mechanisms affect systemic risk both in steady-state conditions and in times of distress. Between 2005 and 2020, three different types of crises occurred one after the other: the 2008 GFC, the subsequent Eurozone sovereign debt crisis, and the Covid-19 pandemic. This has recently led some politicians to identify the state of crisis as a "new normal", which both people and firms must accept and learn to live with.

Agency theory (Jensen & Murphy, 1990) and the law and finance literature (La Porta et al., 1998) suggest that good governance

prescriptions in NFCs should enhance corporate value in the normal course of events, and from this received wisdom we derive that strong corporate governance mechanisms in NFCs should reduce systemic risk. But do these mechanisms apply universally in all situations, of do they fail in crisis periods? Previous literature shows that in the GFC, although they reduced firms' reliance on bank financing and increased their flexibility in terms of external financing (Nguyen, Nguyen, & Yin, 2015), certain corporate governance prescriptions designed to assure managerial oversight were not effective in improving firm performance (Essen, Engelen, & Carney, 2013). Other papers (Jebran & Chen, 2021; Zattoni & Pugliese, 2021) focus on the COVID-19 crisis and try to identify governance mechanisms which might help firms to cope. From an empirical point of view, Ferrero-Ferrero et al. (2012) demonstrate that good corporate governance mechanisms mitigated excessive corporate risk-taking both before and during the GFC. No studies have so far investigated whether good governance prescriptions affect systemic risk of NFCs during crisis periods. Therefore, on the basis of the findings by Ferrero-Ferrero et al. (2012), we assume that:

H7. *Internal corporate governance mechanisms and ATPs in NFCs reduce their exposure and contribution to systemic in both steady-state conditions and crisis periods.*

3. Sample

To construct our sample, we start from all publicly traded holding firms listed in the S&P500 index from 2005 to 2020. We collect data on daily stock price, stock market value and macroeconomic measures (LIBOR, government bond returns, corporate bond returns, the house price index and the US market indices) from Thomson Reuter Eikon. Our market data start on 01/01/2005 (first balance sheet data available) and end on 12/31/2020. The period under investigation therefore includes the GFC (2007–2009), the sovereign debt crisis in European countries (2010−2012), and the Covid-19 pandemic (2020). We exclude from our sample all financial companies (banks, insurance companies and other financial companies) because of the different characteristics of their activities and markets in general. Our final unbalanced sample is composed of 409 non-financial firms for a total of 6364 yearly observations.

Table 1 reports the distribution of our sample across different sectors.

4. Methods

4.1. Systemic risk measures

We use two measures to quantify systemic risk: i) the change in the conditional value at risk as a measure of the firm's contribution to systemic risk (ΔCoVar); and ii) the marginal expected shortfall as a measure of the individual firm's exposure to systemic risk (MES).

Following Adrian and Brunnermeier (2016), we define the ΔCoVar as the marginal contribution of a company to the financial sector's overall systematic risk.

The ΔCoVar can be defined as the difference between the financial system VaR conditional on firm distress ($CoVar_q^{system,|i}$) and the financial system's VaR conditional on firm i functioning on its median state ($CoVar_q^{system,|i,\ median}$).

$$\Delta CoVar_q^i = CoVar_q^{system,|i} - CoVar_q^{system,|i,median} \quad (1)$$

The $CoVar_q^{system,|i}$ represents the value at risk of the entire financial system conditional upon firm i being in distress. Similarly, the $CoVar_q^{system,|i,\ median}$ is the value at risk of financial system conditional on the firm operating in a non-distress situation (median state). q represents the quantile of the quantile regression. For the $CoVar_q^{system,|i}$ the quantile is 5%, while for $CoVar_q^{system,|i,\ median}$ the quantile is 50%.

We run the quantile regression to estimate α^i, β^i, $\alpha^{system|i}$, $\beta^{system|i}$ and $\gamma^{system|i}$ when the quantile is 5% and the $\alpha^{i,\ median} + \beta^{i,\ median}$ when the quantile is 50%.

$$R_t^i = \alpha^i + \beta^i Z_{t-1} + \varepsilon^i \quad (2)$$

$$R_t^{system} = \alpha^{system|i} + \beta^{system|i} Z_{t-1} + \gamma^{system|i} R_{t-1}^i + \varepsilon^{system|i} \quad (3)$$

$$R_t^i = \alpha^{i,median} + \beta^{i,median} Z_{t-1} + \varepsilon^{i,median} \quad (4)$$

R_t^i is the weekly growth of the market return equity of company i; the $R_t^{system}$is the weekly growth rate of the market value equity of all N firms included in our sample and represents the system of non-financial companies on the US market.

In Eqs. (2), (3) and (4), the macroeconomic variables at week t-1 are included in the vector Z_{t-1}. The weekly standard deviation of log market returns is determined to measure market volatility. We use the difference between three months LIBOR and three months T-bill rate to measure the liquidity.

The changes in three different variables are calculated:

a) the default risk: the change in the credit spread between 10-year BAA US corporate bonds and the 10-year T-bill rate;
b) the interest rate risk: the change in the three-month T-bill rate;
c) term structure: the change in the slope of the yield curve of government bonds (the yield spread between the 10-year government bond rate and the three-month T-bill rate).

Finally, we use the house price index (HPI) of the US market as proxy of the real estate return.[1] Following previous literature (Louhichi, Saghi, Srour, & Viviani, 2022; Wen, Weng, & Zhou, 2020), to estimate the yearly contribution to systemic risk, we first calculate a weekly measure of contribution to systemic risk, and then transform it into an annual measure as an average of the weekly estimates.

Since $\Delta CoVar_q^i$ is typically negative and a more negative value means a greater contribution to systemic risk, we use $-\Delta CoVar_q^i$ throughout the paper, indicating that an increase in the variable has to be interpreted as an increase in systemic risk.

To quantify the firm's exposure to systemic risk, we estimate the Marginal Expected Shortfall (MES) proposed by Acharya, Pedersen, Philippon, and Richardson (2017) (Eq. 5). The MES can be defined as the expected equity loss when the market itself is in its left tail. We evaluate the firm's MES at 5% risk level using the market daily return of firms included in our sample. We first consider the 5% worst days in any given year for the stock returns of NFCs listed on S&P500. Second, we sum stock returns of each firm on these 5% worst days for every year. Finally, we measure the average company stock returns on these worst days:

$$MES_{5\%}^i = \frac{\sum R_t^i}{\#days_{t,system\ in\ the\ tail\ 5\%}} \quad (5)$$

In the case of $MES_{5\%}^i$ we also use the $-MES_{5\%}^i$ in the regression model indicating that an increase in the variable is to be interpreted as an increase in systemic risk.

4.2. The empirical model

Following extant literature on the relationship between systemic risk and firm-level characteristics (Bostandzic & Weiss, 2018; Iqbal et al., 2015; Laeven, Ratnovski, & Tong, 2016), we run fixed-effect regressions on panel data. The model aims to detect the determinants of systemic risk in NFCs as follows:

[1] For more details on the $\Delta CoVar_q^i$ measurement, see Brunnermeier, M. K., Dong, G. N., & Palia, D. (2020) Banks' noninterest income and systemic risk *The Review of Corporate Finance Studies*, *9*(2), 229–255.

Table 1
Sample distribution across sectors.

Sectors	No. companies	No. Observations	%	Market value_average (000$)	Total Assets_average (000$)
Retail	116	1784	28.03	33,472,074	32,875,339
Healthcare	55	849	13.34	33,034,372	20,562,136
Industrial	66	1021	16.04	19,300,110	17,696,154
Real Estate	8	128	2.01	15,614,083	13,477,873
Technology	85	1328	20.87	47,773,286	30,250,615
Basic Materials	26	412	6.47	15,523,956	15,043,109
Utilities	28	446	7.01	16,770,566	36,139,535
Energy	25	396	6.22	52,240,136	52,418,967
Total	***409***	***6364***	***100***	***33,714,560***	***28,266,829***

Note: Table 1 reports the number of firms included in the sample, the number of observations, the average market value and the average total asset observed in each sector.

$$SYSTEMIC\_RISK_{i,t} = \alpha_{i,t} + \beta_1 CORPORATE\_GOVERNANCE_t + \beta_2\ FIRM\_CHARACTERISTICS_{t-1} + \beta_3\ CRISES + YEAR + \varepsilon_{i,t} \quad (6)$$

$SYSTEMIC\_RISK_{i,\ t}$ is the dependent variable and can take two meanings: contribution to systemic risk (estimated through ΔCoVar) and exposure to it (measured by MES).

Corporate governance variables are extracted from the Thomson Reuter Eikon Database. They are divided into four groups, covering the key corporate governance categories identified by Aggarwal et al. (2011): i) board; ii) audit, iii) compensation and ownership, and iv) anti-takeover provisions. In the first group (board) we consider four variables: a) board size (BOARD_SIZE), quantified as the natural logarithm of the total number of board members at the end of the fiscal year; b) board independence (BOARD_INDEP), measured by the percentage of independent board members; c) board meetings (BOARD_MEETING), estimated as the logarithm of the number of board meetings during the year; d) board meeting attendance (ATTENDANCE), measured by the average overall attendance percentage of board meetings. In the second area (audit) we consider the independence of the audit committee (AUDIT_INDEP), measured as the percentage of independent directors of the total members of the committee. In the third group (compensation and ownership) we include two variables: a) executive compensation (EXECUTIVE_COMP), a dummy variable that equals 1 (zero otherwise) where the answer to the following question is positive: "Is management and board member remuneration partly linked to objectives or targets which are more than two years forward looking?"; b) shareholder enrolment in compensation decisions (SH_APP_COMP), measured by a dummy variable that equals 1 (0 otherwise) when shareholders approve the executives' compensation plans. Finally, anti-takeover provisions are estimated through the anti-takeover variable (ANTI-TAKEOVER), which measures the number of anti-takeover provisions in place in excess of two.

Following previous literature (Anginer et al., 2018; Brunnermeier et al., 2020; Dungey et al., 2022; Van Cauwenberge et al., 2019; Varotto & Zhao, 2018; Zhu et al., 2020), we include some firm-specific characteristics as control variables: a) firm size (SIZE), measured by the natural logarithm of the market value at the end of the year; b) profitability, proxied by two measures. The first is the interest coverage ratio, i.e., the degree of coverage that the operating result is able to provide of the cost of financial charges (EBITDA). The second is the return on equity (ROE), which estimates firm profitability in relation to shareholders' equity; c) level of indebtedness, measured by total financial debt on total assets (DEBT_TA); d) growth opportunities (MARKET_BOOKVALUE), quantified by the market to book value ratio; e) firm's age (AGE), estimated through the natural logarithm of the difference between the year observed and the year of establishment; f) trade credit, measured by two variables: total receivable over total asset (TOTAL_RECEIVABLE) and accounts payable over total assets (ACCOUNT_PAYABLE); g) firm liquidity (CURRENT_RATIO), measured by the current ratio (current assets divided by current liabilities), which estimates the company's ability to pay short-term obligations within a horizon of one year. We winsorize our variables at 2% and 98% levels in order to avoid outliers.

To control for the crisis periods (Addo et al., 2021), we include in the model the *CRISES* dummies for the three crises from 2005 to 2020: a) the GFC, i.e. the subprime crisis in the banking sector, estimated through a dummy variable that equals 1 during 2007–2009, zero otherwise; b) the sovereign debt crisis which affected European government stability and, consequently, European economies, measured by a dummy variable that equals 1 during 2010–2012, zero otherwise; c) the COVID-19 pandemic, a dummy variable that equals 1 in 2020, and zero otherwise.

Finally, the vector *YEARS* refer to the time fixed effects.

All firm-specific variables - except size, age, and corporate governance vector - are inserted at time t-1. In all regression models we consider standard errors clustered at firm level.[2]

To investigate Hypotheses 5 and 6, following Panayi, Bozos, & Veronesi (2021) we run Eq. (6) including the interaction terms in a hierarchical manner, by adding each interaction term with the associated main effects in a separate model. For significant interactions, we also conduct simple slope tests (Addo et al., 2021; Aiken, West, & Reno, 1991; Cohen, Cohen, West, & Aiken, 2003; Panayi, Bozos, & Veronesi, 2021) and calculate the marginal effects of a specific corporate governance mechanism on systemic risk at different levels of the other governance mechanisms (low levels at 1 standard deviation below the average value, and high levels at 1 standard deviation above the average). This makes it possible to analyze how both internal and external governance mechanisms interact each other at different levels.[3]

Following Vives (1990) the conditions under which complementary and substitution matching between variables are assessed are the following:

a) Substitutive effect:

$$f(X_H, Y_H) - f(X_L, Y_H) \langle f(X_H, Y_L) - f(X_L, Y_L) \quad (7)$$

b) Complementary effect:

$$f(X_H, Y_H) - f(X_L, Y_H) \rangle f(X_H, Y_L) - f(X_L, Y_L) \quad (8)$$

where X and Y represent the corporate governance mechanisms of interest, while H and L denote the high and low levels of our corporate governance practices, respectively.

Finally, to test Hypothesis 7, we split our sample into two different

[2] The description of variables is reported in the Appendix, Table 1A.

[3] "Simple slopes are the sensitivity of the dependent variable on an independent variable at particular values of the moderator variable" (Panayi, Bozos, & Veronesi, 2021).

time periods: a) crisis period, and b) steady-state periods. This reveals whether strong corporate governance mechanisms affect systemic risk in both steady-state conditions and times of distress.

5. Empirical results

5.1. Descriptive statistics and univariate analysis

The descriptive statistics of the total sample, the average value of variables across different time periods and the analysis of variance are reported in Table 2. As can be seen, both corporate governance and balance-sheet firm characteristics are heterogeneous.

Table 2 shows that contribution and exposure to systemic risk of US NFCs both changed over time. In particular, the GFC and the Covid-19 pandemic amplified both exposure and contribution to risk, which were however lower during the sovereign debt crisis and, especially, in non-crisis periods.

With regard to corporate governance characteristics, on average the size of boards, the number of board meetings and board attendance remained stable over time, while the independence rate of both boards and audit committees rose significantly from 2005 to 2020. In this period our data also show clear improvements in shareholder involvement in compensation decisions. This confirms that the governance policy reforms made in the US after the GFC and the subsequent improvement in governance culture contributed to improving governance practices of US NFCs from 2005 to 2020. Further improvements are obviously desirable, particularly in terms of remuneration. Table 2 shows in fact that the percentage of firms in which management and board member remuneration is partly linked to objectives or targets which are more than two years forward looking is still low (22.5%).

In terms of firm-specific characteristics, the size of large US NFCs increased over time. This means that from 2005 to 2020, big US firms became bigger, which is particularly interesting in terms of exposure and contribution to systemic risk. Moreover, in the same 15-year period NFCs reduced their operating performance, trade receivables and payables, and increased their financial debts.

Table 3 shows the differences in term of variance across sectors. While the contribution to systemic risk is similar in all sectors (with an average ΔCoVAR of 3%), the exposure to systemic risk is higher for NFCs operating in the energy sector, as previously demonstrated by Kerste, Gerritsen, Weda, and Tieben (2015) and Dungey et al. (2022).

In the last univariate analysis, we compare the average and the median firms in the top systemic risk quartile (most risky) and the bottom quartile (least risky) in terms of ΔCoVAR and MES. Results are reported in Table 4. It shows the two-tailed *t*-tests of the difference in mean and Wilcoxon/Mann Whitney median tests.

These data show that, on average, larger, older, and more profitable firms are less likely to be identified as both very exposed and significant contributors to systemic risk than others. Focusing only on ΔCoVAR, NFCs characterized by more accounts payable, which we assume to be firms more closely linked to other firms, make a higher contribution to systemic risk. Moreover, looking at MES, Table 4 shows that companies extending more trade credit ("commercial lenders"), with lower growth opportunities and lower financial debt, are more exposed to systemic risk.

Looking at corporate governance mechanisms, focusing on the board and audit variables, almost all best practices in this area are shown to be associated with both lower exposure and lower contribution to systemic risk, except for the independence of the audit committees in the case of MES and the number of board meetings in the case of ΔCoVAR. Looking at compensation and ownership, NFCs where shareholders are involved in compensation decisions appear to be less exposed to systemic risk. Furthermore, NFCs adopting more anti-takeover measures show a higher contribution to systemic risk.

Regarding the evolution of systemic risk from 2005 to 2020, Fig. 1[4] shows not only that US NFCs were "affected" by systemic risk, but also that their exposure and contribution to it increased during periods of financial distress. Specifically, systemic risk, in terms of both MES and ΔCoVAR, shows its highest rates during the GFC and the Covid-19 pandemic, which reflects the fact that both crises involved the US directly. The sovereign debt crisis, on the other hand, appears to have had less impact on US NFCs, and affected their exposure more than their contribution to systemic risk, which is reasonable given that it was a European crisis.

Figs. 2 and 3 report the differences across sectors in terms of exposure and contribution respectively to systemic risk and reveal that sectors matter.

Fig. 2 shows that big differences exist across sectors in terms of exposure to systemic risk. Specifically, real estate companies were more exposed to systemic risk during the subprime crisis, as we would expect, while the utility industry showed the lowest exposure to the risk after the GFC. Looking at the contribution to systemic risk, Fig. 3 confirms that US NFCs made a bigger contribution during periods of financial distress, showing no particular differences across sectors, as suggested by Dungey et al. (2022).

5.2. Corporate governance mechanisms and systemic risk

We study the impact of different corporate governance practices on systemic risk of NFCs. We use single governance attributes covering the four key categories identified by Aggarwal et al. (2011): board (Model 1), audit (Model 2), compensation and ownership (Model 3), and anti-takeover provisions (Model 4). We detect the relationship between the different corporate governance practices and both the contribution (ΔCoVAR) and exposure to (MES) systemic risk. Table 5 reports our results.

Focusing on the contribution to systemic risk (Table 5(a)), no significant relationship emerges between board of directors (BOARD_SIZE; BOARD_INDEP; BOARD_MEETING; ATTENDANCE) and ΔCoVAR, which is however influenced by the independence of the audit committee (AUDIT_INDEP), management remuneration linked to medium-long term objectives (EXECUTIVE_COMP), shareholder involvement in the definition of management compensation (SH_APP_COMP) and ATPs (ANTI-TAKEOVER). This suggests that a higher percentage of independent directors on the audit committee can strengthen its monitoring activity, thus reducing management excessive risk-taking (Tai et al., 2020) and preventing firm specific shock from being transmitted to the overall system. Executive compensation schemes aiming to align manager and shareholder interests are shown to be another powerful tool for lowering the contribution of NFCs to systemic risk. Furthermore, our findings demonstrate that external governance practices, in the form of ATPs, also affect systemic risk. Specifically, ATPs lead managers to increase their risk-taking (Bebchuk et al., 2009), and therefore an NFC specific shock is more likely to be transmitted to the overall system.

On the other hand, focusing on the exposure to systemic risk (Table 5 (b)), no significant relationship emerges between the independence of the audit committee (AUDIT_INDEP) and MES, which is however affected by all the investigated variables relating to board strength (BOARD_SIZE; BOARD_INDEP; BOARD_MEETING; ATTENDANCE). Overall, board strength is shown to reduce the exposure of NFCs to

[4] Fig. 1, 2 and 3 report MES and ΔCoVAR without changing the initial values. In these graphs, the lower the value, the higher the systemic risk. Therefore, the more negative the MES and the *ΔCoVAR,* the higher the exposure and the contribution to systemic risk, respectively.

Table 2
Descriptive statistics and ANOVA test: NFCs' contribution and exposure to systemic risk during different time periods.

	TOTAL SAMPLE					NO CRISIS		GFC		SOVEREIGN		COVID-19		
Variable	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Obs	Mean	Obs	Mean	Obs	Mean	ANOVA
ΔCOVAR	5932	0.030	0.007	0.009	0.085	3378	0.028	1049	0.042	1096	0.027	409	0.040	***
MES	6364	0.024	0.018	0.016	0.164	3572	0.017	1193	0.036	1190	0.026	409	0.052	***
BOARD_SIZE	5009	2.344	0.226	0.000	2.890	2798	2.347	835	2.344	990	2.331	386	2.359	***
BOARD_INDEP	4996	0.815	0.109	0.000	1.000	2794	0.821	827	0.795	989	0.803	386	0.844	***
BOARD_MEETING	4979	1.989	0.378	0.000	3.761	2784	1.984	827	2.011	990	1.997	378	1.957	***
ATTENDANCE	4700	0.797	0.089	0.060	1.000	2651	0.797	705	0.769	977	0.796	367	0.799	*
AUDIT_INDEP	5072	0.995	0.034	0.333	1.000	3146	0.992	901	0.999	1025	0.991	388	0.999	*
EXECUTIVE_COMP♠	5028	0.225	–	–	–	2815	0.282	835	0.057	992	0.227	386	0.163	
SH_APP_COMP♠	5028	0.346	–	–	–	2815	0.379	835	0.198	992	0.292	386	0.559	***
ANTI-TAKEOVER	5027	4.908	2.600	0.000	11.000	2815	5.573	834	1.652	992	5.345	386	5.974	***
SIZE	5859	9.551	1.244	5.042	14.091	3336	9.692	1035	9.098	1079	9.277	409	10.26	***
EBITDA_OF	5273	36.625	85.583	−3.214	500.167	2876	33.967	980	49.816	1045	39.541	372	24.775	***
DEBT_TA	5786	0.259	0.162	0.000	0.860	3443	0.271	1086	0.239	1148	0.236	109	0.307	***
MARKET_BOOKVALUE	5558	5.860	31.116	0.223	1621.688	3333	5.665	1035	5.206	1079	4.747	111	23.610	*
AGE	5935	3.222	0.965	0.000	5.124	3377	3.239	1055	3.107	1094	3.198	409	3.427	***
TOTAL_RECEIVABLE	4955	0.100	0.077	0.000	0.556	2777	0.099	657	0.105	1118	0.103	397	0.095	***
ACCOUNT_PAYABLE	5606	0.072	0.082	0.000	0.753	3021	0.071	1042	0.077	1127	0.071	402	0.065	*
CURRENT_RATIO	5582	0.013	0.012	0.003	0.126	3046	0.019	1048	0.018	1107	0.014	388	0.012	***
ROE	5563	0.191	0.201	−0.322	0.929	3029	0.199	1046	0.165	1100	0.180	388	0.230	***

Note: Table 2 reports the descriptive statistics of variables used in the empirical models, with regard to the total sample and subsamples of different periods. In the last column the significance of the ANOVA test is reported. *,**,*** mean respectively 10%, 5% and 1% statistical significance. ♠ indicates the dummy variables that take value 1 or zero. For these variables we report the number of observations, and the percentage of the observations showing the characteristic(s) identified by the dummy variables.

systemic risk. Specifically, the financial market recognizes a lower vulnerability to system-wide shocks to NFCs where boards are large, meet frequently, and meeting attendance and the number of independent directors are high. This can be explained by the fact that a higher number of directors, especially independent directors, brings more knowledge and expertise to the board (Di Vito & Trottier, 2021) and lowers the cost of acquiring information and monitoring managers (Jensen, 1993), thus better containing executive excessive risk-taking (Tai et al., 2020). Moreover, frequent and well attended meetings encourage discussion among board members on how they wish to monitor managers and firm strategy, and thus promote better risk management practices. Furthermore, executive compensation contracts based on long-term incentives are also shown to reduce the exposure of NFCs to systemic risk, which is however enhanced by the implementation of ATPs.

Overall, our evidence totally supports H_3, while the validity of H_1, H_2 and H_4 is partially demonstrated in relation to exposure (H_2 and H_4) and contribution (H_1) to systemic risk. We can therefore state that well-governed NFCs, through various internal and external governance mechanisms, stimulate managers to avoid excessive risk-taking, thus reducing systemic risk. Previous literature shows that good corporate governance encourages rather than constrains excessive risk-taking among banks, but our findings are that the opposite occurs in NFCs. This could be because the "dark side to expertise" of board of directors, which during the GFC encouraged moral-hazard behaviors and led to increased systemic risk in banks (Mehran et al., 2011), is not present in NFCs. And unlike financial companies, NFCs cannot rely on the safety nets of additional regulatory capital and deposit insurance systems. NFCs are thus subject to stricter stakeholder control than banks, which means their governance is more effective in containing systemic risk.

We also include in the models some firm-specific characteristics as control variables.

In terms of contribution to systemic risk, Table 5(a) shows that larger and younger US NFCs, characterized by high levels of financial indebtedness (DEBT_TA) and low liquidity (CURRENT_RATIO), are those which most transmit firm-specific shocks to the overall system. In term of exposure to systemic risk, Table 5(b) shows that younger (AGE) and less profitable firms (ROE), characterized by high levels of financial indebtedness (DEBT_TA), low liquidity (CURRENT_RATIO), and low trade receivable (TOTAL_RECEIVABLE), are the most vulnerable US NFCs to system-wide shocks. These findings are consistent with most previous findings (Anginer et al., 2018; Dungey et al., 2022).

The dummy variables included in the model demonstrate the important role played by the macro-economic context in affecting systemic risk. Table 5 shows that during crisis periods NFCs enhance both their contribution and exposure to systemic risk, thus confirming the results of our univariate analysis. The magnitude of this impact differs according to the involvement of the USA in the crisis. Our findings show in fact that the GFC and the Covid-19 pandemic were the most severe crises in terms of contribution and exposure of NFCs to systemic risk. This is reasonable considering that both these crises directly involved the USA. The GFC has been the biggest financial crisis of the century so far, starting in the US financial market and rapidly spreading to the real economy, thus increasing systemic risk for NFCs, as shown by Dungey et al. (2022). The COVID-19 pandemic, on the other hand, started as a health crisis and quickly became an economic crisis too. Our results also demonstrate that, during the sovereign debt crisis, US NFCs lowered their contribution to systemic risk, at the same time as increasing their exposure to it. However, the increase was smaller, in terms of coefficients, compared to that of the other two crises. This is reasonable if we consider that the sovereign debt crisis originated and developed in Europe and was therefore exogenous for the USA.

We also investigate whether and how different corporate governance mechanisms complement or substitute each other in affecting systemic risk. Tables 6 and 6bis report our results.

Following Addo et al. (2021) and Becher and Frye (2011), to test hypotheses H_5 and H_6 we include our four corporate governance categories and their interactions, step by step, in Regression (6).[5] We also check the correlations between our corporate governance measures (Table 3A in the Appendix) and report the variance inflation factor (VIF) test (Table 4A in the Appendix). All the VIF values are lower than 2, suggesting that multicollinearity is not an issue in our models.

In Table 6 (Model 5) we interact the board of directors'

[5] We consider, respectively: board and audit, board and compensation, board and ownership, board and anti-takeover devices, audit and compensation, audit and antitakeover, and finally, compensation and antitakeover devices. All corporate governance and control variables are included as main effects. We mean-center all continuous regressors, before computing interactions.

Table 3
Analysis of variance across sectors.

Variable	BASIC_ MATERIAL		RETAIL		ENERGY		HEALTH CARE		INDUSTRIAL		REAL ESTATE		TECHNOLOGY		UTILITIES		ANOVA
	Obs	Mean	Obs	Mean	Obs	Mean	Obs	Mean	Obs	Mean	Obs	Mean	Obs	Mean	Obs	Mean	
ΔCOVAR	359	0.030	1633	0.030	354	0.030	825	0.031	957	0.030	128	0.030	1233	0.030	443	0.030	***
MES	412	0.026	1784	0.022	396	0.029	849	0.021	1021	0.026	128	0.027	1328	0.025	446	0.016	***
BOARD_SIZE	325	2.331	1409	2.388	300	2.345	646	2.319	783	2.355	111	2.300	1039	2.263	396	2.446	***
BOARD_INDEP	322	0.838	1406	0.773	300	0.850	643	0.835	783	0.835	111	0.820	1037	0.808	394	0.861	***
BOARD_MEETING	332	1.962	1394	1.938	306	2.052	637	2.068	777	1.896	111	1.962	1031	2.003	391	2.168	***
ATTENDANCE	310	0.837	1299	0.792	289	0.807	604	0.789	743	0.805	107	0.768	977	0.782	371	0.820	***
AUDIT_INDEP	334	0.992	1411	0.995	307	0.999	646	0.991	797	0.992	111	0.994	1047	0.997	396	0.998	***
EXECUTIVE_COMP♣	334	0.218	1411	0.216	307	0.198	646	0.252	784	0.193	111	0.171	1039	0.284	396	0.161	***
SH_APP_COMP♣	334	0.470	1411	0.350	307	0.433	646	0.306	784	0.278	111	0.369	1039	0.268	396	0.555	**
ANTI-TAKEOVER	334	5.080	1411	4.694	307	5.032	645	5.339	784	5.080	111	5.045	1039	4.988	396	4.143	***
SIZE	352	9.299	1607	9.596	348	10.073	822	9.480	945	9.387	128	9.288	1215	9.665	442	9.430	***
EBITDA_OF	357	16.676	1497	32.246	343	27.604	708	30.444	840	33.277	120	4.151	991	78.074	417	4.926	***
DEBT_TA	364	0.311	1600	0.278	346	0.221	785	0.239	932	0.256	120	0.488	1221	0.184	418	0.370	***
MARKET_BOOKVALUE	329	3.843	1524	6.852	327	2.891	778	4.760	900	7.457	120	3.889	1165	7.143	415	1.717	***
AGE	356	3.213	1673	3.297	362	3.231	814	3.327	946	3.350	128	2.936	1211	2.923	445	3.366	***
TOTAL_RECEIVABLE	338	0.105	1340	0.092	307	0.093	655	0.111	795	0.131	91	0.057	1039	0.109	390	0.035	***
ACCOUNT_PAYABLE	360	0.078	1562	0.110	342	0.086	752	0.051	909	0.068	100	0.029	1164	0.049	417	0.031	***
CURRENT_RATIO	359	0.011	1535	0.009	341	0.110	762	0.018	896	0.110	104	0.120	1169	0.021	416	0.005	***
ROE	356	0.208	1527	0.225	334	0.112	766	0.153	886	0.232	119	0.085	1161	0.200	414	0.101	***

Note: Table 3 reports the number of observations and the average value of the variables used in the empirical models, distinguishing the different sectors in which firms operate. The last column reports the significance of the ANOVA test. *, **, *** mean respectively 10%, 5% and 1% statistical significance. ♣ indicates the dummy variables that take value 1 or zero. For these variables we report the number of observations, and the percentage of the observations showing the characteristic(s) identified by the dummy variables.

characteristics with the audit independence. We observe that the variable interacting board and audit independence (BOARD_INDEP#AUDIT_INDEP) shows a negative and significant relationship with both ΔCoVAR and MES. The simple slope test suggests that the relationship between board independence and the contribution to systemic risk is significant when the audit independence is both high (simple slop 3.904; $p < 0.000$) and low (simple slope 3.9132; $p < 0.000$). Also considering MES, the relationship between audit independence and board independence is significant when audit independence is high (simple slop = 3.803, p-value<0.000) and low (simple slop = 3.814, p-value = 0.001). These two monitoring mechanisms thus work together in reducing the contribution and the exposure to systemic risk. Interacting the number of board meetings and the compensation of executive directors (BOARD_MEETING#EXECUTIVE_COMP) (Model 6), the relationship with ΔCoVAR is also negative and significant. The simple slope test suggests that the relationship between executive compensation linked to long term objectives and the contribution to systemic risk is significant when the number of board meetings is high (simple slope = −0.0861; $p = 0.000$), but not significant when it is low. Therefore, the two governance practices are complementary in limiting the contribution to systemic risk. Moreover, Model 7 shows a positive and significant relationship between the variable interacting board independence and the number of ATPs (BOARD_INDEP#ANTI_TAKEOVER) and ΔCoVAR. The simple slope test indicates that the relationship between the number of ATPs and ΔCoVAR is statistically significant both when board independence is low (simple slope − 0.2833; $p = 0.049$) and high (simple slope = 0.263; $p = 0.045$). We therefore conclude that there is a complementary effect between board independence and the number of ATPs.

Models 8, 9 and 10 show the results of MES. Looking at board characteristics and audit independence, only the interaction between board meeting attendance and audit independence (BOARD_MEETING#AUDIT_INDEP) shows a negative and significant relationship with MES. The single slope test suggests that NFCs where board meetings are more frequent have a lower exposure to systemic risk when the audit independence is both high (simple slope 1.893; $p = 0.050$) and low (simple slope = 1.897; p = 0.050). This demonstrates the complementary effect of these two corporate governance mechanisms in reducing the exposure to systemic risk. Model 9 shows that the interaction between board independence and shareholder enrolment in compensation decisions (BOARD_INDEP#SH_APP_COMP) is significant in constraining MES. The single slope test shows that the relationship between shareholder engagement in defining manager compensation and exposure to systemic risk is negative and statistically significant both when board independence is high (single slope = −4.449; $p = 0.006$) and low (single slop = 4.407; $p = 0.007$). These two monitoring mechanisms thus work together in reducing the exposure to systemic risk. Furthermore, Model 10 shows that the variable interacting board meeting attendance and the number of ATPs is positively and significantly related to MES. The simple slope test suggests that the relationship between board attendance and MES is positive and significant when the number of ATPs is low (simple slope = −2.413; p < 0.000), but is not significant when it is high (simple slope = 0.316; $p = 0.280$). In this case our findings demonstrate a substitution effect between ATPs and board attendance: in NFCs where the two corporate governance mechanisms work together, the exposure to systemic risk is higher.

In Table 6bis we report our evidence on the interactions between the other corporate governance mechanisms: a) audit independence and compensation (Models 11 and 14); b) audit independence and ATPs (Models 12 and 15) and finally, c) compensation and ATPs (Models 13 and 16). Our results show that, except for Model 16, where no statistically significant interactions are observed, in all our models at least one interaction is statistically significant in explaining the dependent variable. In particular, Model 11 shows that the interacted variable between executive compensation linked to long term objectives and audit independence (EXECUTIVE_COMP#AUDIT_INDEP) is significant in reducing

Table 4
Univariate comparison: top and bottom systemic risk quartiles.

	LOWEST CONTRIBUTION			HIGHEST CONTRIBUTION					LOWEST EXPOSURE			HIGHEST EXPOSURE				
Variable	Obs	Mean	Median	Obs	Mean	Median	T_TEST	Mann –Whitney test	Obs	Mean	Median	Obs	Mean	Median	T_TEST	Mann –Whitney test
ΔCoVAR	1477	0.027	0.025	1477	0.034	0.025	***	***	–	–		–	–		–	
MES	–	–	–	–	–	–	–		1585	0.009	0.007	1585	0.038	0.029	***	*
SIZE	1441	9.674	9.545	1448	9.413	9.420	***	***	1109	9.827	9.721	1575	9.301	9.324	***	***
EBITDA	1296	36.179	11.58	1366	36.959	10.807		*	1146	27.993	9.322	1372	35.258	11.039		
DEBT_TA	1401	0.265	0.263	1556	0.257	0.251			1241	0.292	0.307	1,51	0.254	0.243	***	***
MARKET_BOOKVALUE	1367	0.007	0.002	1369	0.006	0.003		***	1,04	0.008	0.002	1,5	0.005	0.002	*	***
AGE	1438	3.232	3.258	1582	3.040	3.091	***	***	1255	3.273	3.332	1549	3.093	3.091	***	***
TOTAL_RECEIVABLE	1206	0.099	0.082	1257	0.097	0.086			1087	0.078	0.059	1246	0.103	0.090	***	***
ACCOUNT_PAYABLE	1,36	0.067	0.044	1437	0.076	0.048	*		1178	0.073	0.037	1449	0.070	0.052		***
ROE	1365	0.187	0.159	1427	0.174	0.154	*		1163	0.212	0.159	1458	0.163	0.152	***	***
CURRENT_RATIO	1367	0.019	0.014	1453	0.020	0.015			1192	0.015	0.012	1455	0.022	0.017		***
BOARD_SIZE	1221	2.360	2.397	1,23	2.334	2.397	**	*	1022	2.396	2.397	1312	2.309	2.302	**	***
BOARD_INDEP	1215	0.824	0.846	1228	0.811	0.833	***	*	1018	0.832	0.857	1309	0.810	0.833	***	***
BOARD_MEETING	1215	1.986	1.947	1219	2.009	1.945		***	1,02	2.031	1.945	1304	1.984	1.945	*	***
ATTENDANCE	1153	0.801	0.750	1157	0.791	0.750	**	**	976	0.811	0.750	1227	0.786	0.750	***	***
AUDIT_INDEP	1245	0.999	1	1261	0.993	1	***		1461	0.994	1	1317	0.996	1	**	***
EXECUTIVE_COMP♠	1222	0.215		1235	0.219				1025	0.207		1317	0.251			
SH_APP_COMP♠	1222	0.367		1235	0.344				1025	0.500		1317	0.304			
ANTI-TAKEOVER	1222	4.784	5	1235	5.098	5	**	*	1025	4.918	5	1317	4.943	5		***
RETAIL♠	1477	0.235		1909	0.330				1585	0.359		1585	0.237			
HEALTHCARE♠	1477	0.122		1909	0.140				1585	0.156		1585	0.072			
INDUSTRIAL♠	1477	0.167		1909	0.139				1585	0.088		1585	0.189			
REAL_ESTATE♠	1477	0.021		1909	0.010				1585	0.018		1585	0.025			
TECHNOLOGY♠	1477	0.220		1909	0.207				1585	0.130		1585	0.255			
BASIC_MATERIALS♠	1477	0.049		1909	0.078				1585	0.050		1585	0.091			
UTILITIES♠	1477	0.106		1909	0.040				1585	0.164		1585	0.009			

Note: Table 4 reports the average value of variables shown as the highest/lowest contributors to systemic risk and the highest/lowest exposed firms to systemic risk. The highest contributors and exposed firms are NFCs in the top quartile of the distribution of ΔCoVAR and MES respectively, and the lowest contributors and exposed firms to systemic risk are NFCs in the bottom quartile of the distribution of systemic risk measures. In the columns T-TEST and Mann –Whitney we report the significance of the tests of the difference in means and medians, respectively. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. ♠ indicates the dummy variables that take value 1 or zero. For these variables we report the number of observations, and the percentage of the observations showing the characteristic(s) identified by the dummy variables.

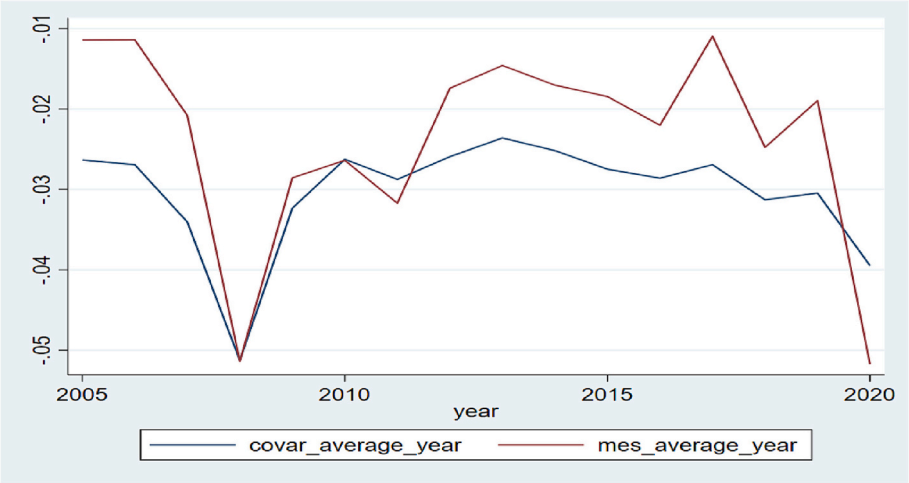

Fig. 1. MES and ΔCoVAR across the cycle.

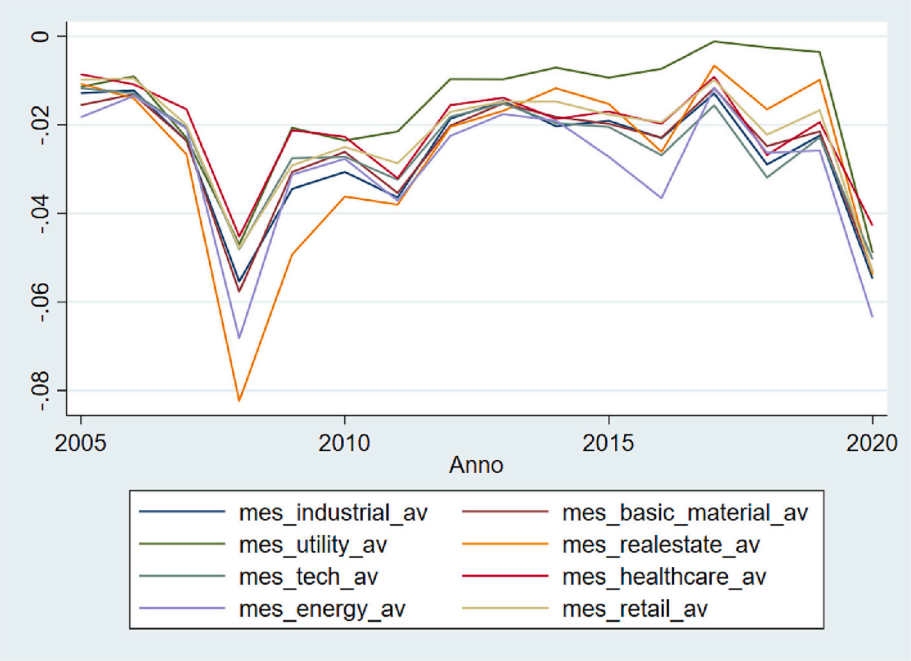

Fig. 2. MES across sectors.

ΔCoVAR. The simple slope test suggests that there is a negative relationship between executive compensation linked to long term objectives and contribution to systemic risk both when audit independence is high (simple slope = 1.309; $p < 0.001$) and low (simple slope = 1.407; p = 0.001). This means that the two monitoring mechanisms work together in reducing the contribution to systemic risk.

Model 12 reports our results on the interaction between the number of ATPs and audit independence (ANTI-TAKEOVER#AUDIT_INDEP), which shows a negative and significant relationship with the dependent variable. The simple slope test is significant only when the number of ATPs is low (simple slope = 0.007; $p = 0.001$), but not when it is high (simple slope = −0.005; $p = 0.187$). This result suggests that there is a complementary effect of these two corporate governance mechanisms in constraining the contribution to systemic risk. Moreover, also the interaction between executive compensation oriented to long term period and the number of ATPs (EXECUTIVE_COMP#ANTI-TAKEOVER) is also negative and significant in explaining the dependent variable. The simple slope test shows that the relationship between executive compensation linked to long term objectives and systemic risk is significant when the number of ATPs is low (simple slope = −0.109; $p = 0.030$), but not significant when it is high (simple slope = −0.103; $p = 0.530$). This result also suggests complementary effects of these two corporate governance measures.

Looking at the complementary or substitution effects of corporate governance mechanisms in terms of MES, Model 14 shows a negative and significant relationship between audit independence and shareholder enrollment in compensation decisions (SH_APP_COMP#AUDIT_INDEP) and the exposure to systemic risk. The simple slope test suggests that a link between shareholder engagement in manager compensation and MES exists when the audit independence is high (simple slope = 0.011; $p = 0.022$), but not when it is low (simple slope test = −0.001; $p = 0.884$). This means that when NFCs implement both

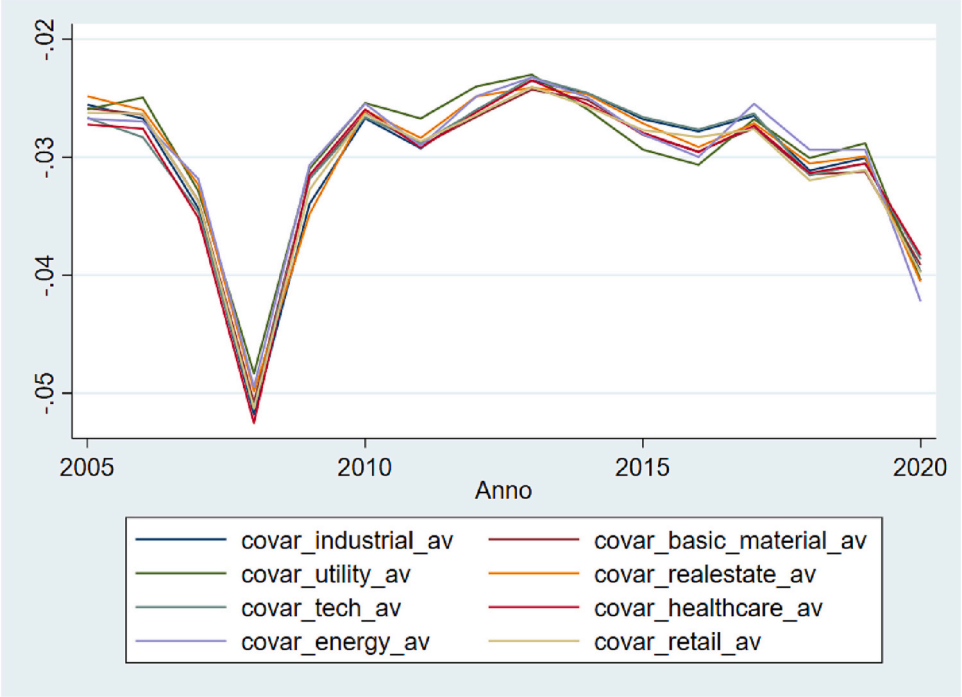

Fig. 3. ΔCoVAR across sectors.

governance mechanisms, the exposure to systemic risk is lower. Model 15 shows the positive and significant relationship between the variable interacting the number of ATPs and the audit independence (ANTI-TAKEOVER#AUDIT_INDEP) and MES. The simple slope test underlines a significant relationship when the number of ATPs is low (simple slope $= -0.190$; $p = 0.053$), but non-significant when it is high (simple slope $= -0.004$; $p = 0.998$). This finding suggests a substitution effect between ATPs and independence of the audit committee: when in a NFCs there is a low number of ATPs as well as high audit independence, the exposure to systemic risk is higher than when only one corporate governance mechanism is implemented.

Our overall results (Table 7) suggest that in corporate governance mechanisms there is no "one size fits all" solution. Depending on the internal and external governance practices implemented, the effect on systemic risk, as suggested by previous literature (Panayi, Bozos, & Veronesi, 2021), can be complementary or substitutive. In particular, our findings show that there is a complementary effect between internal corporate governance mechanisms in reducing both the contribution and the exposure to systemic risk. On the other hand, internal and external governance practices show a substitution effect in constraining the exposure of NFCs to systemic risk. Specifically, when a firm implements a low number of ATPs together with other internal corporate governance mechanisms, their impact on systemic risk is substitutable.

Table reports the summary of the results observed in Table 6 and 6bis.

Results reported in Table 5 demonstrate that during crisis periods, NFCs enhance their contribution and exposure to systemic risk. In this context, we further investigate whether strong corporate governance practices reduce systemic risk in steady-state conditions and in times of distress. In 2005–2020 three different crises occurred: the GFC, the subsequent Eurozone sovereign debt crisis, and the Covid-19 pandemic. Therefore, we subdivide our sample between steady-state conditions (NO CRISIS) and periods of financial distress (CRISIS). Our results are reported in Table 8. Table 8 shows only the coefficients of corporate governance variables, although we included in the regression models both time fixed effects and firm controls used in the main analysis (Table 5). In the CRISIS subsample we also controlled for the different kinds of crises (CRISES_FE).

Our findings show that a high number of independent directors sitting on the audit committee, shareholder involvement in the definition of management compensation and the implementation of less than two anti-takeover provisions are all factors which reduce the transmission of a firm specific shock to the overall system in both steady-state conditions and periods of financial distress. Only management incentive pay loses its power to limit firm contribution to systemic risk during crisis periods. Moreover, our results show that the financial market, in both steady-state and crisis periods, recognizes a lower vulnerability to system-wide shocks to NFCs where boards are large and implement executive compensation mechanisms aiming to align manager and shareholder interests. ATPs, on the other hand, are shown to increase the exposure to systemic risk only during non-crisis periods.

Our analysis thus demonstrates that in crisis periods too, good corporate governance practices are effective in reducing the exposure and contribution of NFCs to systemic risk.

6. Robustness checks and additional analyses

We test the robustness of our results on the relationship between corporate governance mechanisms and systemic risk in NFCs.

First, we include sector fixed effect in Eq. (6). Our findings (Table 9) confirm our previous main analysis (Table 5). Specifically, strong boards, executive compensation schemes that align manager and shareholder interests and the absence (or very limited implementation) of ATPs constrain the contribution of NFCs to systemic risk (Table 9,

Table 5
Regression results: corporate governance mechanisms and systemic risk.

	(a) ΔCoVar				(b) MES			
VARIABLES	Mod 1	Mod 2	Mod 3	Mod 4	Mod 1	Mod 2	Mod 3	Mod 4
BOARD_SIZE	−0.031				−0.412***			
	(0.033)				(0.095)			
BOARD_INDEP	−0.055				−0.396*			
	(0.064)				(0.215)			
BOARD_MEETING	0.001				−0.090*			
	(0.018)				(0.053)			
ATTENDANCE	−0.080				−0.872***			
	(0.074)				(0.206)			
AUDIT_INDEP		−0.440**				−0.513		
		(0.203)				(0.364)		
EXECUTIVE_COMP			−0.023*				0.043	
			(0.013)				(0.040)	
SH_APP_COMP			−0.008*				−0.093**	
			(0.013)				(0.040)	
ANTI-TAKEOVER				0.010***				0.025***
				(0.002)				(0.008)
SIZE	0.027***	0.0264***	0.023***	0.024***	0.004	−0.000	−0.016	−0.024
	(0.007)	(0.00744)	(0.007)	(0.007)	(0.020)	(0.0186)	(0.019)	(0.018)
EBITDA(t-1)	0.000	5.54e-05	0.000	0.000	−0.001	0.000	−0.001	−0.000
	(0.000)	(0.000124)	(0.000)	(0.000)	(0.000)	(0.000282)	(0.000)	(0.000)
DEBT_TA(t-1)	0.172***	0.189***	0.177***	0.174***	0.354*	0.353*	0.308*	0.276
	(0.056)	(0.0595)	(0.057)	(0.057)	(0.190)	(0.188)	(0.185)	(0.186)
MARKET_BOOKVALUE(t-1)	−0.605	−0.319	−0.532	−0.535	0.253	1.281	0.474	0.551
	(0.375)	(0.479)	(0.378)	(0.372)	(0.951)	(1.361)	(0.993)	(0.997)
AGE	−0.019**	−0.00348	−0.017*	−0.013	−0.122***	−0.144***	−0.136***	−0.137***
	(0.008)	(0.00855)	(0.008)	(0.008)	(0.022)	(0.0235)	(0.023)	(0.023)
ACCOUNT_PAYABLE(t-1)	0.028	0.161*	0.0998	0.105	−0.397	−0.318	−0.341	−0.290
	(0.090)	(0.0928)	(0.089)	(0.089)	(0.253)	(0.242)	(0.244)	(0.244)
TOTAL_RECEIVABLE(t-1)	−0.097	0.0467	−0.081	−0.061	−2.056***	2.125***	−1.993***	−1.926***
	(0.104)	(0.110)	(0.103)	(0.104)	(0.299)	(0.296)	(0.297)	(0.300)
CURRENT_RATIO(t-1)	−1.592***	−0.496	−1.193**	−1.277**	−7.530***	11.11***	−9.215***	−9.402***
	(0.551)	(0.569)	(0.552)	(0.547)	(1.498)	(1.462)	(1.473)	(1.452)
ROE(t-1)	−0.038	−0.0232	−0.042	−0.038	−0.761***	−0.686***	−0.695***	−0.689***
	(0.034)	(0.0344)	(0.033)	(0.033)	(0.107)	(0.111)	(0.107)	(0.107)
GFC	0.946***	0.986***	0.959***	1.007***	2.002***	2.025***	2.016***	2.125***
	(0.042)	(0.0394)	(0.040)	(0.041)	(0.104)	(0.0989)	(0.101)	(0.107)
SOVEREING	−0.035***	−0.0294**	−0.040***	−0.034***	0.976***	0.992***	0.959***	0.973***
	(0.011)	(0.0117)	(0.011)	(0.011)	(0.045)	(0.0450)	(0.045)	(0.045)
COVID	1.168***	0.133***	1.176***	1.174***	3.457***	0.497***	3.499***	3.476***
	(0.026)	(0.0174)	(0.026)	(0.025)	(0.091)	(0.0622)	(0.087)	(0.087)
Constant	2.712***	2.887***	2.558***	2.475***	4.072***	2.404***	2.139***	2.047***
	(0.126)	(0.218)	(0.084)	(0.084)	(0.349)	(0.406)	(0.218)	(0.223)
Observations	3953	4395	4166	4165	3953	4395	4166	4165
R-squared	0.513	0.511	0.514	0.515	0.448	0.433	0.440	0.441
YEAR_FE	YES	YES	YES	YES	YES	YES	YES	YES

Note: Table 5 reports results of the OLS regression with time fixed effects. The dependent variables are ΔCoVAR and MES. The independent variables are the corporate governance characteristics, firm characteristics, and crisis dummies. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

(a)). Furthermore, firm exposure to systemic risk (Table 9, (b)) is reduced by board strength and shareholder involvement in executive compensation, while it is enhanced by the adoption of more than two ATPs.

Second, we control for endogeneity bias linked to corporate governance mechanisms. The problem of endogeneity is common in corporate governance literature. Although previous studies typically implement cross-sectional Ordinary Least Square (OLS) regressions where corporate governance measures are taken as exogenous variables (Vafeas, 1999; Yermack, 1996), recent papers have shown that corporate governance variables cannot be considered exogenous, as their implementation depends on firm decisions (Addo et al., 2021; Tai et al., 2020). This is why corporate governance analyses may suffer from "unobserved heterogeneity" problems; the observed relationship may depend on unobserved factors. All these issues may lead to biased coefficients when the OLS is implemented. To establish whether our corporate governance measures are endogenous, we run the Durbin and Wu–Hausman test, with the null hypothesis that our variables are exogenous. The *p*-values of the tests are reported in Table 10 and show that they are statistically significant. This confirms that our independent variables are endogenous and that the findings of our analysis above may be biased. To overcome this limit, we use a two-stage last square regression (2sls), the most frequently used model which can take account of both unobserved heterogeneity and simultaneous causality. Following previous literature (Addo et al., 2021), we include in the first-stage regression the average corporate governance mechanisms at country level as instrumental variables. The results of the second-stage regression are reported in Table 10 and strongly confirm the results shown in Table 5. Moreover, to verify the appropriateness of our instrumental variables, we run the Sargan and Basmann tests to check

Table 6
Regression results: complementary vs substitutive corporate governance drivers of NFCs' systemic risk.

	(a) ΔCoVAR			(b) MES		
VARIABLES	Mod5	Mod6	Mod7	Mod8	Mod9	Mod10
BOARD_SIZE	0.042	−0.007**	−0.008*	0.052	−0.045***	−0.050***
	(0.072)	(0.003)	(0.004)	(0.228)	(0.010)	(0.011)
BOARD_INDEP	−3.909***	−0.047	−0.057	−2.569*	−0.268	−0.403
	(0.949)	(0.075)	(0.082)	(0.693)	(0.248)	(0.273)
BOARD_MEETING	0.0550	0.032	0.035	−1.896**	−0.064	−0.063
	(0.475)	(0.020)	(0.023)	(0.967)	(0.062)	(0.071)
ATTENDANCE	−0.160	−0.162**	−0.172**	−0.006	−0.845***	−1.049***
	(1.797)	(0.075)	(0.083)	(6.023)	(0.210)	(0.219)
AUDIT_INDEP	−0.009***	–	–	−0.002	–	–
	(0.002)			(0.005)		
EXECUTIVE_COMP	–	−0.049***	–	–	0.033	–
		(0.013)			(0.041)	
SH_APP_COMP	–	0.009	–	–	−0.014	–
		(0.015)			(0.044)	
ANTI-TAKEOVER	–	–	0.010***	–	–	0.015
			(0.003)			(0.009)
BOARD_SIZE#AUDIT_INDEP	−0.001	–	–	−0.001	–	–
	(0.000)			(0.002)		
BOARD_INDEP#AUDIT_INDEP	−0.039***	–	–	−0.023*	–	–
	(0.009)			(0.017)		
BOARD_MEETING#AUDIT_INDEP	−0.001	–	–	−0.018*	–	–
	(0.004)			(0.009)		
ATTENDANCE#AUDIT_INDEP	0.000	–	–	−0.008	–	–
	(0.018)			(0.061)		
BOARD_SIZE#EXECUTIVE_COMP	–	−0.005	–	–	0.015	–
		(0.006)			(0.019)	
BOARD_INDEP#EXECUTIVE_COMP	–	0.075	–	–	−0.200	–
		(0.140)			(0.456)	
BOARD_MEETING #EXECUTIVE_COMP	–	−0.096**	–	–	−0.164	–
		(0.039)			(0.121)	
ATTENDANCE#EXECUTIVE_COMP	–	0.076	–	–	−0.110	–
		(0.154)			(0.459)	
BOARD_SIZE#SH_APP_COMP	–	−0.007	–	–	−0.027	–
		(0.006)			(0.019)	
BOARD_INDEP#SH_APP_COMP	–	0.202	–	–	−1.288***	–
		(0.148)			(0.475)	
BOARD_MEETING#SH_APP_COMP	–	−0.031	–	–	−0.069	–
		(0.039)			(0.129)	
ATTENDANCE#SH_APP_COMP	–	0.131	–	–	−0.072	–
		(0.149)			(0.421)	
BOARD_SIZE#ANTI_TAKEOVER	–	–	0.001	–	–	0.003
			(0.002)			(0.004)
BOARD_INDEP#ANTI_TAKEOVER	–	–	0.079*	–	–	0.168
			(0.041)			(0.124)
BOARD_MEETING#ANTI_TAKEOVER	–	–	−0.004	–	–	−0.023
			(0.011)			(0.030)
ATTENDANCE#ANTI_TAKEOVER	–	–	0.053	–	–	0.525***
			(0.046)			(0.112)
Constant	3.315***	2.413***	2.414***	1.673***	1.388***	1.299***
	(0.226)	(0.093)	(0.090)	(0.591)	(0.247)	(0.244)
Observations	3721	3721	3721	3721	3721	3721
R-squared	0.382	0.383	0.382	0.293	0.296	0.298
FIRM CHARACTERISTICS	YES	YES	YES	YES	YES	YES
YEAR_FE	YES	YES	YES	YES	YES	YES

Note: Table 6 reports results of the OLS regression with time fixed effects. The dependent variables are the ΔCoVAR and MES. The independent variables are the corporate governance characteristics. We also include firm controls and time fixed effect. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 6bis
Continue of Regression results: complementary vs substitutive corporate governance drivers of NFCs' systemic risk.

	(a) ΔCoVAR			(b) MES		
VARIABLES	Mod11	Mod12	Mod13	Mod14	Mod15	Mod16
AUDIT_INDEP	−0.005***	−0.001*	–	−0.005	−0.009*	–
	(0.001)	(0.000)		(0.003)	(0.005)	
EXECUTIVE_COMP	−1.359***	–	−0.059***	0.286	–	0.009
	(0.402)		(0.017)	(1.010)		(0.049)
SH_APP_COMP	−0.056	–	0.006	−1.157*	–	−0.090**
	(0.354)		(0.016)	(0.727)		(0.045)
ANTI-TAKEOVER	–	0.245***	0.007**	–	0.339*	0.016*
		(0.091)	(0.003)		(0.202)	(0.009)
EXECUTIVE_COMP#AUDIT_INDEP	−0.014***	–	–	−0.002	–	–
	(0.004)			(0.010)		
SH_APP_COMP#AUDIT_INDEP	0.001	–	–	−0.012*	–	–
	(0.003)			(0.007)		
ANTI-TAKEOVER#AUDIT_INDEP	–	−0.002***	–	–	0.003*	–
		(0.001)			(0.002)	
EXECUTIVE_COMP#ANTI-TAKEOVER	–	–	−0.019**	–	–	0.031
			(0.008)			(0.022)
SH_APP_COMP#ANTI-TAKEOVER	–	–	0.008	–	–	0.018
			(0.008)			(0.021)
Constant	3.022***	2.579***	2.504***	2.270***	2.799***	1.682***
	(0.194)	(0.261)	(0.087)	(0.414)	(0.566)	(0.221)
Observations	3876	3876	3876	3876	3876	3876
R-squared	0.387	0.387	0.387	0.289	0.289	0.290
FIRM CHARACTERISTICS	YES	YES	YES	YES	YES	YES
YEAR_FE	YES	YES	YES	YES	YES	YES

Note: Table 6bis reports results of the OLS regression with time fixed effects. The dependent variables are the ΔCoVAR and MES. The independent variables are the corporate governance characteristics. We also include firm controls and time fixed effect. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 7
Summarize of complementary and substitute hypotheses.

	ΔCoVAR	MES
BOARD_INDEP#AUDIT_INDEP	*Complementarity Hypothesis*	*Complementary Hypothesis*
BOARD_MEETING#AUDIT_INDEP	–	*Complementarity Hypothesis*
BOARD_MEETING #EXECUTIVE_COMP	*Complementarity Hypothesis*	–
BOARD_INDEP#SH_APP_COMP	–	*Complementarity Hypothesis*
BOARD_INDEP#ANTI_TAKEOVER	*Complementarity Hypothesis*	–
ATTENDANCE#ANTI_TAKEOVER	–	*Substitution hypothesis*
EXECUTIVE_COMP#AUDIT_INDEP	*Complementarity Hypothesis*	–
SH_APP_COMP#AUDIT_INDEP	–	*Complementarity Hypothesis*
ANTI-TAKEOVER#AUDIT_INDEP	*Complementarity Hypothesis*	*Substitution hypothesis*
EXECUTIVE_COMP#ANTI-TAKEOVER	*Complementarity Hypothesis*	–

for over-identification. Table 10 reports that for both tests the p-value is high, which means that our instrumental variables are valid.

Finally, as last robustness check, we detect whether the complementary and substitutive effects of different corporate governance variables found in our main analysis are confirmed also distinguishing between crisis and non-crisis periods. We therefore run the regressions performed in Table 8 on the two subsamples referred to crisis and steady-state conditions. Results are reported in Tables 11 and 12, respectively.

Splitting the sample, previous findings are mainly confirmed. Specifically, both in crisis and non-crisis periods the interactions between BOARD_INDEP and AUDIT_INDEP, BOARD_MEETING and AUDIT_INDEP, BOARD_MEETING and EXECUTIVE_COMP, EXECUTIVE_COMP and AUDIT_INDEP, and ANTI-TAKEOVER and AUDIT_INDEP are the same observed for the whole sample.

Moreover, in some cases we find some additional complementary and substitution effects. Specifically, the interaction between BOARD_INDEP and SH_APP_COMP confirms, both in crisis and non-crisis periods, the complementary hypothesis for MES shown in our baseline results, but only during non-crisis period a complementary effect emerges for the ΔCoVAR. Similarly, in the case of the interaction between EXECUTIVE_COMP and ANTI-TAKEVOER, in addition to the complementary effect observed for ΔCoVAR in the two subsamples, as in our main analysis, only during crisis periods we find a substitution effect for MES.

Overall, this robustness check confirms the complementary effect between internal corporate governance mechanisms in reducing both the contribution and the exposure to systemic risk, and the substitution effect between internal and external governance practices in constraining the exposure of NFCs to systemic risk.

The summary of the complementary or substitution relationships between the corporate governance measures and the dependent variables are reported in Table 13.

7. Conclusions

Although the important role of corporate governance is unanimously recognized in determining risks in NFCs, extant literature has so far given very little attention to its role in explaining systemic risk. We extend knowledge in this area by studying the case of US NFCs listed in the S&P500 from 2005 to 2020.

Our findings have important implications for theory, practice and policy.

Table 8
Regression results: corporate governance mechanisms and systemic risk in crisis and steady-state periods.

VARIABLES	(a) NO CRISIS ΔCoVAR				MES				(b) CRISIS ΔCoVAR				MES			
BOARD_SIZE	−0.034	–	–	–	−0.494***	–	–	–	−0.038	–	–	–	−0.341*	–	–	–
	(0.037)				(0.093)				(0.059)				(0.186)			
BOARD_INDEP	0.003	–	–	–	−0.092	–	–	–	−0.123	–	–	–	−0.835*	–	–	–
	(0.069)				(0.184)				(0.120)				(0.452)			
BOARD_MEETING	−0.006	–	–	–	−0.107**	–	–	–	0.004	–	–	–	−0.068	–	–	–
	(0.019)				(0.052)				(0.034)				(0.105)			
ATTENDANCE	−0.119	–	–	–	−0.886***	–	–	–	−0.037	–	–	–	−0.800**	–	–	–
	(0.073)				(0.214)				(0.151)				(0.404)			
AUDIT_INDEP	–	−0.535***	–	–	–	−0.778**	–	–	–	−1.440***	–	–	–	1.185	–	–
		(0.207)				(0.360)				(0.484)				(2.930)		
EXECUTIVE_COMP	–	–	−0.031**	–	–	–	−0.103**	–	–	–	0.001	–	–	–	−0.063	–
			(0.014)				(0.040)				(0.027)				(0.092)	
SH_APP_COMP	–	–	−0.034**	–	–	–	−0.019	–	–	–	−0.080***	–	–	–	−0.208**	–
			(0.014)				(0.042)				(0.028)				(0.084)	
ANTITAKEOVER	–	–	–	0.011***	–	–	–	0.062***	–	–	–	0.009*	–	–	–	−0.011
				(0.003)				(0.008)				(0.005)				(0.016)
Constant	2.544***	2.367***	2.430***	2.294***	3.325***	1.664***	1.502***	1.074***	3.946***	3.826***	3.681***	3.933***	7.176***	5.012***	4.994***	6.908***
	(0.133)	(0.076)	(0.085)	(0.084)	(0.331)	(0.192)	(0.206)	(0.202)	(0.235)	(0.143)	(0.156)	(0.173)	(0.714)	(0.361)	(0.426)	(0.492)
Observations	2321	2522	2434	2434	2321	2522	2434	2434	1632	1873	1732	1731	1632	1873	1732	1731
R-squared	0.031	0.034	0.035	0.035	0.092	0.074	0.074	0.089	0.550	0.520	0.536	0.535	0.317	0.284	0.301	0.299
YEAR_FE	YES	YES	YES	YES	YES	YES	YES	YES	NO	NO	NO	NO	NO	NO	NO	NO
CRISIS_CONTROL	NO	NO	NO	NO	NO	NO	NO	NO	YES	YES	YES	YES	YES	YES	YES	YES
FIRM_CONTROL	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Note: Table 8 reports results of the OLS regression with time fixed effects on two subsamples: NO CRISIS refers to quiet years; CRISIS is the period of crises observed during the last 15 years. The dependent variables are ΔCoVAR and MES. The independent variables are the corporate governance characteristics. We include also firm and crisis controls. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Theoretically, our analysis shows that many corporate governance mechanisms significantly reduce the contribution and the exposure of US NFCs to systemic risk. This result is very interesting when compared to previous studies on the banking sector, which almost unanimously show that good corporate governance raises rather than lowers systemic risk among banks. We demonstrate that the opposite occurs in well-governed NFCs where, in the absence of safety nets related to additional regulatory capital and deposit insurance systems, effective oversight of boards and audit committees, together with long-term executive-pay incentives, appears to encourage the management to act in the best interests of all stakeholders, thus avoiding excessive risk-taking and lowering systemic risk.

Specifically, the transmission of firm specific shock to the overall system is shown to be reduced by a high number of independent directors sitting on the audit committee and executive compensation schemes aiming to align manager and shareholder interests. It is shown to be enhanced by the number of ATPs hindering the efficient functioning of the market for corporate control. On the other hand, the financial market recognizes as less vulnerable to system-wide shocks NFCs with the following characteristics: strong boards (where boards are large, meet frequently, and meeting attendance and the number of independent directors are high), shareholder approval of executive compensation contracts and an absence or very low number of ATPs.

Moreover, we extend previous studies on the interaction of different corporate governance mechanisms in affecting firm risk. Specifically, we demonstrate that there is a complementary effect between internal corporate governance mechanisms in reducing both the contribution and the exposure to systemic risk. However, there appears to be a substitution effect between internal and external governance practices in constraining the exposure of NFCs to systemic risk.

Finally, our analysis enriches the debate on contingency approaches in comparative corporate governance as we show that, in crisis periods too, good corporate governance is effective in reducing both the exposure and the contribution of NFCs to systemic risk.

Practically, our findings are useful for managers in identifying specific corporate governance practices which will limit the contribution and/or the exposure of NFCs to systemic risk. Our analysis shows in fact that applying a "one size fits all" set of governance measures is not effective in decreasing systemic risk. Some corporate governance variables reduce firm contribution to systemic risk, while others reduce exposure to it. NFCs thus require strategic flexibility in designing a bundle of governance practices to achieve the desired level of systemic risk.

From the policy point of view, our findings suggest that supervisory authorities should consider the important role played by both internal and external corporate governance measures in NFCs in reducing systemic risk. Monitoring these variables and stimulating good governance practices among NFCs would therefore be a useful tool for supervisors in limiting systemic risk.

CRediT authorship contribution statement

Doriana Cucinelli: Data curation, Methodology, Software, Writing – review & editing. **Maria Gaia Soana:** Conceptualization, Writing – original draft.

Declaration of Competing Interest

None.

Table 9
Robustness check using sector fixed effect.

VARIABLES	(a) ΔCoVAR				(b) MES			
BOARD_SIZE	−0.038	–	–	–	−0.152*	–	–	–
	(0.034)				(0.093)			
BOARD_INDEP	0.021	–	–	–	−0.158*	–	–	–
	(0.067)				(0.205)			
BOARD_MEETING	0.004	–	–	–	0.014	–	–	–
	(0.018)				(0.050)			
ATTENDANCE	−0.055	–	–	–	−0.547***	–	–	–
	(0.075)				(0.189)			
AUDIT_INDEP	–	−0.373*	–	–	–	−0.418	–	–
		(0.203)				(0.365)		
EXECUTIVE_COMP	–	–	−0.026**	–	–	–	0.008	–
			(0.013)				(0.036)	
SH_APP_COMP	–	–	−0.002*	–	–	–	−0.029*	–
			(0.004)				(0.037)	
ANTI-TAKEOVER	–	–	–	0.008***	–	–	–	0.006*
				(0.002)				(0.008)
SIZE	0.027***	0.027***	0.022***	0.024***	−0.013	−0.014	−0.026	−0.023
	(0.007)	(0.007)	(0.007)	(0.007)	(0.021)	(0.017)	(0.019)	(0.018)
EBITDA(t-1)	0.000	−0.000	0.000	0.000	−0.001	−0.000	−0.000	−0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
DEBT_TA(t-1)	0.172***	0.202***	0.191***	0.184***	0.846***	0.839***	0.831***	0.837***
	(0.059)	(0.060)	(0.059)	(0.059)	(0.188)	(0.175)	(0.182)	(0.182)
MARKET_BOOKVALUE(t-1)	−0.607	−0.531	−0.552	−0.556	−0.019	0.289	0.132	0.118
	(0.379)	(0.381)	(0.379)	(0.376)	(0.819)	(0.838)	(0.815)	(0.814)
AGE	−0.024***	−0.018**	−0.019**	−0.017*	−0.047**	−0.062***	−0.062***	−0.062***
	(0.009)	(0.008)	(0.009)	(0.008)	(0.021)	(0.021)	(0.021)	(0.022)
ACCOUNT_PAYABLE(t-1)	−0.081	0.017	0.001	0.001	0.572**	0.483*	0.477*	0.490*
	(0.101)	(0.099)	(0.098)	(0.098)	(0.264)	(0.250)	(0.257)	(0.255)
TOTAL_RECEIVABLE(t-1)	−0.091	−0.110	−0.063	−0.057	−1.085***	−0.962***	−1.027***	−1.041***
	(0.109)	(0.114)	(0.109)	(0.109)	(0.307)	(0.298)	(0.306)	(0.305)
CURRENT_RATIO(t-1)	−2.137***	−1.299**	−1.918***	−1.955***	−4.840***	−6.102***	−5.874***	−5.828***
	(0.586)	(0.607)	(0.588)	(0.585)	(1.538)	(1.480)	(1.516)	(1.515)
ROE(t-1)	−0.067*	−0.066*	−0.068*	−0.064*	−0.794***	−0.771***	−0.745***	−0.747***
	(0.036)	(0.035)	(0.035)	(0.035)	(0.105)	(0.101)	(0.103)	(0.103)
GFC	0.946***	1.004***	0.958***	1.001***	2.073***	2.071***	2.110***	2.078***
	(0.042)	(0.038)	(0.040)	(0.041)	(0.098)	(0.088)	(0.095)	(0.100)
SOVEREING	−0.034***	−0.029***	−0.040***	−0.034***	1.021***	1.035***	1.015***	1.010***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.041)	(0.040)	(0.041)	(0.041)
COVID	1.168***	1.179***	1.174***	1.174***	3.417***	3.441***	3.436***	3.441***
	(0.026)	(0.026)	(0.026)	(0.026)	(0.085)	(0.080)	(0.081)	(0.081)
Constant	2.705***	2.621***	2.623***	2.541***	3.052***	2.229***	2.300***	2.334***
	(0.131)	(0.083)	(0.089)	(0.090)	(0.335)	(0.205)	(0.222)	(0.229)
Observations	3953	4395	4166	4165	3953	4395	4166	4165
R-squared	0.516	0.514	0.517	0.518	0.532	0.519	0.527	0.527
SECTOR_FE	YES	YES	YES	YES	YES	YES	YES	YES
YEAR_FE	YES	YES	YES	YES	YES	YES	YES	YES

Note: Table 9 reports results of the OLS regression with time and sector fixed effects. The dependent variables are ΔCoVAR and MES. The independent variables are the corporate governance characteristics, firm characteristics and crisis dummies. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 10
Robustness check for endogeneity problems.

VARIABLES	(a) ΔCoVar				(b) MES			
BOARD_SIZE	0.002	–	–	–	−0.497***	–	–	–
	(0.041)				(0.124)			
BOARD_INDEP	−0.014	–	–	–	−0.701***	–	–	–
	(0.086)				(0.258)			
BOARD_MEETING	−0.070	–	–	–	−0.212**	–	–	–
	(0.032)				(0.095)			
ATTENDANCE	−0.128	–	–	–	−1.192***	–	–	–
	(0.099)				(0.299)			
AUDIT_INDEP	–	−1.316***	–	–	–	−1.184	–	–
		(0.279)				(0.797)		
EXECUTIVE_COMP	–	–	−0.045**	–	–	–	−0.033	–
			(0.019)				(0.058)	
SH_APP_COMP	–	–	−0.004*	–	–	–	−0.165***	–
			(0.017)				(0.050)	
ANTI-TAKEOVER	–	–	–	0.002*	–	–	–	0.027**
				(0.004)				(0.013)
Constant	2.807***	2.602***	2.627***	2.585***	4.863***	2.404***	2.209***	2.616***
	(0.145)	(0.073)	(0.080)	(0.088)	(0.435)	(0.209)	(0.235)	(0.260)
Observations	3630	4256	3936	3935	3630	4256	3936	3935
R-squared	0.516	0.508	0.514	0.514	0.448	0.422	0.437	0.434
YEAR_FE	YES	YES	YES	YES	YES	YES	YES	YES
FIRM_CONTROL	YES	YES	YES	YES	YES	YES	YES	YES
Durbin and Wu–Hausman	0.0012	0.0029	0.0021	0.0029	0.0019	0.0031	0.0022	0.0030
P-value Sargan score	0.2051	0.2023	0.1941	0.1942	0.2102	0.2031	0.1911	0.1948
P-value Basmann chi2	0.2063	0.2022	0.1932	0.1945	0.2105	0.2037	0.1923	0.1929

Note: Table 10 reports 2sls regression results. The instrumental variables inserted in the first-stage regression are the corporate governance measures at time t-1 and the average corporate governance mechanisms implemented at country level.

Table 11
Robustness checks: *complementary* vs *substitutive corporate governance drivers of NFCs' systemic risk during steady-state periods.*

VARIABLES	ΔCoVAR						MES					
	1	2	3	4	5	6	7	8	9	10	11	12
BOARD_SIZE	0.024	−0.007*	−0.008**	–	–	–	−0.074	−0.048***	−0.053***	–	–	–
	(0.075)	(0.003)	(0.004)				(0.235)	(0.009)	(0.010)			
BOARD_INDEP	−4.258***	−0.015	−0.022	–	–	–	−3.567**	0.071	−0.131	–	–	–
	(0.957)	(0.077)	(0.074)				(1.782)	(0.188)	(0.188)			
BOARD_MEETING	−0.122	−0.0224*	−0.025*	–	–	–	−2.224**	−0.122**	−0.149**	–	–	–
	(0.468)	(0.019)	(0.021)				(0.972)	(0.057)	(0.061)			
ATTENDANCE	−1.398	−0.076	−0.035	–	–	–	−4.400	−0.588***	−0.685***	–	–	–
	(1.927)	(0.074)	(0.076)				(6.174)	(0.201)	(0.205)			
AUDIT_INDEP	−0.010***	–	–	−0.006***	−0.002	–	−0.003		–	−0.007**	−0.013**	–
	(0.002)			(0.001)	(0.002)		(0.005)			(0.003)	(0.005)	
EXECUTIVE_COMP	–	−0.044***	–	1.405***	–	−0.047***	–	0.111***	–	−0.319	–	0.110**
		(0.015)		(0.414)		(0.016)		(0.041)		(0.967)		(0.045)
SH_APP_COMP	–	−0.046***	–	−0.226	–	0.049***	–	0.0340	–	0.291	–	−0.010
		(0.015)		(0.357)		(0.014)		(0.042)		(0.718)		(0.042)
ANTI-TAKEOVER	–	–	0.008**	–	0.189**	0.012***	–	–	0.055***	–	−0.427**	0.062***
			(0.003)		(0.095)	(0.003)			(0.008)		(0.203)	(0.008)
BOARD_SIZE#AUDIT_INDEP	−0.000	–	–	–	–	–	0.000	–	–	–	–	–
	(0.000)						(0.002)					
BOARD_INDEP#AUDIT_INDEP	−0.042***	–	–	–	–	–	−0.036**	–	–	–	–	–
	(0.009)						(0.018)					
BOARD_MEETING#AUDIT_INDEP	0.001	–	–	–	–	–	−0.021**	–	–	–	–	–
	(0.004)						(0.009)					
ATTENDANCE#AUDIT_INDEP	0.013	–	–	–	–	–	0.038	–	–	–	–	–
	(0.019)						(0.062)					
BOARD_SIZE#EXECUTIVE_COMP	–	−0.007	–	–	–	–	–	0.003	–	–	–	–
		(0.007)						(0.019)				
BOARD_INDEP#EXECUTIVE_COMP	–	−0.011	–	–	–	–	–	−0.584	–	–	–	–
		(0.154)						(0.374)				
BOARD_MEETING #EXECUTIVE_COMP	–	−0.072*	–	–	–	–	–	−0.210	–	–	–	–
		(0.069)						(0.465)				
ATTENDANCE#EXECUTIVE_COMP	–	−0.027	–	–	–	–	–	0.037	–	–	–	–
		(0.043)						(0.122)				
BOARD_SIZE#SH_APP_COMP	–	−0.010	–	–	–	–	–	−0.024	–	–	–	–
		(0.007)						(0.018)				
BOARD_INDEP#SH_APP_COMP	–	−0.327**	–	–	–	–	–	−0.610**	–	–	–	–
		(0.149)						(0.077)				
BOARD_MEETING#SH_APP_COMP	–	0.010	–	–	–	–	–	0.249	–	–	–	–
		(0.148)						(0.421)				
ATTENDANCE#SH_APP_COMP	–	−0.057	–	–	–	–	–	0.011	–	–	–	–
		(0.041)						(0.129)				

(*continued on next page*)

Table 11 (*continued*)

VARIABLES	ΔCoVAR						MES					
	1	2	3	4	5	6	7	8	9	10	11	12
BOARD_SIZE#ANTI_TAKEOVER	–	–	0.001	–	–	–	–	–	0.003	–	–	–
			(0.001)						(0.003)			
BOARD_INDEP#ANTI_TAKEOVER	–	–	0.070**	–	–	–	–	–	−0.013	–	–	–
			(0.035)						(0.082)			
BOARD_MEETING#ANTI_TAKEOVER	–	–	−0.018	–	–	–	–	–	0.294***	–	–	–
			(0.039)						(0.098)			
ATTENDANCE#ANTI_TAKEOVER	–	–	0.001	–	–	–	–	–	0.030	–	–	–
			(0.009)						(0.022)			
EXECUTIVE_COMP#AUDIT_INDEP	–	–	–	−0.014***	–	–	–	–	–	0.004	–	–
				(0.004)						(0.009)		
SH_APP_COMP#AUDIT_INDEP	–	–	–	0.002	–	–	–	–	–	−0.003*	–	–
				(0.003)						(0.007)		
ANTI-TAKEOVER#AUDIT_INDEP	–	–	–	–	−0.001*	–	–	–	–	–	0.005**	–
					(0.000)						(0.002)	
EXECUTIVE_COMP#ANTI-TAKEOVER	–	–	–	–	–	−0.003*	–	–	–	–	–	−0.021
						(0.001)						(0.018)
SH_APP_COMP#ANTI-TAKEOVER	–	–	–	–	–	0.001	–	–	–	–	–	0.000
						(0.007)						(0.017)
Constant	3.366***	2.364***	2.261***	3.086***	2.582***	2.405***	1.464**	1.169***	0.950***	2.270***	2.696***	1.369***
	(0.227)	(0.090)	(0.088)	(0.195)	(0.255)	(0.084)	(0.574)	(0.226)	(0.217)	(0.402)	(0.561)	(0.207)
Observations	2348	2348	2348	2463	2463	2463	2348	2348	2348	2463	2463	2463
R-squared	0.049	0.046	0.039	0.049	0.042	0.044	0.092	0.094	0.106	0.075	0.092	0.091
FIRM CHARACTERISTICS	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
YEAR_FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Note: Table 11 reports results of the OLS regression with time fixed effects. The dependent variables are the ΔCoVAR and MES. The independent variables are the corporate governance characteristics and their interactions. The regression is run on the subperiod referring to non-crisis period. We also include firm controls and time fixed effect. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 12
Robustness checks: complementary vs substitutive corporate governance drivers of NFCs' systemic risk during crisis periods.

	ΔCoVAR						MES					
VARIABLES	1	2	3	4	5	6	7	8	9	10	11	12
BOARD_SIZE	0.016	0.000	0.008	–	–	–	−0.092	−0.034	−0.025	–	–	–
	(0.075)	(0.009)	(0.009)				(0.236)	(0.022)	(0.023)			
BOARD_INDEP	−4.285***	−0.219	−0.170	–	–	–	−3.630**	−0.973*	−0.719	–	–	–
	(0.959)	(0.196)	(0.187)				(1.771)	(0.543)	(0.570)			
BOARD_MEETING	−0.127	−0.192***	−0.113**	–	–	–	−2.281**	0.176	0.073	–	–	–
	(0.466)	(0.057)	(0.049)				(0.964)	(0.138)	(0.138)			
ATTENDANCE	−1.679	−0.251	−0.315	–	–	–	−4.536	−1.329***	−1.367***	–	–	–
	(1.923)	(0.210)	(0.193)				(6.207)	(0.468)	(0.461)			–
AUDIT_INDEP	−0.010***	–	–	−0.006***	−0.009***	–	−0.001	–	–	−0.006*	−0.068***	
	(0.002)			(0.001)	(0.002)		(0.005)			(0.003)	(0.006)	
EXECUTIVE_COMP	–	−0.247***	–	1.423***	–	−0.196***	–	−0.279***	–	−0.237	–	−0.250**
		(0.037)		(0.415)		(0.039)		(0.091)		(0.972)		(0.098)
SH_APP_COMP	–	−0.137***	–	−0.222	–	−0.116***	–	−0.190*	–	0.374	–	−0.263***
		(0.044)		(0.356)		(0.038)		(0.107)		(0.719)		(0.096)
ANTI-TAKEOVER	–	–	−0.131***	–	−0.560***	−0.131***	–	–	−0.128***	–	−2.737***	−0.136***
			(0.008)		(0.072)	(0.007)			(0.019)		(0.160)	(0.018)
BOARD_SIZE#AUDIT_INDEP	−0.000	–	–	–	–	–	0.000	–	–	–	–	–
	(0.000)						(0.002)					
BOARD_INDEP#AUDIT_INDEP	−0.043***	–	–	–	–	–	−0.036**	–	–	–	–	–
	(0.009)						(0.018)					
BOARD_MEETING#AUDIT_INDEP	0.001	–	–	–	–	–	−0.022**	–	–	–	–	–
	(0.004)						(0.009)					
ATTENDANCE#AUDIT_INDEP	0.016	–	–	–	–	–	0.040	–	–	–	–	–
	(0.019)						(0.062)					
BOARD_SIZE#EXECUTIVE_COMP		0.000	–	–	–	–		0.024	–	–	–	–
		(0.014)						(0.042)				
BOARD_INDEP#EXECUTIVE_COMP		0.276	–	–	–	–		0.197	–	–	–	–
		(0.345)						(1.032)				
BOARD_MEETING #EXECUTIVE_COMP		−0.682*	–	–	–	–		0.714	–	–	–	–
		(0.392)						(0.995)				
ATTENDANCE#EXECUTIVE_COMP		−0.073	–	–	–	–		−0.377	–	–	–	–
		(0.102)						(0.256)				
BOARD_SIZE#SH_APP_COMP		0.014	–	–	–	–		−0.017	–	–	–	–
		(0.017)						(0.041)				
BOARD_INDEP#SH_APP_COMP	–	−0.204	–	–	–	–		−3.246***	–	–	–	–
		(0.431)						(1.144)				
BOARD_MEETING#SH_APP_COMP	–	0.629	–	–	–	–		−0.601	–	–	–	–
		(0.442)						(0.972)				
ATTENDANCE#SH_APP_COMP	–	0.161	–	–	–	–		0.153	–	–	–	–
		(0.127)						(0.301)				

(*continued on next page*)

Table 12 (*continued*)

	ΔCoVAR						MES					
VARIABLES	1	2	3	4	5	6	7	8	9	10	11	12
BOARD_SIZE#ANTI_TAKEOVER	–	–	−0.004	–	–	–	–	–	0.000	–	–	–
			(0.003)						(0.008)			
BOARD_INDEP#ANTI_TAKEOVER	–	–	−0.004	–	–	–	–	–	0.184	–	–	–
			(0.084)						(0.232)			
BOARD_MEETING#ANTI_TAKEOVER	–	–	−0.0107	–	–	–	–	–	−0.042	–	–	–
			(0.021)						(0.054)			
ATTENDANCE#ANTI_TAKEOVER	–	–	0.061	–	–	–	–	–	0.601***	–	–	–
			(0.097)						(0.224)			
EXECUTIVE_COMP#AUDIT_INDEP	–	–	–	−0.014***	–	–	–	–	–	0.003	–	–
				(0.004)						(0.009)		
SH_APP_COMP#AUDIT_INDEP	–	–	–	0.002	–	–	–	–	–	−0.004	–	–
				(0.003)						(0.007)		
ANTI-TAKEOVER#AUDIT_INDEP	–	–	–	–	−0.004***	–	–	–	–	–	0.026***	–
					(0.000)						(0.001)	
EXECUTIVE_COMP#ANTI-TAKEOVER	–	–	–	–	–	−0.059***	–	–	–	–	–	0.083*
						(0.018)						(0.042)
SH_APP_COMP#ANTI-TAKEOVER	–	–	–	–	–	−0.011	–	–	–	–	–	−0.008
						(0.017)						(0.041)
Constant	3.323***	3.230***	3.813***	3.048***	4.737***	3.670***	1.429**	3.592***	4.181***	2.230***	11.56***	4.380***
	(0.226)	(0.240)	(0.209)	(0.195)	(0.354)	(0.205)	(0.576)	(0.562)	(0.533)	(0.404)	(0.824)	(0.481)
Observations	2279	1373	1373	2366	1413	1413	2279	1373	1373	2366	1413	1413
R-squared	0.053	0.055	0.224	0.052	0.224	0.243	0.090	0.087	0.116	0.074	0.103	0.112
FIRM CHARACTERISTICS	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
CRISES FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Note: Table 12 reports results of the OLS regression with time fixed effects. The dependent variables are the ΔCoVAR and MES. The independent variables are the corporate governance characteristics and their interactions. The regression is run on the subperiod referring to crisis period. We also include firm controls and time fixed effect. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 13
Summarize of complementary and substitute hypotheses.

VARIABLES	*NO CRISIS*		*CRISIS*	
	ΔCoVAR	*MES*	*ΔCoVAR*	*MES*
BOARD_INDEP#AUDIT_INDEP	*Complementarity Hypothesis*	*Complementarity Hypothesis*	*Complementarity Hypothesis*	*Complementarity Hypothesis*
BOARD_MEETING#AUDIT_INDEP	–	*Complementarity Hypothesis*	–	*Complementarity Hypothesis*
BOARD_MEETING #EXECUTIVE_COMP	*Complementarity Hypothesis*	–	*Complementarity Hypothesis*	–
BOARD_INDEP#SH_APP_COMP	*Complementarity Hypothesis*	*Complementarity Hypothesis*	–	*Complementarity Hypothesis*
BOARD_INDEP#ANTI_TAKEOVER	*Complementarity Hypothesis*	–	–	–
BOARD_MEETING#ANTI_TAKEOVER	–	*Substitution hypothesis*	–	–
ATTENDANCE#ANTI_TAKEOVER	–	–	–	*Substitution hypothesis*
EXECUTIVE_COMP#AUDIT_INDEP	*Complementarity Hypothesis*	–	*Complementarity Hypothesis*	–
SH_APP_COMP#AUDIT_INDEP	–	*Complementarity Hypothesis*	–	–
ANTI-TAKEOVER#AUDIT_INDEP	*Complementarity Hypothesis*	*Substitution hypothesis*	*Complementarity Hypothesis*	*Substitution hypothesis*
EXECUTIVE_COMP#ANTI-TAKEOVER	*Complementarity Hypothesis*	–	*Complementarity Hypothesis*	*Substitution hypothesis*

Note: Table 13 reports the summary of the complementary and substitution effect of corporate governance mechanisms on the contribution to and exposure to systemic risk.

Appendix A. Appendix

Table 1A
Variable description.

Variable	Description	Sources
Systemic risk measures		
ΔCoVAR	The change in the conditional variance is the measure of the contribution to systemic risk at firm level	Authors' calculation
MES	The marginal expected shortfall is the measure of the exposure to systemic risk at firm level	Authors' calculation
Firm characteristics		
SIZE	The natural logarithm of market value	Thomson Reuter Eikon Database
EBITDA	Earnings before taxes, depreciation and amortization over financial expenditures	Thomson Reuter Eikon Database
DEBT_TA	Debt over total asset	Thomson Reuter Eikon Database
MARKET_BOOK_VALUE	Market value over equity book value	Thomson Reuter Eikon Database
AGE	The natural logarithm of the age of the firm, given by the difference between the year observed and the year in which firm was established	Thomson Reuter Eikon Database
TOTAL_RECEIVABLE	The total receivable over total asset ratio	Thomson Reuter Eikon Database
ACCOUNT_PAYABLE	The total payable over total asset ratio	Thomson Reuter Eikon Database
ROE	The return on equity	Thomson Reuter Eikon Database
CURRENT_RATIO	The current asset over current liabilities ratio	Thomson Reuter Eikon Database
Corporate governance mechanisms		
BOARD_SIZE	The natural logarithm of the total number of board members at the end of the fiscal year	Thomson Reuter Eikon Database
BOARD_INDEP	Percentage of independent board members as reported by the company	Thomson Reuter Eikon Database
BOARD_MEETING	The natural logarithm of the total number of board meetings in one fiscal year	Thomson Reuter Eikon Database
ATTENDANCE	The average overall attendance percentage of board meetings as reported by the company	Thomson Reuter Eikon Database
AUDIT_INDEP	Percentage of independent directors over total members of the committee	Thomson Reuter Eikon Database
EXECUTIVE_COMP	Dummy variable equal to 1 if the answer to the following question is 'yes', "Is the management and board members remuneration partly linked to objectives or targets which are more than two years forward looking?", zero otherwise	Thomson Reuter Eikon Database
SH_APP_COMP	Shareholders are involved in the definition of management compensation	Thomson Reuter Eikon Database
ANTI-TAKEOVER	The number of anti-takeover provisions in place in excess of two	Thomson Reuter Eikon Database
Crises		
SUBPRIME	Dummy variable equal to 1 during 2007–2009, 0 otherwise	Authors' calculation
SOVEREIGN	Dummy variable equal to 1 during 2010–2012, 0 otherwise	Authors' calculation
COVID19	Dummy variable equal to 1 in 2020, 0 otherwise	Authors' calculation

Table 2A
Evolution of MES and ΔCoVAR year by year.

YEAR	ΔCoVAR	MES
2005	0.026	0.011
2006	0.026	0.011
2007	0.034	0.020
2008	0.051	0.051
2009	0.032	0.028
2010	0.026	0.026
2011	0.028	0.032
2012	0.025	0.017
2013	0.023	0.014
2014	0.025	0.017
2015	0.027	0.018
2016	0.028	0.022
2017	0.026	0.010
2018	0.031	0.025
2019	0.030	0.019
2020	0.039	0.051

Table 3A
Correlation matrix of corporate governance variables.

	BOARD_SIZE	BOARD_INDEP	BOARD_MEETING	ATTENDANCE	AUDIT_INDEP	EXECUTIVE_COMP	SH_APP_COMP	ANTI-TAKEOVER
BOARD_ SIZE	1							
BOARD_ INDEP	0.123	1						
BOARD_ MEETING	0.115	0.107	1					
ATTENDANCE	0.033	0.043	−0.018	1				
AUDIT_ INDEP	0.029	0.059	−0.021	0.044	1			
EXECUTIVE_COMP	−0.072	−0.067	−0.005	−0.020	−0.004	1		
SH_APP_ COMP	0.243	0.211	0.133	0.112	0.002	−0.017	1	
ANTI-TAKEOVER	−0.066	0.069	−0.029	−0.073	−0.091	0.193	0.007	1

Note: Table reports the correlation matrix.

Table 4A
VIF Test for multicollinearity.

Variable	VIF	1/VIF
GFC	1.61	0.619477
DEBT_TA(t-1)	1.56	0.641403
ANTI-TAKEOVER	1.51	0.661808
SIZE	1.46	0.684490
TOTAL_RECEIVABLE(t-1)	1.41	0.709105
EBITDA(t-1)	1.41	0.711501
ACCOUNT_PAYABLE(t-1)	1.38	0.726173
ROE(t-1)	1.27	0.789130
SH_APP_COMP	1.25	0.798961
BOARD_SIZE	1.24	0.803666
SOVEREING	1.23	0.815826
CURRENT_RATIO(t-1)	1.22	0.820344
AGE	1.15	0.868591
BOARD_INDEP	1.12	0.895593
MARKET_BOOKVALUE(t-1)	1.11	0.902314
COVID	1.11	0.904867
ATTENDANCE	1.08	0.928056
EXECUTIVE_COMP	1.06	0.945276
BOARD_MEETING	1.04	0.965732
AUDIT_INDEP	1.03	0.966531
Mean VIF	1.25	

Note: Table reports the VIF test to check for the multicollinearity issue.

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