Were Bank CEOs Rewarded for Taking Subprime Gambles?

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Abstract

Bank incentives differ markedly from non-bank incentives because risk plays a much greater role in banks. The gambling ratio (Vega to Delta) captures risk incentives relative to effort incentives. Increasing the gambling ratio increases bank and subprime risks. It also decreases bank profitability but increases CEO payouts. Bank CEOs were rewarded for (subprime) gambles. In the period leading up to the subprime crisis, the growth in the gambling ratio was caused by adding more outsiders to bank boards. This was triggered by 1998 reforms and Sarbanes-Oxley while steam-rolling outsiders due to peer pressure in the run-up to the crisis.

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Key words: Subprime crisis; gambling ratio; excessive risk taking; incentives; board outsiders.

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"We conclude dramatic failures of corporate governance (...) were a key cause of this crisis. (...) We conclude a combination of excessive borrowing, risky investments, and lack of transparency put the financial system on a collision course with crisis. (...) Compensation systems encouraged the big bet — where the payoff on the upside could be huge and the downside limited." (Excerpt from the main conclusions of the U.S. Financial Crisis Inquiry Commission (2011) on pages xiii-xx.)

1 Introduction

The subprime crisis has been the banking crisis of our times with enormous social, political and financial impact worldwide (global financial crisis, GFC). In the aftermath, various political inquiry commissions around the globe, e.g., the U.S. Financial Crisis Inquiry Commission (2011), studied the causes of the crisis: therein, they argued that deficiencies in governance and (performance-based) compensation led to excessive risk taking, leading to various regulatory measures that aim at reducing risks. Yet banks' business model consists in taking risks, so it is important to balance this with bank profitability and set incentives for risk taking correctly (Stulz (2022)).

While the literature studied drivers of risk taking, it is largely silent on *excessive* risk taking. But understanding the latter is crucial to prevent future crisis through (appropriately) targeted regulatory action. For this purpose, we study empirically whether (the structure of) executive compensation benefited shareholders, how it led to incentives for *excessive* risk taking, in particular for subprime gambling and what role corporate governance reforms at the beginning of the millennium played in this.

Our dataset consists of 725 U.S. bank holding companies from 2000 to 2019, a total of 6,440 bank-year observations. We first study how bank risk affects both the value of the bank and the value of the CEO. Contrary to a common intuition that risk taking is beneficial for the bank and for the CEO, we find empirically that both are increasing *only* up to a critical level of bank risk and decreasing above that level (a hump-shaped function), as discussed theoretically by, e.g., Stulz (2016). Moreover, we find that the optimal level of bank risk is higher for the CEO than it is for owners. Hence, we consider as *excessive* risk taking that level of risk taking which exceeds the level desired by shareholders.

We then aim at understanding the driver of excessive risk taking. When performance-based pay includes options, it provides both performance incentives (PPS, pay-performance-sensitivity; aka Delta) and risk incentives, referred to as Vega), see DeYoung et al. (2013) and Armstrong et al. (2022) among others. In banks, risk taking is (part of) their business model and as such necessary for performing; but risks may also include so-called gambling risk that would not generate value for shareholders.[1] We conjecture that when risk incentives are "too strong" relative to performance incentives, CEOs engage in gambling to their benefit but detriment of the bank. To assess gambling incentives, we introduce the gambling ratio[2], defined as Vega divided by Delta (PPS). We document that gambling ratios are positively related to bank risk and with bank tail risks ("gambling risks"). Finally, we document that both bank gambling incentives and increases in risk taking were detrimental for shareholders but beneficial for CEOs.

The U.S. Financial Crisis Inquiry Commission (2011), the Report of Walker (2009) in the UK, the BCBS (2010), and the FSB (2013) all argued that corporate governance issues caused the subprime crisis as they led to ill-designed remuneration systems and excessive risk-taking; they all called for greater board independence. The Financial Stability Board (FSB (2013)) requests as its sound risk governance practice that the board "comprises largely independent directors". This push for board independence leads us to look at the impact of outsiders on the gambling incentives. We document that increasing the fraction of outsiders on the board does precisely the reverse of what the four reports hoped to achieve. It increases the gambling incentives and it does increase bank risk as well as tail risks. We then use the Sarbanes-Oxley legislation (SOX)[3] as an exogenous shock in a Difference-in-Difference analysis and document the causality of outsider ratios on gambling incentives and bank/tail risk.

Moreover, we document that banks with lower (higher) outsider ratios than the current average of that ratio do increase (decrease) their ratio, a mean-reverting effect that one may view as a form of peer pressure, alternatively, a "keeping up with the Jones" effect. However,

[1]For example, idiosyncratic risk taking does not generate value for banks and tail risk taking may destroy value, potentially not over the short-run, see, e.g., Goetzmann et al. (2007).

[2]We study the relative importance of risk incentives to effort incentives for gambling. Somewhat related, in a setup that ignores effort/shirking, Ross (2004) observed theoretically that the ratio of slope over curvature matters to assess whether options lead to more/less risk taking for a risk-averse manager.

[3]It led to the mandated requirement for boards of listed companies (including banks) to have a majority of independent directors.

the response is asymmetric: for example, if a bank's outsider ratio is 0.1 below (above) that of its peers, then its next year's ratio is roughly 0.05 higher (0.025 lower, about a half of 0.05). What might account for this asymmetric response? Plausibly, the CEO was motivated to increase both power and influence. Appointing outsiders who could be easily replaced if they challenged the CEO may have been seen as preferable to a sizeable shareholder or knowledgeable former CEO, or even an incentivized senior executive workmate familiar with all of his weaknesses.

This asymmetrical response created a vicious cycle which ever-increased the average outsider ratio year-on-year. It was triggered by the mandated outsider ratios following SOX legislation. This then also increased gambling incentives, and associated increased bank/tail risks, in particular increased subprime gambles that were at the root of the global financial crisis.

Our paper contributes to understanding the role of executive compensation in the run-up to the subprime crisis (GFC). First of all, we specifically ask: do shareholders get the level of risk they want? The literature appears to suggest that the answer is affirmative[4], but our paper argues that it is negative. Put differently, we show that bank risk taking was excessive from shareholders perspective: (i) the optimal level of risk for shareholders is less than that for CEOs; (ii) increasing bank risk does *decrease* bank performance.

Second, we aim to understand the drivers of *excessive* risk taking. We note that the previous literature studied risk-taking incentives mostly through Vega but falls short of addressing *excessive* risk taking ("gambling"): such risks mean that CEOs "substitute" effort by gambling. To our knowledge, we are the first to point out that the relative importance of associated incentives should matter and introduce for that purpose our gambling ratio (GR), defined as the ratio Vega over PPS. We confirm empirically that it is a crucial driver: increasing GR makes risk taking more excessive; it is beneficial for CEOs but detrimental for shareholders.

Regulators around the globe currently address excessive risk taking in two ways. The first aims at reducing the level of risk that shareholders take through stronger Basel capital

[4]Akin et al. (2020) show that insiders understood the large risk-taking in their banks. Fahlenbrach and Stulz (2011) found that those banks with better alignment between CEOs and shareholders performed worse during the crisis, indicative that they took greater risks. Laeven and Levine (2009) also document a strong relation between bank risk and the comparative power of shareholders, and Anginer et al. (2018) find that shareholder-friendly corporate governance is associated with more bank risk.

regulation, addressing that optimal shareholder risk is excessive from the perspective of society/regulator/debtholders. The second way consists in addressing a variant of excessive risk taking, short-termism, by putting limits on bonus payments in relationship to fixed salary and request bonus deferrals. However, this leaves out the shareholder-CEO conflict in risk taking: our paper points out significant misalignment and that this shows up through excessive risk taking and gambling (e.g., subprime risks). In addition to the remedies discussed so far, it is therefore advisable to decrease gambling incentives as much as possible, i.e., eliminate options in performance-based pay of banks altogether.

Finally, we also contribute to the corporate governance literature that studies how board characteristics (board independence) affect bank risk taking. In addition to the previous literature, we look at this through the incentives for risk taking that the board sets (through the structure of performance-based compensation). We find that a more independent boards sets stronger risk incentives than desired by shareholders: it increases gambling incentives that increase bank risk beyond the desired level and increase tail risks. Overall, having more outsiders increases bank and tail risk. Our results clear up mixed results from the literature: while the Global Financial Stability Report (IMF (2014)) and Vallascas et al. (2017) find that having more outsiders reduces bank risks, there is also evidence to the contrary, e.g., Pathan (2009) and Minton et al. (2014). Moreover, Becht et al. (2011), Beltratti and Stulz (2012), and Erkens et al. (2012) show that banks with better governance performed worse during the subprime crisis period, which means more independent boards taking more risks. Our results question the remedy to the GFC to have more outsiders on bank boards.

Along the way we shed some light on the causes of the GFC that have been previously ignored in the literature: the SOX induced mandate of a majority of outsiders on boards triggered a process of increasing outsider ratios, which led to higher gambling ratios and then to even more excessive risk taking. Different from the various inquiry reports that attribute the crisis to a lack of outsiders on boards, we show that the regulation and ensuing large increase in outsiders (well beyond the mandated minimum) caused the crisis.[5]

[5]Before the subprime crisis, financial firms already had much higher ratios of outside directors than did non-financial firms, see, e.g., Table III/Figure 5 in Ferreira et al. (2011) Adams (2012) further notes that bailed-out banks had particularly high ratios. Moreover, as anecdotal evidence, when Lehman Brothers was declared bankrupt in 2008 as the defining moment in the subprime crisis, it over-complied on the existing regulation. (At the time, eight of the ten directors of Lehman Brothers met the standards of the NYSE regarding outside directors, exceeding by far the regulatory minimum of 50%.) The second biggest bank failure since the collapse of Lehman Brothers and the second in U.S. history occurred on March 10, 2023,

The paper is organized as follows: The next Section describes our data and introduces our main variables. Section 3 looks at the driver of excessive risk taking and the following section studies the impact of outsider ratios on the driver. Putting together our results, Section 5 then studies how risk became excessive. Finally, Section 6 concludes. Technical material and additional (robustness) regressions are postponed to the Appendix.

2 Data, Variables and Descriptive Statistics

Our main dataset is the intersection of BoardEx with the U.S. Federal Reserve's Bank Holding Company (BHC) database (quarterly FR 9Y-C reports). The BHC database provides a granular view on banks' balance sheets. BoardEx provides a comprehensive description of director characteristics at each reporting date, starting in 1999. We add stock market data from CRSP and CEO compensation data from ExecuComp, both accessed through WRDS. (This includes inflation data as well as the risk-free rate of United States debt obligations.) Overall our sample consists of a Panel of 725 banks with 6,440 bank-year observations from 2000 to 2019.

Throughout, all monetary values are inflation-adjusted and expressed in 2019 dollars. Moreover, we winsorize all financial data yearly at the 1%/99% levels. Winsorizing strengthens the statistical significance of our results but does not affect their qualitative implications. Moreover, unless stated otherwise, we study lagged risk governance variables.

Table 1 provides summary statistics of the main variables[6] used in our analysis, broadly separated into four Panels A-D. The key variables in our analysis are the outsider ratio (Panel A), bank risk and tail risk measures (Panel B) and CEO Delta/Vega/wealth (Panel C) that we now detail. We define:

$$\text{Outsider Ratio (OR)} \quad = \quad \frac{\text{\# Outside Board Members}}{\text{\# Board Members}}.$$

The literature studies many different measures of bank risk; for example, the IMF (2014) provides in Table 3.4 of Chapter 3 an overview on the use of risk measures in bank governance

with the collapse of the Silicon Valley (SV) Bank. Like Lehman Brothers, it over-complied with regulations with its eleven outside directors.

[6]We detail the major variables in our analysis below. The other variables are straightforward from the literature and, for completeness, are defined in the Appendix.

Table 1: Summary statistics.

	Count	Mean	Std. Dev.	Min	Quantiles 25%	50%	75%	Max
Panel A: Bank Characteristics								
Tot. Ass. ($ billion)	5634	40.88	214.8	0.165	1.100	2.507	7.955	2,687.4
ln (Tot. Ass.)	5634	8.363	1.670	5.403	7.159	8.004	9.131	14.86
Board Size (Numb. Dir.)	6440	11.35	3.324	4	9	11	13	32
Outsider Ratio (OR)	6440	0.789	0.120	0	0.722	0.818	0.889	0.947
ROE (%)	5447	8.499	11.82	-134.0	6.269	9.908	13.65	47.77
ROA (%)	5448	0.837	1.037	-9.073	0.622	0.979	1.292	4.253
Stock Return (%)	6440	8.801	31.79	-177.6	-4.618	10.77	26.55	166.1
Panel B: Risk								
Z	5321	2.612	0.556	-0.258	2.343	2.631	2.918	5.455
DER (%)	3685	71.86	374.2	-0.0610	1.063	4.476	14.26	3916.8
Tail Risk (%)	6427	-12.02	6.703	-43.26	-14.61	-10.17	-7.684	1.962
Panel C: CEO								
Direct Comp ($ thsd.)	1846	1699.9	2588.3	0	740.4	1004.2	1458.4	41655.7
Delta ($ thsd.)	1697	0.760	3.270	0.000190	0.0524	0.145	0.483	75.71
Vega ($ mill.)	1400	0.156	0.326	0	0.0102	0.0358	0.150	3.764
CEO GR	1377	0.349	0.335	0	0.0876	0.259	0.516	3.001
Bank rel. wealth (log)	1697	9.656	1.691	3.234	8.550	9.563	10.75	16.23
Panel D: Insiders								
Direct Comp ($ thsd.)	1895	924.1	1406.1	106.5	358.1	489.6	732.7	13407.1
Delta ($ thsd.)	1780	0.158	0.640	0.000132	0.0140	0.0340	0.111	11.32
Vega ($ mill.)	1586	0.0467	0.113	0	0.00329	0.0106	0.0388	1.952
Insider GR	1562	0.462	2.504	0	0.147	0.334	0.588	98.50
Bank rel. wealth (log)	1780	8.207	1.542	2.728	7.193	8.071	9.239	13.95

research. It would overwhelm our presentation to look at all these and so we focus on a single risk measure in (the main body of) this paper.[7] It appears that common risk measures in the literature are the so-called distance-to-default (aka z-score), defined as $z = (ROA +$

Tier 1 Capital/Assets)/(Asset volatility), and, building on it, the logarithm $Z = \log z$ of it, see, e.g., Demirgüç-Kunt and Huizinga (2010) and Laeven and Levine (2009). The literature notes that distribution of z is highly skewed, and so we also study exclusively Z. Throughout our further analysis we measure bank risk by the negative Z-score, such that higher readings correspond to higher risk.

Risk taking for gambling is usually associated with tail risk taking that relates to events of small probability but "catastrophic" outcome. For this we look at non-hedging derivatives usage (DER) and stock return tail risk.

Throughout this paper, we study three types of incentives that will be further discussed (and introduced/motivated) in subsection 3.2: First, the component of incentives that is at the center of effort analysis for (non-financial) firms: the CEO's pay-for-performance sensitivity (PPS). For simplicity we refer to as CEO Δ, calculated as the dollar change in wealth associated with a 1% change in the bank's stock price. Second, to understand the driving force behind excessive risk taking, we consider explicitly the associated risk taking incentives stemming from incentive-based compensation, commonly referred to as Vega and calculated as the dollar change in wealth associated with a 0.01 change in the standard deviation of the bank's stock returns.

Third, for reasons that will be elaborated in subsection 3.2, we are interested in the relative importance of both types of incentives and therefore introduce

$$\text{Gambling Ratio (GR)} = \frac{\text{CEO Vega}}{\text{CEO } \Delta}.$$

Moreover, we are later interested in the current value of the stock and option portfolio held by the bank, called firm related wealth. Relying on ExecuComp, one could calculate delta, vega, and firm related wealth ourselves but for comparability we take them from Lalitha Naveen's public database.[8] We note that both delta and vega (but not GR) are highly

[7] The appendix considers a variety of other risk measures. There we look at the T1 (=Capital Adequacy) measure, defined as the ratio of Tier 1 capital to risk-weighted assets, and the LEV measure, defined as total assets divided by Tier 1 capital. We also consider the probability of default (PD), defined as the inverse of the z-score $z = (ROA + LEV^{-1})/(\text{Asset vol.})$, see, Laeven and Levine (2009), Houston et al. (2010), among others. Studies also use the average risk-weight, a widely used measure of ex-ante portfolio risk, see Shrieves and Dahl (1992), BCBS (2015), and Berger et al. (2014) and various forms of equity/asset/ROE/ROA/stock return volatilities.

[8] Accessed and available at: https://sites.temple.edu/lnaveen/files/2020/11/deltavega2020_for_posting.xlsx The algorithm is documented in Coles et al. (2006).

right-skewed, and so we study the logarithm of delta and vega throughout this paper.

3 What Drives (Excessive) Risk Taking?

Banks' business model consists in taking risks, differentiating them from non-financial companies, where risks appear as a by-product of the normal course of business. Given a financing structure on the liability side of the balance sheet, asset management seems to suggests that risk taking increases a bank's value on the asset side.

However, theory suggests that increasing risk does not always provide value: First, finance 101 stresses that idiosyncratic risk taking does not contribute to risk premiums. Moreover, the asset management literature points out the importance of risk-adjusted premiums (Jensen's alpha), which can be negative. Investing in such assets would be value destroying; one may view it either as a form of gambling or as (a form of) excessive risk taking.[9] Second, banks face several informational disadvantages compared to borrowers. In particular asset substitution by borrowers may increase risk after credit provision, leading potentially to a hump-shaped curve between bank revenue (value) and loans rates, see, e.g., Stiglitz and Weiss (1981). A curve with such a hump-shape would mean that there is a level of risk taking beyond which banks' value decreases, hence further risk taking may be considered excessive.

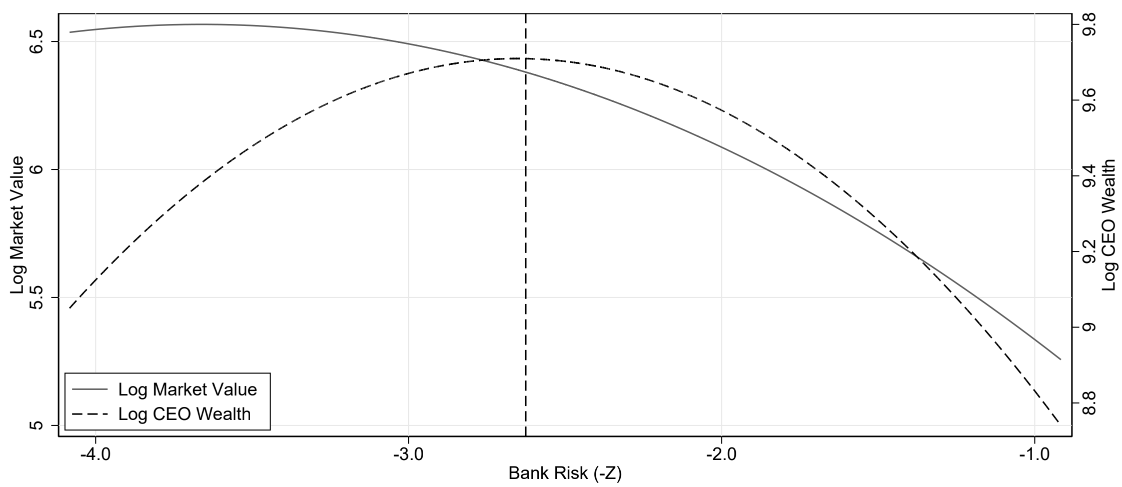
3.1 Misalignment in optimal risk

Figure 1 illustrates how bank risk affects bank (logarithmic) market value of the bank and (logarithmic) CEO wealth. It uses the estimated coefficients that result from the Panel regression coefficients with bank fixed effects that we present in columns (2, 6) of Table 2. (Further details will be provided below when discussing Table 2.)

This Figure shows a hump-shaped relationship for both bank market value and CEO wealth. Moreover, there is a level of bank risk that maximizes bank market value and another level of bank risk (further to the right in the figure) that maximizes CEO wealth. This means that the optimal level of the CEO is misaligned from that of the owner and, in

[9] Foreshadowing our analysis, a Panel regression with bank fixed effects shows that increasing risks decreases bank value, see regression (1) in Table 2.

Figure 1: Illustrating how bank risk affects bank market value and CEO wealth. The plot presents the quadratic fit of the market value of the firm and the value of the CEO's firm related wealth as functions of bank risk. Bank risk is measured by the negative Z-score, i.e., higher readings correspond to higher risk. Market/CEO values are presented through logarithms. The quadratic fit here is based on the coefficients of a bank fixed effects Panel regression with linear and quadratic (-Z) terms; these can be found in columns (2, 6) of Table 2. We plot bank risk over the range of the 1%- to the 99%-ile and mark the median (50%-ile) by a dashed horizontal line.



particular, it is higher than that which maximizes bank market values.[10] As such the CEO is incentivized to take excessive bank risk.

In this Figure and throughout all figures of this paper, we plot variables over the x-axis range from the 1%- to the 99%-ile and mark the median (50%-ile) by a dashed horizontal line. Here, the median bank risk in our sample is well beyond the level of bank risk that maximizes the (log) market value of the bank: the full line in Figure 1 based on our empirically estimated quadratic fit from regression (2) of Table 2 suggests that the optimum is at $-1.273/(2 \cdot (-0.174)) = -3.658$. As the median bank risk is at (the higher level) -2.631, this quantifies that bank is "excessive". Interestingly, however, the median bank risk (the dotted horizontal line) appears to match visually the optimal level bank risk that maximizes the (log) value of CEO wealth: the dashed line in Figure 1 based on our empirically estimated quadratic fit

[10]Interestingly, the media bank risk in our sample visually appears to coincide with the optimal bank risk level from a CEO's perspective.

Table 2: Studying how bank risk affects firm value and CEO wealth. This table presents Panel regressions with bank fixed effects of logarithmic market value/CEO wealth on bank risk. Negative Z-scores correspond to higher bank risk. All explanatory variables are lagged one year. Coefficient statistics are calculated using robust methods; t-statistics are reported in parentheses; significance levels refer to * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

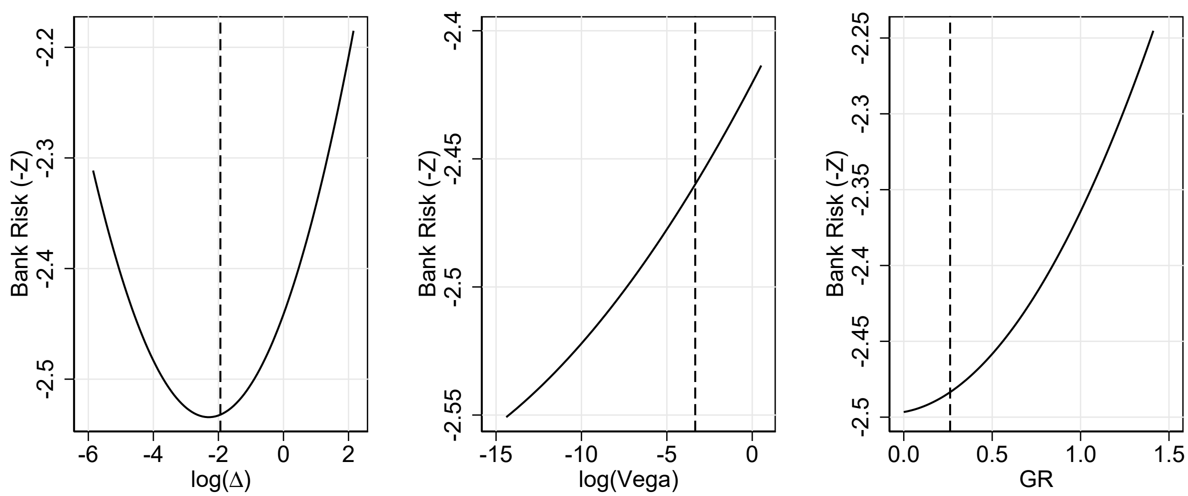
	(1) Mkt Val	(2) Mkt Val	(3) Mkt Val	(4) Mkt Val	(5) CEO wlth	(6) CEO wlth	(7) CEO wlth	(8) CEO wlth
-Z	-0.443***	-1.273***	-0.210***	-0.862***	-0.225***	-1.706***	0.0522	-0.646**
	(-13.14)	(-8.06)	(-7.08)	(-6.06)	(-2.98)	(-5.07)	(0.81)	(-2.15)
-Z × -Z		-0.174***		-0.135***		-0.322***		-0.149**
		(-5.97)		(-5.03)		(-4.39)		(-2.33)
ROE			0.00569	-0.00225			0.0180***	0.00903
			(1.44)	(-0.35)			(3.42)	(1.37)
ROE × -Z			-0.0108***	-0.0118*			-0.0124***	-0.0166**
			(-5.55)	(-1.76)			(-4.12)	(-2.08)
ROE × -Z × -Z				0.000968				-0.000163
				(0.53)				(-0.06)
Observations	4809	4809	4808	4808	1501	1501	1501	1501
Adjusted R^2	0.908	0.910	0.922	0.923	0.734	0.742	0.783	0.784
F	172.6	88.82	190.6	122.7	8.908	16.10	64.00	42.93

from regression (6) of Table 2 suggests that the optimum is at $-1.706/(2\cdot(-0.322)) = -2.649$. This matches very well the observed level of bank risk in our sample.

Table 2 studies this in greater detail using Panel regressions with bank fixed effects. Therein, regressions (1-4) look at (logarithmic) bank market value whereas the analogous regressions (5-9) look at (logarithmic) CEO wealth. Note that the bank fixed effects control, among others, for differences in bank size in these regression with logarithmic value/wealth. We carry out regressions with/without squared bank risk and control in some of these for bank performance (ROE) and associated interaction terms with (squared) bank risk. We recall that bank risk is measured by the negative Z-score, such that higher readings correspond to higher risk.

Regressions (1, 5) in Table 2 show that increasing bank risk negatively affects both market value and CEO wealth, which suggests that most observations of bank risk are towards the right of the optimal risk level illustrated in Figure 1. Those regressions that include the

Figure 2: Illustrating how CEO incentives affect bank risk. Three plots present quadratic fits of risk on the logarithm of CEO effort incentives (Δ), the logarithm of risk incentives (vega) and on gambling incentives (gambling ratio, GR). They use the coefficients from the Panel regressions with bank fixed effects that we present in columns (1, 3, 5) of Table 3, respectively. We plot all three variables over a range that covers the 1%- to the 99%-ile and mark the median (50%-ile) by a dashed horizontal line. Bank risk is measured by the negative Z-score, i.e., higher readings correspond to higher risk.



square of bank risk, that coefficient is (always) negative, which confirms the hump-shape (and the presence of a maximum), as illustrated above in Figure 1.

3.2 Gambling Ratio and Incentives

There is a common belief that incentive-based compensation is beneficial for firm value. Within non-financials, that is well-rooted within theoretical and empirical analyses. But, as noted above, for banks it is imperative to both consider risk taking and, in particular, setting (bank) risk at the right level.

To further study this, we now look at the component of incentives that is at the center of such analysis for (non-financial) firms: the CEO's pay-for-performance sensitivity (PPS), here referred to as CEO Δ, see Subsection 2. The left-hand plot in Figure 1 illustrates how (log) CEO Δ impacts bank risk, as measured by the (negative) Z-score. This plot uses the estimated coefficients from the Panel regression with bank fixed effects in column (1) of

Table 3: Studying how incentives affect bank risk. We present Panel regressions with bank fixed effects of bank risk on (log) CEO effort incentives (log (Δ)) in columns (1, 2), on (log) CEO risk incentives (log (Vega)) in columns (3, 4), and on CEO gambling incentives (GR) in columns (5, 6). Negative Z-scores correspond to higher bank risk. All explanatory variables are lagged one year. Coefficient statistics are calculated using robust methods; t-statistics are reported in parentheses; significance levels refer to * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	(1) -Z	(2) -Z	(3) -Z	(4) -Z	(5) -Z	(6) -Z
log(Δ)	0.0810***	0.0312**				
	(5.13)	(2.11)				
log(Δ) $\times$ log(Δ)	0.0176***	0.0102***				
	(5.15)	(3.05)				
log(Vega)			0.0127	-0.0143		
			(1.46)	(-1.63)		
log(Vega) $\times$ log(Vega)			0.000253**	-0.0000642		
			(2.11)	(-0.60)		
GR					0.0208	-0.177**
					(0.29)	(-2.49)
GR $\times$ GR					0.111***	0.180***
					(2.76)	(4.20)
Year		-0.0275***		-0.0304***		-0.0289***
		(-14.76)		(-13.42)		(-12.52)
Observations	1574	1574	1298	1298	1279	1279
Adjusted R^2	0.561	0.614	0.582	0.637	0.591	0.642
F	15.74	80.30	3.372	63.99	12.83	62.90

Table 3. We see that the dependency has a U-shape: below a critical level of bank risk that is roughly at the median in our sample, increasing CEO Δ decreases bank risk but once we pass that critical level, higher Δ increases bank risk.[11]

[11] Theoretically, performance-based compensation should help align the interests of manager with those of shareholders. It is widely perceived to be in their interests to increase bank risks (Galai and Masulis (1976)) and hence better alignment should increase bank risk taking. Fahlenbrach and Stulz (2011) find that banks in which management possessed higher stock ownership performed worse during the crisis, which suggests that risk increases with Δ. However, we find this only for banks with Delta above the median. Berger et al. (2016) find that shareholdings of banks' CEOs do not have a direct impact on bank failure. This appears to be consistent with averaging out the illustrated U-shape in the left-hand plot of Figure 1.

Interestingly, upon visual inspection, the lowest level of bank risk is attained roughly at the median log Δ in our sample (depicted by the vertical dotted line). In fact, the plot is based on regression (i) in Table 3 and we calculate from there that the minimum is attained at log Δ equal to $-0.0810/(2 \cdot 0.0176) = -2.3$, whereas the median of $\log \Delta$ in our sample is -1.9.

However, CEO Δ measures (only) whether (locally) how much the incentive component is equivalent (in terms of wealth impact on the CEO) to an incentive component that consists in providing (units in) the underlying stock. Here risk taking is a side product of aligning the interests of the CEO with those of the shareholders. In itself, this would not lead to the wedge in optimal risk taking (shareholder vis-a-vis CEO) that we observed in the previous subsection.

To understand the driving force behind excessive risk taking, we need to consider explicitly the risk incentives via Vega. The center-plot in Figure 1 illustrates how log CEO Vega impacts bank risk, as measured by the (negative) Z-score. This plot uses the estimated coefficients from the Panel regression with bank fixed effects in column (3) of Table 3. We find that (log) CEO Vega does increase bank risk, indeed.[12]

The CEO then faces two types of incentives: the first type provides incentives to increase value, alongside shareholders, potentially selecting good borrowers and decreasing undesired risks. We refer to these as “effort incentives”, for simplicity. The second type, however, provides incentives to take risks, i.e., it consists in selecting high risk borrowers, potentially taking tail risks in markets (CDS, MBS, ...), and/or taking unsystematic risks.

In this agency relationship, however, there is a conflict that is often noted: higher risk-taking incentives are beneficial (detrimental) for the CEO (shareholders). We note that the associated risk taking is driving the wedge in optimal risk level between CEO and bank value (the “excessiveness” of risk taking). To understand the relative importance of both types of incentives we therefore look at the Gambling Ratio (GR), introduced as the ratio of risk to effort incentives (Vega over Delta) in Subsection 2.

We note that the Vega of common stock is zero, hence the GR of stock is zero. Setting

[12] Vega is the sensitivity to the volatility of the underlying bank stock, while we study bank risk via the (accounting) measure -Z throughout this paper. While the former would suggest that increasing Vega does increase, the results on the impact of increasing Vega are mixed, see, e.g., the survey by Haan and Vlahu (2016). For example, Fahlenbrach and Stulz (2011) cannot confirm any impact of bank performance during the subprime crisis.

the gambling ratio should be an important decision variable for banks, as it determines a CEO's tradeoff between effort and risk incentives: higher GR means that increasing risk, potentially at the expense of effort (current and future income), becomes relatively more important. Throughout, we refer to GR as a measure of CEOs' gambling incentives.

The right-hand plot in Figure 2 illustrates how the gambling ratio (GR) impacts bank risk, as measured by the (negative) Z-score. This plot uses the estimated coefficients from the Panel regression with bank fixed effects in column (5) of Table 3. The plot shows that risk increases when GR increases, as expected. Moreover, we recall that vega is zero when the gambling ratio is zero. We note here that this would correspond to the situation without excessive risk taking. Put differently, this difference allows us to assess the extent of excessive risk taking.

Table 3 presents the Panel regressions with bank fixed effects that underlie our discussion so far. Specifically, this Table looks at the impact of (the logarithm of) CEOs' effort incentives (Δ) in regressions (1, 2), the impact of (the logarithm of) CEOs' risk taking incentives (Vega) in regressions (3, 4) and the impact of CEO's gambling incentives (the gambling ratio GR, the ratio of risk taking over effort incentives) in regressions (5, 6). Each one comes in a variant with and one without controlling for time trends, by including (or not) the year as independent variable. Our regressions in Table 3 support the shape of the three plot (GR) in Figure 2 as the coefficients on the squared log Δ, log Vega and GR are positive, respectively, thus confirming over the respective either strictly increasing or a U-shaped relationship.[13]

4 Do Board Outsiders Affect Drivers of (Excessive) Risk Taking?

Agency issues suggest that CEOs prefer to gamble rather than to work harder. The previous section noted the wedge between optimal risk taking from the perspectives of CEO vis-a-vis its shareholders, which leads to excessive risk taking. We attributed this wedge to the

[13] In particular, the estimated coefficients in regression (3) and (5) for the squared log vega and for squared GR are positive, respectively, such that both curves are U-shaped. Their linear correspondents are both insignificant, however for the shape of the curve over the relevant range we note that for the reported coefficients the curve for log vega has a minimum at $-0.0127/(2 \cdot 0.000253) = -50.2$. Over the range from the 1%/99%-ile, the curve is increasing. For the reported coefficients, the curve for GR has a minimum at $-0.0208/(2 \cdot 0.111) = -0.09 < 0$. Since GR is restricted to positive values, the curve is increasing.

gambling ratio (GR), the ratio of risk incentives (vega) to effort incentives (Δ), capturing gambling incentives.

4.1 Insiders versus Outsiders on Bank Boards

In the run-up before the Enron fraud and culminating with the Sarbanes-Oxley legislation (SOX), there was discussion that board oversight of firms was not sufficiently independent from management. Looking into the rear view, five years after enactment, the aftermath of the global financial crisis (subprime crisis) has led to various inquiries. These attributed the crisis to *excessive* risk taking and identified a lack of risk oversight as one of its main causes. In particular, the various subprime reports express concern about independent oversight, i.e., a lack of outside directors on the boards of banks. As the board is entrusted with setting CEOs' incentives and monitoring its risk taking, we study now how the outsider ratio (OR) affects these.

A key difference to non-financials is that risk is not a by-product of operations but rather that banks' business model consists in taking risks. Alas, risk is a concept that is hard to measure and understand, in part due to its counter-factual nature. Moreover, more risk can easily be portrayed as beneficial to outsiders, as one can be tempted to capture higher risk-premiums. Nevertheless, theory tells us that (idiosyncratic) risk does not increase bank performance, rather that it decreases risk-adjusted performance. At the same time, such risk-taking would increase CEO wealth due to their risk incentives (vega).

Bank senior executives and insiders on bank boards are full-time, knowledgeable about the company, its business model, and how things get done, usually work closely with the CEO and thus are aware of both strengths and, particularly, weaknesses. They are well aware of the conceptual differences in increases in risk-adjusted outperformance vis-a-vis idiosyncratic risk taking and their effect on bank performance/firm value vis-a-vis that of (increases in) CEO wealth. Also, they are well-versed in the day-to-day intricacies of bank risk taking and are well aware that "gambling" is not a viable strategy. Moreover, they are generally motivated by shares that mitigate against pressure from the CEO to simply do his bidding to the detriment of the bank.

This has to be contrasted with outsiders/independent directors that displace the insiders/executives on bank board. These outsiders are not sizable shareholders.[14] After the subprime crisis, the deficiency has been noted that a financial background has not been required to become an outside director that displaces an insider and that other considerations played an important role, among them prestige/reputation of outsiders. But even checking the box that an outsider has a financial background may not enough. In general, they may not have sufficient information to verify whether a particular business is not idiosyncratic risk taking or a gamble. Moreover, financial innovations evolve rapidly and profound financial knowledge may be necessary to assess the specific risks stemming from new products. This was particularly acute in the run-up to the subprime crisis, when various forms of securitizations came up. As such, outsiders are more vulnerable than insiders to be tricked into increased risk taking.[15]

4.2 Incentives and Bank Risk

Figure 3 illustrates how the outsider ratio (OR) affects the gambling ratio of the CEO (GR) and bank risk (-Z). These plots are based on the coefficients in regressions (1, 4) in Panel A of Table 4, respectively, averaging out the annual trend. They show that increasing the fraction of outsiders increase both CEOs' gambling ratios[16] and, in line with what was shown in the previous section, that (this) increases bank risk.

Panel A of Table 4 presents the Panel regressions with bank fixed effects that underlie Figure 3. Specifically, this Table carries out two regressions for both dependent variables (GR and bank risk), controlling for annual trends. The first of each uses the (lagged) outsider ratio as an explanatory variable, while the second adds the quadratic OR. Panel B will be discussed in the next Subsection 4.3.

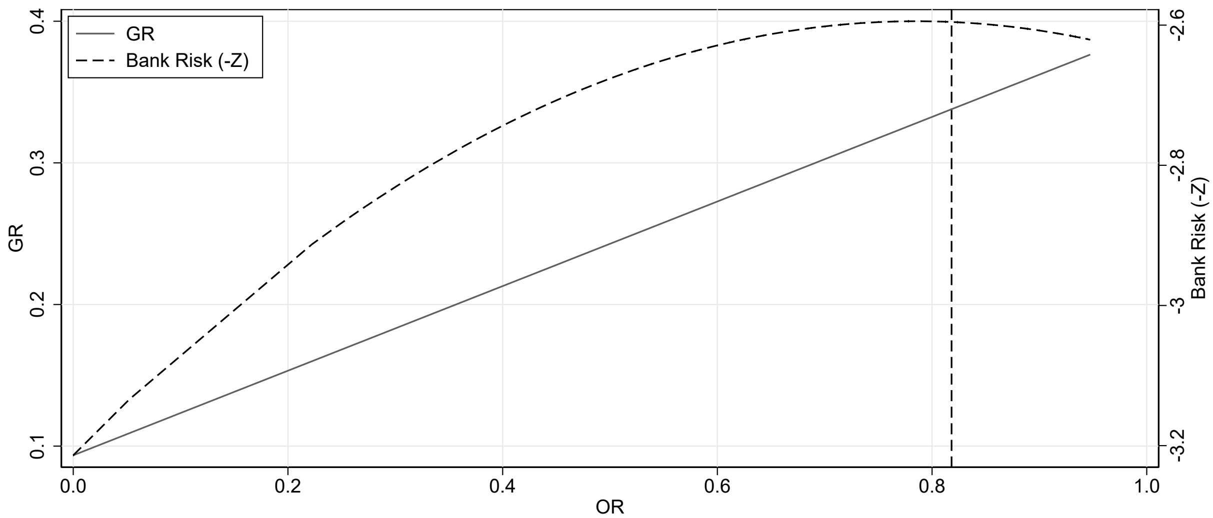
Regressions (1, 2) in Panel A of Table 4 show that increasing the fraction of outsiders

[14] If they were sizable shareholders, their independence would undoubtedly be questioned. In both the U.K. and Australia, the regulator deems significant shareholders to be non-independent, whereas this is not strictly the case in the United States.

[15] One way would be to portray to them that these increase performance due to the associated risk premium, ignoring any idiosyncratic component. In line with that, we noted earlier that the risk of a typical bank is beyond its optimum (Figure 1) and that increases in risk do decrease the market value of banks (most clearly in regressions 1 & 2 of Table 2). Anecdotally, the various forms of ABS, MBS, CDO were often portrayed as being risk-free while paying a higher interest rate than a comparable (risk-free) U.S. government bond.

[16] Further analysis show that outsiders decrease effort incentives (Δ), but we cannot confirm an impact on risk incentives (Vega). This suggests that increasing OR does increase GR via a decrease in Δ. Further analysis is beyond our scope, however.

Figure 3: Illustrating how the fraction of outsiders on the board (OR) affects the (logarithm of) CEO effort incentives (Δ), CEO gambling ratio (GR) and bank risk (-Z). Plots use the coefficients of regressions (2, 4) in Table 4, respectively, averaging out the annual trend. We plot the outsider ratio over the range of the 1%- to the 99%-ile and mark the median (50%-ile) by a dashed horizontal line.



increases CEOs' gambling incentives (GR). The quadratic term is insignificant and so we base our plot in Figure 3 on regression (i). Moreover, increasing OR does also increase bank risk with decreasing slope, see regressions (3, 4). (This is to be expected from the previous section then: increases in GR do increase bank risk.)

In regression (4) the squared OR is also statistically significant as an explanatory variable: as it is negative, the marginal impact (of an increase in OR on bank risk) decreases, i.e., the curve has a hump shape and a maximum. Interestingly, upon visual inspection of Figure 3, the maximum level of bank risk is attained at an outsider ratio of the median in our sample, denoted in the figure through the vertical dotted line. approximately 80%, which is roughly our sample average. Specifically, we calculate from the coefficients in regression (4) that the maximum bank risk (in this quadratic fit) is at an outsider ratio of $1.578/(2 \cdot 1.004) = 0.786$. This is close to the median OR in our sample (0.818) and almost exactly its mean (0.789).

A mathematical implication of the hump-shape is that for outsider ratios beyond the critical value (with maximum bank risk), (further) increases in the fractions of outsiders decrease bank risk. It is tempting to argue (based on this) that increases in OR *are* beneficial,

Table 4: Studying in Panel A how the outsider ratio affects CEO gambling incentives (GR) and bank risk. Panel B presents the average treatment effect on treated banks in a difference-in-difference analysis of SOX. Both Panels use Panel regressions with bank fixed effects. All explanatory variables are lagged one year. In Panel B the treatment is based on year 2003, assumed to be effective in year 2005. Coefficient statistics are calculated using robust methods; t-statistics are reported in parentheses; significance levels refer to * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	Panel A: Panel Regressions with bank FE			
	(1)	(2)	(3)	(4)
	CEO GR	CEO GR	-Z	-Z
OR	0.299***	1.012*	0.148*	1.578***
	(2.94)	(1.92)	(1.77)	(2.84)
OR × OR		-0.511		-1.004***
		(-1.31)		(-2.61)
Year	-0.0235***	-0.0232***	-0.0182***	-0.0181***
	(-8.81)	(-8.68)	(-12.05)	(-11.90)
Observations	1277	1277	4805	4805
Adjusted R^2	0.406	0.406	0.555	0.556
F	42.78	28.67	86.46	62.74

	Panel B: Average Treatment Effect of SoX			
	(1)	(2)	(3)	(4)
	CEO GR	CEO GR	-Z	-Z
DiD	0.266***	0.205**	0.0339	-0.0537
	(3.25)	(2.41)	(0.32)	(-0.54)
OR	-0.377***	0.817	-0.345***	1.334**
	(-3.69)	(1.48)	(-4.05)	(2.30)
OR × OR		-0.843**		-1.166***
		(-2.10)		(-2.93)
Post 2005	0.0473*	0.0454*	0.0207	0.0160
	(1.85)	(1.77)	(0.98)	(0.76)
Observations	1277	1277	4805	4805
Adjusted R^2	0.356	0.358	0.541	0.542
F	8.136	6.483	6.143	7.033
p(pll trends)	0.178	0.186	0.272	0.421

but this is mis-leading: the potential quantitative impact is fairly small in itself as the ratio is limited by (less than 100%) — in practice the limit is even lower, since (our definition of) the outsider ratio includes the CEO that is usually a member of the board of directors –. It also pales in comparison to increases in OR that go beyond the regulatory minimum (and those also before the mandate). Hence, we conclude that increases in OR lead to more (excessive) bank risk taking. This clears up previous contradictory results in the literature, see the review at the end of the introduction.

4.3 The SOX Shock Putting the Financial System Off its Course

The Sarbanes-Oxley Act of 2002 (SOX) led to the requirement that boards be composed of a majority of independent (outside) directors (OR>0.5). Banks with lower OR had to increase their ratios, which itself lead to an increase in the average OR. This may have triggered the vicious circle in increasing OR that we mentioned above.

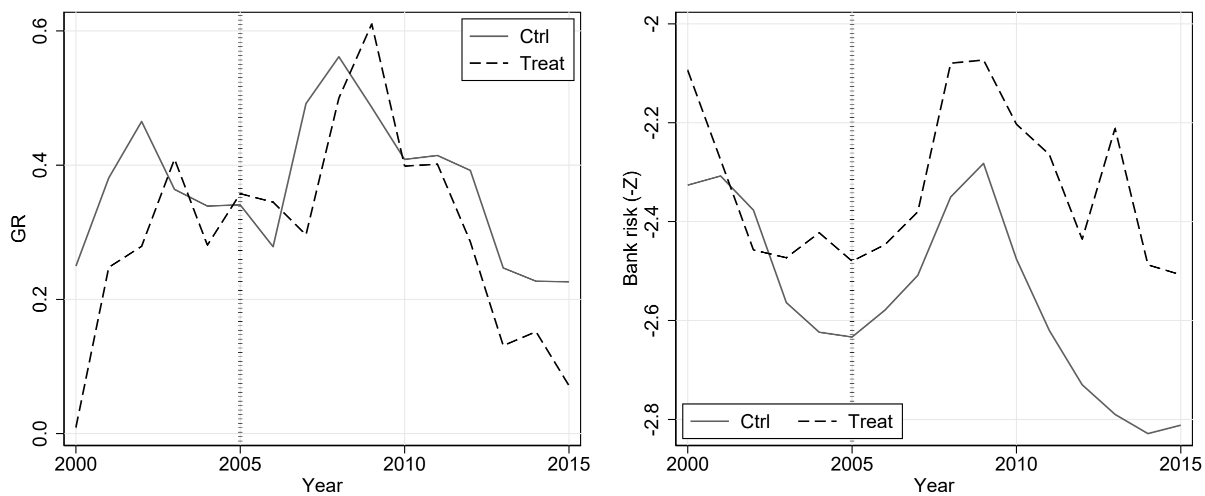
SOX provides us with a form of exogenous natural experiment to assess the impact of OR on the gambling ratio. For that purpose we consider those banks that did not fulfill the requirement in 2003. Those banks had to increase the fraction of independent directors on the board. To assess the impact of this exogenous "shock" to the OR ratio, we introduce a dummy variable, called "SOX treated", that is set equal to 1 for those banks that had to increase the outsider ratio, and zero for the other banks that are in our sample in year 2003. We carry out a difference-in-difference (DiD) analysis. Therein the former constitute the set of "treated banks", while the latter constitute the "control" group.

For the DiD analysis we need to distinguish the time before/after the SOX legislation and define a dummy variable "post 2005" that is equal to one for years after 2005, and zero for years up to 2005. We then define the difference-in-difference (DiD) term as the interaction of the "SOX treated" variable and the "post 2005" variable.[17] In the difference-in-difference analysis the DiD term captures the effect of the SOX shock on the variable of interest.

Figure 4 illustrates the CEO's gambling ratio for treated banks – banks not fulfilling SOX in 2003 – versus non-treated/control banks. *Before 2005*, both categories had similar sized and dynamics of GR and (somewhat less so) of bank risk. Thus, they exhibit so-called parallel trends, which leads to to study this further in a difference-in-difference (DiD)

[17] In our Panel regressions with bank fixed effects, the "SOX treated" is collinear and so we cannot and do not introduce that one.

Figure 4: Showing the average gambling ratio, and bank risk over the years up to 2015 for treated banks versus control (non-treated) banks. Treated banks are those with outsider ratios below 50% in 2003. The dotted vertical line displays the year 2005, when we consider treatment (SOX) to have become effective.



approach that increases in OR cause changes in the gambling ratio and in bank risk.[18]

Panel B of Table 4 extends the regression of Panel A to a difference-in-difference analysis: we add a variable indicating years after 2005, and its interaction with the treatment variable, called DiD, displaying the average treatment effect on treated banks.[19] The last line in that Panel also presents the p-value of a statistical test for parallel trends.[20] Throughout, that p-value is not at a significant level, leading us to conclude that in the respective regression the parallel trends assumption is not violated.

Panel B confirms that increases in OR do cause increases in GR. Unfortunately, here we cannot confirm (nor reject) that increases in OR also lead to increases in bank risk. It

[18]Parallel trends (before the treatment becomes effective) is an assumption in such analysis. This will be tested using a formal statistical test of parallel trends in our analysis below. For illustration only, we present averages of GR and bank risk also in years after the treatment becomes effective (2005).

[19]As we use Panel regression with bank and year fixed effects, the treatment variable is collinear with the (individual) bank fixed effect and not added.

[20]For each of our DiD regressions, we study an extended regression up to 2005, where the interaction term is added that comes from interacting the treatment variable with the year variable. That interaction term would pick up any non-parallel trend. Testing for our Null-hypothesis that trends are parallel then boils down to testing whether that coefficient is different from zero (statistically significant).

is important to put the latter result into perspective: It is well-understood from theory that risk incentives lead to higher risk taking. While we do not study this separately for our gambling ratio from a theory perspective, it seems reasonable to us to assume from a theoretical perspective that gambling incentives increase bank risk. Moreover, our empirical analysis so far documented that this holds, so while we cannot confirm explicitly causality of OR on bank risk, we take the previous mentioned causality of OR on GR as a confirmation. We will take another look at the impact of OR on risk taking, when we take an explicit look at *tail* risk taking in subsection 5.3 below.

5 How did Bank Risk Become Excessive?

The previous sections showed that increasing the outsiders on boards drives up gambling ratios and that this then increases bank risks beyond the level desired by shareholders. In short, they lead to too much gambling within the bank.

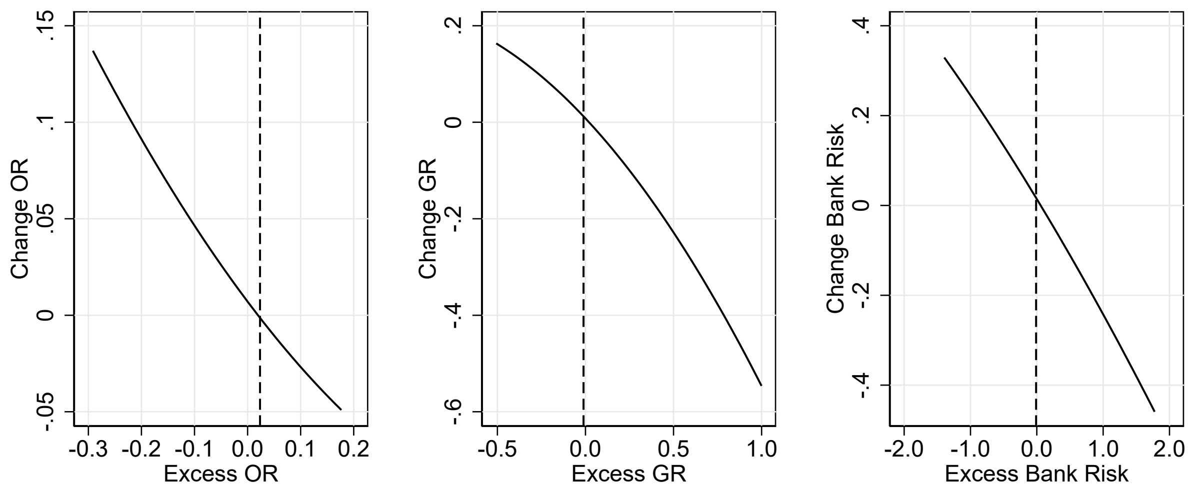
It is well-known that outsider ratios increased over time and so the first subsection studies the dynamics of our three variables of interest (OR, GR, bank risk). The second subsection then shows that the same drivers do increase the CEO's performance, indeed, thus re-confirming that the documented dynamics are beneficial for the CEO. At the same time we also document here that these drivers are detrimental for bank performance. Finally, the last/third subsection shows that outsiders and gambling ratios (also) drive up tail risks, specifically, in addition to what we noted previously about bank risk, in general. Moreover, we trace this to the changes in SOX.

5.1 Peer Pressure

The left-hand plot in Figure 5 illustrates how the OR changes over a year in response to being higher/lower than its (sample) average in the current year, i.e., in response to positive/negative excess OR. Specifically, we calculate in each year the average outsider ratio and then subtract this from the current outsider ratio of a bank to get the excess outsider ratio. The center and right-hand plots are analogous to that but look at changes in the gambling ratio and changes in bank risk changes over a year, respectively.

First we take a look at OR (the left-hand plot): We note that the slope is decreasing and

Figure 5: Illustrating how the excess values of three variables (outsider ratio, CEO gambling ratio, bank risk) drive their change over the following year, respectively. The excess value of a variable is here its value beyond that of the average of their peers in a given year (in our sample). The dashed vertical line shows the position of the respective median excess value. We plot the respective variable over its range of the 1%- to 99%-percentile and mark the median (50%-ile) by a dashed horizontal line. Plots are based on the coefficients in regressions (2, 4, 6) in Table 5, respectively, by averaging out the annual trend in those regressions.



that positive/negative excess OR (higher/lower than average OR) lead to a decrease/increase in OR the following year. This means that outsider ratios are reverting to the mean. It is akin to peer pressure which reverts outsider ratios to that of a "typical" bank (a bank with the average OR). In isolation, this suggests that when these variables are in equilibrium, any departure by an individual bank puts pressure on that bank to revert back to the equilibrium value.

However, we also note that the curve in the left-hand plot in Figure 5 is concave. Put differently, the dependency becomes flatter and implies an asymmetric response to lower/higher than average OR. For example, if a bank's OR is 0.1 below (above) that of its peers, then its next year's OR is roughly 0.05 higher (0.025, about a half of 0.05, lower). The asymmetry in the OR change between negative/positive excess OR creates a vicious cycle that ever

Table 5: Studying how the excess values of three variables (outsider ratio, CEO gambling ratio, bank risk) drive their change over the following year, respectively. The excess value of a variable is here its value beyond that of the average of their peers in a given year (in our sample). We present Panel regressions with bank fixed effects, controlling for (changes in) return on equity ROE, bank risk (-Z) and for yearly trend. Coefficient statistics are calculated using robust methods; t-statistics are reported in parentheses; significance levels refer to * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	(1) Δ OR	(2) Δ OR	(3) Δ GR	(4) Δ GR	(5) Δ (-Z)	(6) Δ (-Z)
Exc OR	-0.357***	-0.366***	-0.139		-0.102	
	(-23.05)	(-25.19)	(-1.30)		(-1.61)	
Exc OR × Exc OR	0.170**	0.273***				
	(2.03)	(2.63)				
Exc GR			-0.383***	-0.390***		
			(-7.87)	(-8.44)		
Exc GR × Exc GR			-0.154**	-0.164**		
			(-2.38)	(-2.53)		
Exc (-Z)					-0.252***	-0.244***
					(-5.09)	(-11.32)
Exc (-Z) × Exc (-Z)					-0.00696	-0.0128
					(-0.33)	(-0.65)
ROE	0.000747***		0.00253**		0.00384***	
	(5.66)		(2.22)		(3.18)	
Exc ROE	-0.000947***		-0.00126		-0.00547***	
	(-6.60)		(-1.09)		(-4.89)	
-Z	0.000335		0.0126		-0.0117	
	(0.14)		(0.45)		(-0.25)	
Year	-0.00141***	-0.00145***	-0.00707***	-0.00925***	0.00168	0.000330
	(-6.88)	(-7.78)	(-3.23)	(-5.56)	(1.10)	(0.47)
Observations	4808	5677	1106	1161	4644	4645
Adjusted R^2	0.201	0.210	0.200	0.205	0.176	0.166
F	96.79	224.2	16.18	42.44	28.47	51.32

increases the average OR year-over-year.[21]

[21] In addition, subsection C.3 in the appendix documents that high gambling ratios lead to more outsiders on the board. This shows a feedback loop between outsiders and gambling ratios: once outsider ratios increased due to SOX, the ensuing increase in gambling ratios kept outsider ratios high itself. One may view

We recall that the Sarbanes-Oxley Act (SOX) forced banks with OR below 50% to increase their OR, such that *average* OR increased (considerably) up to the implementation year 2005. Together with the peer pressure that we just documented would then[22] force even compliant banks to further increase their OR, leading to a further increase in average OR, a vicious cycle.[23]

(Asymmetric) Peer pressure together with the SOX shock would then explain the empirically documented observation that OR continued to increase well beyond the SOX implementation, up to a much higher level of OR at approximately 80%, well above the mandated minimum (50%).

Finally, we take a look at the center- and right-hand plots in Figure 5. Both curves have a negative slope, which means that we see peer pressure in both gambling ratios and bank risk.

Columns (2, 4, 6) of Table 5 present the regressions that underlies our illustration in the three plots of Figure 5. In regression (2), the dependent variable is (annual) changes in the outsider ratio. The explanatory variable is the excess OR and its square, controlling for yearly trends. The regression column (1) extends this by controlling (in addition) for bank (excess) performance (return on equity, ROE) and bank risk (-Z). Both are Panel regressions with bank fixed effects.

Regression coefficients on excess OR and of its square are negative and positive, respectively: the sign of the latter coefficient tells that the dependency is U-shaped and concave. Quantitatively, in column (1), the (relative) size of both coefficients (in this quadratic fit) means that the minimum would be at $0.366/(2 \cdot 0.273) = 0.67$, well beyond the 99%-ile in our sample, i.e., the observations in our sample are to the left of the minimum. Hence, the curve is decreasing and concave, as illustrated in the left-hand plot of Figure 5.

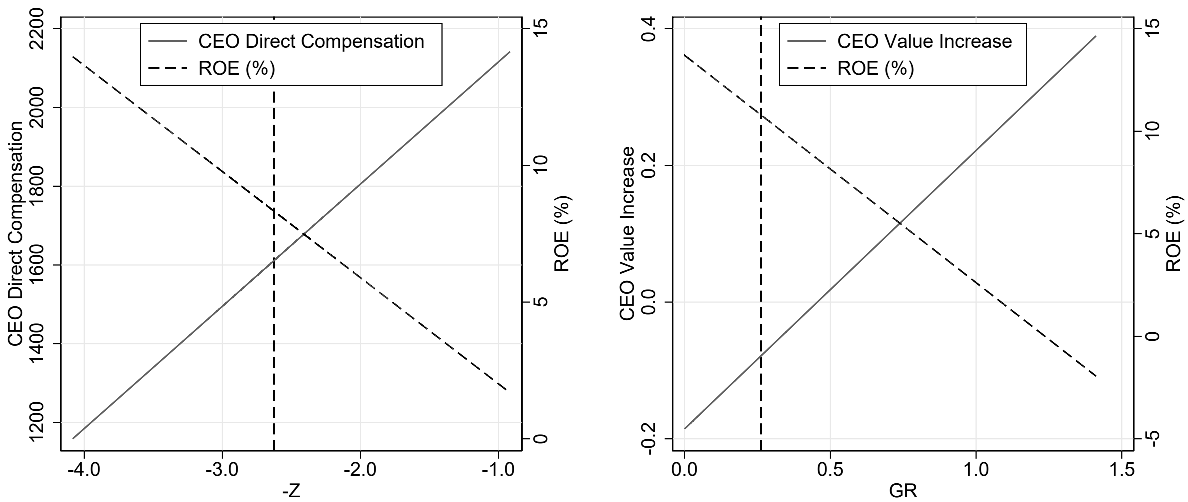
Regressions (3, 4) and (5, 6) are analogous to regressions (1, 2) but look at gambling ratios and bank risk, respectively. As such, in regression (3, 4) the main explanatory variable is the excess gambling ratio (and its square), in regressions (5, 6) it is the excess bank risk

this as a new regime with a culture of risk gambling. But further analysis is beyond our scope in this paper and so we report this in the appendix, only.

[22]For example, an (exogenous) increase in the average outsider ratio would decrease the pressure on banks with large OR. It would also put pressure on banks to increase the OR that were previously had OR at the average.

[23]We note that peer pressure also forces banks with OR above the average to decrease their OR. But due to the concaveness noted above, the pressure is smaller and this does not break this vicious cycle.

Figure 6: Illustrating how gambling ratios and bank risk (-Z) affect bank performance (ROE) and CEO pay. CEO pay is direct compensation in the left-hand plot and (relative) change in CEO value in the right-hand plot. We plot the respective variable over its range of the 1%- to 99%-percentile and mark the median (50%-ile) by a dashed horizontal line. Plots are based on regressions (1, 2, 4, 6) in Table 6, respectively.



(and its square), replacing OR (and its square). These regressions support the main features of our illustration in the center- and right-hand plots in Figure 5 that we discussed above: the coefficient on excess GR and on excess bank risk is negative, respectively, i.e., there is also peer pressure. The coefficients on their respective squares are also negative, subject to (s.t.) the response is convex, i.e., peer pressure is also asymmetric but does not reinforce itself[24]. (Rather, in itself it is mean-reverting.)

5.2 Gambling Decreases Performance and Increases CEO Pay

The starting point of our analysis was the observation in Section 3 that the optimal level of bank risk from CEO's perspective is larger than that of the optimum from a shareholder

[24]Different to the left-hand plot in Figure 5, however, the centre and right-hand curves have convex shapes. Different to our previous observations with OR (concavity of the curve), there is no vicious circle in gambling ratios (bank risk) over the years. Nevertheless, as documented in the previous Section, increases in OR do lead to increases in gambling ratios and bank risk. Together with the vicious circle of increasing OR, this (helps) explain that gambling ratio and henceforth bank risk increased in the run-up to the subprime crisis.

Table 6: Studying the drivers of bank performance and CEO pay. All three Panels A-C carry out Panel regressions with bank fixed effects. The dependent variable in Panel A is bank performance, measured through ROE (in excess of the current risk-free rate) and in Panel B is CEO compensation, measured either through direct compensation or change in value of CEO wealth in the bank. The dependent variable in Panel C is either bank business risk or the risk-adjusted performance (Alpha). Bank business risk is calculated as the residual in a Panel regression with bank fixed effects of bank risk on the gambling ratio (not reported). Alpha is calculated as the residual in a Panel regression with bank fixed effects of performance (ROE in excess of riskfree) on the bank risk (-Z) (not reported). Coefficient statistics are calculated using robust methods; t-statistics are reported in parentheses; significance levels refer to * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	Panel A: Performance			Panel B: CEO Comp.			Panel C: Residuals	
	(1) ROE	(2) ROE	(3) ROE	(4) Direct	(5) Direct	(6) Value Inc.	(7) Bs. Risk	(8) Alpha
-Z	-3.881*** (-4.24)		4.003*** (3.01)	310.3** (2.44)	461.1*** (3.27)			
GR		-11.08*** (-7.03)	-48.88* (-1.85)			0.407*** (4.50)		-11.84*** (-7.66)
GR × GR			47.17* (1.89)					
OR			-11.41* (-1.80)				0.401*** (2.94)	-8.281** (-2.04)
OR × GR			60.21* (1.91)					
OR × GR × GR			-62.58** (-2.08)					
Exc ROE			0.393*** (5.54)					
CEO Delta							0.00463* (1.79)	-0.194 (-1.47)
Year			0.114 (1.35)				-0.00411 (-1.63)	-0.390*** (-6.01)
Avg. ROE			0.645*** (10.55)					
ROE					23.07*** (4.10)			
Observations	4668	1313	1253	1631	1631	1237	1279	1253
Adjusted R^2	0.185	0.255	0.420	0.567	0.574	-0.024	-0.126	0.059
F	17.97	49.41	36.40	5.945	9.368	20.29	3.570	27.70

perspective (excessive risk taking)[25]. We further argued that this is driven by gambling

[25] Figure 1 illustrates and the Table there confirms: first, we noted there that the (logarithmic) market value (of the bank) has an optimal level of risk taking; second, (most important for our discussion here) we

incentives in CEO's compensation.

This leads us to the conjecture that bank performance decreases but CEO pay increases as bank risk increases. Moreover, as we argue that bank risk is driven by gambling incentives, a second conjecture is that bank performance decreases and CEO pay increases as gambling ratios increase. Both conjectures would imply a wedge between shareholder and CEO interests that in this agency relationship would lead to excessive risk taking. This subsection will now study both conjectures.

Figure 6 illustrates left-hand the impact of bank risk on CEO direct compensation (salary and bonus) and on bank performance (ROE). The right-hand plot illustrates the impact of the CEO's gambling ratio on change in the value[26] of the CEO's wealth in the bank and on bank performance, respectively. The plots are based on the coefficients in regressions (1, 2, 4, 6) of Table 6, respectively.

Figure 6 illustrates left-hand (right-hand) that increasing bank risk taking (gambling ratios/incentives) decreases bank performance, in line with both conjectures. Moreover, the left-hand (right-hand) plot also illustrates that increasing bank risk taking (gambling ratios/incentives) *increases* CEO compensation, also in line with both conjectures. This creates a wedge between the interests of shareholders and CEO which is of serious concern as it may lead to excessive risk taking.

Table 6 studies this in greater detail. There, Panel A and B study the drivers of bank performance and of CEO compensation (Direct Compensation and changes in CEO wealth), respectively. Throughout Table 6, "ROE" refers to ROE in excess of the current risk-free rate, since it is customary in finance to study performance in excess of the current risk-free rate.[27]

Regressions (1, 2) of Table 6 underlie the performance plots in Figure 6. They consider either only bank risk or only gambling ratios as explanatory variables, respectively, and show that higher bank risk (higher gambling ratios) decrease performance. Regressions (3) in Table 6 then studies bank risk and GR together and jointly with control variables. We

noted that most observations are to the right of that optimum, see the vertical dotted line illustrating the median there; as most observations are to the right of the maximum, any increase in bank risk does decrease the market value, which is consistent with the decrease in performance shown here.

[26] We could not confirm that CEO compensation itself is significantly affected by the CEO's GR.

[27] Studying excess ROE instead of ROE seems to be conceptually more appropriate but does not affect our insights from that Table. To control for time trends, we considered adding the year as an explanatory variable but it turned out insignificant and hence we do not report this here.

confirm that performance decreases when increasing either bank risk or gambling incentives (GR). Moreover, we find that having more outsiders (higher OR) decreases performance and increase (decreases) the sensitivity to the linear (quadratic) term in GR. The latter means that higher OR even makes the (negative) sensitivity of performance to gambling incentives even stronger.

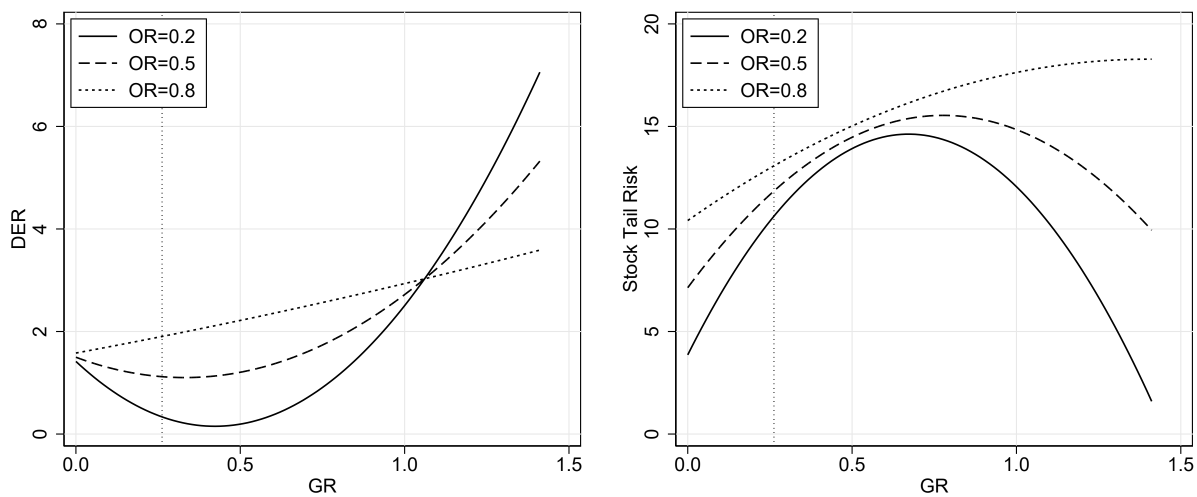
Regressions (4, 6) of Panel B in Table 6 underlie the CEO compensation plots in Figure 6. They consider either bank risk or the gambling ratio as explanatory variables. Regression (5) extends (4) by adding ROE as a control variable. We confirm the insights from our plots: higher bank risk or higher gambling ratios do increase CEO compensation.

Panel C in Table 6 studies further the drivers of the decrease in bank performance directly and, indirectly, through bank risk taking. For the latter, we recall from Section 3 that gambling ratios drive bank risk taking away from its optimal level, which we view for a moment as the inherent business risk of the bank. This observation leads us to a decomposition of (observed) bank risk into its (unobserved) optimal level and gambling. (We report the regression in Table C4 of Appendix C.) As we argue throughout the paper that the latter is driven by gambling ratios, we conjecture that the residual, from a Panel regression (with bank fixed effects) of bank risk on the gambling ratio, does capture the inherent risk of running the bank's business. We then study this (then so-called) bank business risk as the dependent variable in regression (7).

The dependent variable in regression (8) is the residual from a Panel regression (with bank fixed effects) of bank performance (ROE beyond the risk-free rate) on bank risk, reported in Table C4 of Appendix C. This regression captures that taking risks should be compensated by an associated risk-premium within the performance. Within asset management, after "properly" controlling for risk factors, the performance residual would capture out-/underperformance. This term is commonly referred to as Alpha and captures the performance component of superior/inferior asset selection/timing, which is supposedly driven by effort. We conjecture that the residual from a regression of performance on bank risk captures that component and do term it Alpha.

We find in regression (7) that outsiders increase bank business risk. Regression (8) complement this by noting that this increased risk taking leads to lower bank residual performance: it shows that both OR and gambling are decreasing risk-adjusted bank performance.

Figure 7: Illustrating how CEO incentives and bank outsiders affect tail risk of bank stock returns. We plot the gambling ratio over the range of the 1%- to 99%-percentile and mark the median (50%-ile) by a dashed horizontal line. Plots are based on regressions (3, 6) in Table 7, respectively.



5.3 Gambling Risks

Gambling is often associated with a particular form of risk taking: tail risks. We now further study how gambling ratios and outsiders affect tail risk taking. Therein we are particularly interested in the use of financial derivatives that became prevalent at the beginning of the new millennium, e.g., asset backed and mortgage backed securities that are specifically blamed for the subprime crisis. Moreover, we are interested in the impact on shareholder tail risks, hence study the tail risks in shareholder returns.

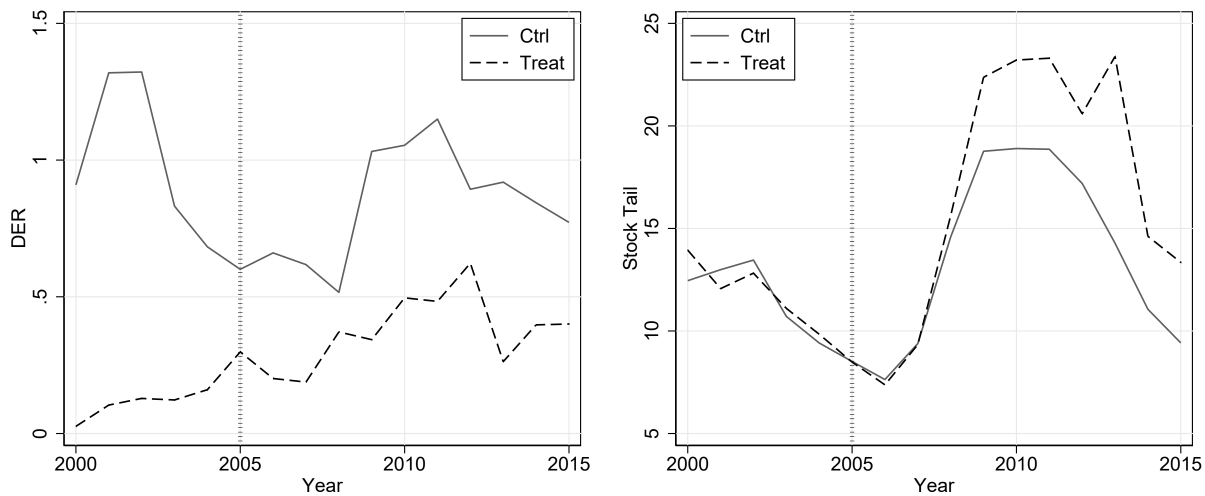
Figure 7 illustrates the impact of CEOs' gambling ratios and of board outsiders on bank tail risks: the left-hand plot look at the impact on the use of financial derivatives. The right-hand plot looks stock return tail risks. Both plots consider three curves: first, a board with a small number of outsiders, with an OR of 20% that is slightly lower than the average of those banks which had to increase the outsider ratio to comply with SOX; second, a board with OR exactly at the 50% mandated by SOX; finally, third, a board with OR of 80%, slightly higher than the OR shortly after SOX implementation.

At the high outsider ratio of 80% tail risks increases with increases in the gambling

Table 7: Studying how the outsider ratio affects gambling risk (derivatives usage and tail/VaR of stock returns). Panel A presents Panel regressions with bank fixed effects. Panel B presents the average treatment effect on treated banks in a difference-in-difference analysis of SOX, using Panel regressions with bank fixed effects. (The treatment is based on year 2003, assumed to be effective in year 2005.) Coefficient statistics are calculated using robust methods; *t*-statistics are reported in parentheses; significance levels refer to * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	Panel A: Panel Regressions with bank FE					
	(1) DER	(2) DER	(3) DER	(4) Tail Risk	(5) Tail Risk	(6) Tail Risk
CEO GR	1.884**	1.815**	-8.371*	10.38***	10.07***	38.97***
	(2.54)	(2.48)	(-1.89)	(7.98)	(7.72)	(2.86)
CEO GR × CEO GR	-0.519	-0.511	9.370*	-2.703***	-2.618***	-30.44**
	(-0.88)	(-0.86)	(1.85)	(-3.03)	(-2.96)	(-2.44)
OR		2.080**	0.273		5.720**	10.91***
		(2.23)	(0.29)		(2.43)	(2.81)
OR × CEO GR			11.95**			-34.68**
			(2.39)			(-2.14)
OR × CEO GR × CEO GR			-11.51**			33.05**
			(-2.09)			(2.23)
Year	0.00992	-0.0141	-0.0126	0.0558	-0.0126	-0.0179
	(0.53)	(-0.67)	(-0.61)	(1.47)	(-0.29)	(-0.41)
Observations	1199	1199	1199	1314	1314	1314
Adjusted R^2	0.928	0.928	0.928	0.377	0.380	0.383
F	5.529	4.453	3.175	43.45	34.95	24.42
	Panel B: Average Treatment Effect of SoX					
DiD	-0.325	-0.401*	-0.774**	5.533***	5.300***	6.355***
	(-1.30)	(-1.67)	(-2.31)	(4.59)	(4.21)	(4.70)
OR		1.857*	0.129		7.338***	12.13***
		(1.73)	(0.13)		(2.99)	(3.11)
OR × CEO GR			11.84**			-33.71**
			(2.30)			(-2.10)
CEO GR	1.808**	1.780**	-8.312*	10.54***	10.32***	38.41***
	(2.43)	(2.41)	(-1.83)	(8.11)	(7.94)	(2.84)
CEO GR × CEO GR	-0.504	-0.503	9.380*	-2.739***	-2.667***	-30.31**
	(-0.85)	(-0.85)	(1.83)	(-3.07)	(-3.02)	(-2.45)
OR × CEO GR × CEO GR			-11.50**			32.82**
			(-2.06)			(2.24)
Post 2005	0.341	0.190	0.165	-0.678	-1.355**	-1.272**
	(1.29)	(0.64)	(0.54)	(-1.26)	(-2.41)	(-2.29)
Observations	1199	1199	1199	1314	1314	1314
Adjusted R^2	0.928	0.928	0.928	0.377	0.382	0.385
F	3.787	3.313	2.672	31.55	28.86	22.59
p(pll trends)	0.810	0.671	0.596	0.495	0.493	0.315

Figure 8: Showing the average derivative use and stock return tail risk over the years up to 2015 for treated banks versus control (non-treated) banks. Treated banks are those with outsider ratios below 50% in 2003.



ratio of the CEO (both plots). This level of the outsider ratio covers the empirically relevant level, as it roughly prevails in the run-up to the subprime crisis and the years thereafter. The observations in that figure about tail risks support our discussion and analysis in this paper throughout that looked at bank risk in general. They are, however, particularly worrying as tail risks can bring down a bank, irrespective of the bank risk that we studied so far, and as such it is well understood that they were at the root of the subprime crisis. Hence, our analysis in this subsection extends our previous analysis of risk taking, targeting specifically subprime risks: again, we study whether increased gambling incentives (due to increased gambling ratios) were a driver of the subprime crisis.

Notwithstanding that OR of 80% are the empirically relevant one, it is interesting to study the other curves as they show what might have happened if the fraction of outsiders would have been lower. Our discussion throughout this paper notes that lower OR lead to lower GR, hence the relevant range for gambling ratios would be smaller (the highest GR would shift towards the left). On that range, both plots suggests that tail risks (derivative usage and stock tail risks) may be (considerably) lower.

Panel A of Table 7 presents the results of Panel regressions with bank fixed effects. Panel

B extends these in a difference-in-difference analysis based on SOX analogous our previous one in subsection 4.3. The first three regressions look at DER, the remaining three at stock tail risks. Therein, regressions (3, 6) study interaction terms of OR and GR and are illustrated in Figure 7. The other regressions do not study interaction terms. (We considered adding the squared OR as an explanatory variable but it turned out insignificant and hence we do not report this here.)

Panel A of Table 7 supports our conclusions based on Figure 7. Increasing either OR or GR does increase both tail risks. Surprisingly, the Difference-in-Difference (DiD) term for DER is negative, which seems to be against our insights in this paper so far. We recall, however, the U-shape of that dependency in the left-hand plot of Figure 7 for OR below 50%. The observed negative DiD sign are consistent with this, as long as the (observed) majority of GR at that time fall would be within the decreasing part of that curve. The DiD term for stock tail risks is unanimously positive, thus supporting our insights so far.

Overall then, we find in this subsection that increases in outsider ratios (cause) increase(s) (in) gambling risks, in particular in the subprime/tail risks that are at the root of the subprime crisis.

6 Conclusion

The subprime (global financial crisis, GFC) has been blamed on deficiencies in governance and (performance-based) compensation that led to excessive risk taking. This paper studied empirically the drivers of excessive risk taking.

We found that the optimal level of risk for the CEO is higher than the optimal level for shareholders, i.e., bank risk taking is excessive from the perspective of shareholders. We argued that the relative importance of risk to effort incentives captures gambling incentives. For performance-based CEO pay we introduced the gambling ratio, the ratio of curvature (Vega) to slope (Delta, aka pay-performance-sensitivity). Increases in the gambling ratio led to increased bank risk and subprime risks, decreased bank value/performance, but also increased CEO wealth/pay), i.e., bank CEOs were rewarded for (subprime) gambles.

We use the change in mandated outsider ratios following Sarbanes-Oxley legislation as an exogenous shock to establish a causal link between increased outsider ratios, increased gambling incentives, and associated increased bank/tail risks, in particular increased subprime gambles that were at the root of the global financial crisis.

We then documented that board outsider ratios are mean-reverting to the bank average, a form of peer pressure. But the response is asymmetric: above average ratios lead to decrease that is only about half as strong as the increase from above ratios. That asymmetry creates a vicious cycle that ever increases the average outsider ratio year-over-year, triggered by the mandated outsider ratios following Sarbanes-Oxley legislation.

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Appendix

A Data and Variables

We create our merged dataset (CRSP, BHC, BoardEx) by starting with the CRSP-Compustat merged (CCM) data file (gvkey and permco identifiers), adding bank holding company (BHC) database through the link table from the Federal Reserve Bank of New York[28]. BoardEX data is added using its database that links its CompanyID identifier with the Central Index Key (CIK) of the U.S. Securities and Exchange Commission (SEC).

Table A1 describes our variables. Note that we could calculate delta, vega, and firm related wealth ourselves from ExecuComp but for comparability we take them from Lalitha Naveen's public database, see our discussion in Section 2.

At times, (common) equity, tier 1 equity are zero or negative in the BHC database. In either of these cases we ignore the reported value. Estimations of stock/asset volatility and stock tail risk (value-at-risk) use data from the previous five years (60 months/20 quarters).

While the standard deviation and Value-at-Risk measures are well known, some comments are in order regarding the other risk measures. First, the leverage ratio that we consider here is the definition in banking regulation. Importantly, this (banking) leverage measure is the inverse of the common leverage in finance. The Tier 1 capital ratio is another measure of leverage. It differs from the leverage ratio in the numerator (Tier 1 capital versus common equity for the leverage ratio) and in denominator (T1 capital ratio: risk-weighted assets; Leverage ratio: total assets). Second, the z-score (aka distance to default) is a balance sheet measure defined in the usual way. Since z is skewed, it is common to use Z, see, e.g., Laeven and Levine (2009) and Houston et al. (2010), among others. For details on the probability of default (PD) see, e.g., Laeven and Levine (2009).

An increase in T1 corresponds to a reduction in "leverage" w.r.t. risk-weighted assets and an increase in **Z** means that default is *less* likely. Throughout, we look at the negative values -**T1** and -**Z** (then denoted explicitly), such that increases in all reported risk measures correspond to increases in risk taking[29].

[28] Source: Federal Reserve Bank of New York. 2022,
available at: https://www.newyorkfed.org/research/banking_research/datasets.html

[29] Increases in **DER** mean more *non-hedging* activities in derivatives, which are usually attributed to an increase in risk-taking.

B Robustness to Changes in Risk Measure

Throughout this paper, we looked at one risk measure, -Z, only. Other bank risk measures have been presented by the literature, most importantly -T1, LEV, and PD, see our discussion in section 2. This appendix assesses the robustness of our results throughout the paper. For this, we revisit the main regressions in each table, redo them with the other main risk measures (-T1, LEV, PD) and discuss whether the results support our insights.

Table B1 revisits columns (2, 6) of Table 2 that underlie our discussion in the main body of this text, covering our three alternative risk measures. The results do support our conclusions in the main body of the text but that requires some discussion.

First, looking at the -T1 risk measure, while market value is hump-shaped, CEO wealth is U-shaped. Yet, the minimum for CEOs is at $-0.0454/(2 \cdot 0.000436) = -52.1$. This is less than the minimum in our sample (-47.3), s.t. the function is increasing on the relevant range. Hence, CEOs have incentives for excessive risk taking, risk taking larger than desired by shareholders.

Second, looking at LEV, while market value is U-shaped, CEO wealth is hump-shaped. Yet, the minimum for shareholders is at $0.13/(2 \cdot 0.00116) = 56.0$. Such high leverage is not permitted by regulators, such that shareholders are restricted to lower values and hence have incentives to decrease LEV as much as possible. The optimal level of CEO LEV is at $0.0207/(2 \cdot 0.00122) = 8.5$, which is larger than that desired by shareholders.

Third, looking at PD, we see that both, market value and CEO wealth are U-shaped. The minimum for shareholders is at $0.0542/(2 \cdot 0.000342) = 79.2$ (%) and the minimum for the CEO is at $0.0269/(2 \cdot 0.0000351) = 383.2$ (%), which suggests that both aim to set PD as low as possible. However, the coefficient on squared PD is insignificant and so we cannot exclude it being negative, such that the latter corresponds to a hump-shape function for CEO wealth and the maximum possible PD of 100% would be desired by CEOs.

Table B2 revisits columns (1, 3, 5) of Table 3 that underlie our discussion in the main body of this text, covering our three alternative risk measures. We find that all (statistically significant) coefficients are positive, thus confirming our results from the main body of the text.

Table B3 revisits column (4) of Table 4 that underlie our discussion in the main body of this text, covering our three alternative risk measures. We find that all (statistically significant) coefficients on OR (squared OR) positive (negative), thus confirming our results from the main body of the text.

Table B4 revisits column (6) of Table 5 that underlie our discussion in the main body of this text, covering our three alternative risk measures. We find that all (statistically significant) coefficients on the respective risk measure are negative, thus confirming our results from the main body of the text (peer pressure). (Also, the coefficients on the respective squared excess risk measure are negative, also confirming our discussion there.)

Table B5 revisits columns (1, 4) of Table 6 that underlie our discussion in the main body of this text, covering our three alternative risk measures. We find that all (statistically significant) coefficients of bank performance (CEO compensation) on the respective risk measure are negative (positive), thus confirming our results from the main body of the text.

C Additional Panel Regressions

C.1 Delta and Vega

Our paper introduces gambling ratios (GR) and focuses on it, but the literature studies Delta and Vega. For completeness we revisit our analysis for these two variables, instead of GR: Table C1 revisits columns (1, 2) in Panel A of Table 4, Table C2 revisits columns (2, 6) in Table 6 and Table C3 revisits columns (1, 4) in Table 7.

Only one coefficient in Table C1 is significant: increasing OR decreases effort incentives (Δ) which matches our insight from column (8) in Table 6 that having more outsiders is bad for risk-adjusted performance (Alpha). In Panel B, only one DiD term is (weak) significant and suggests that increasing OR increases risk incentives (log) Vega. This result is analogous our stronger results throughout the paper that increasing OR increases gambling incentives (GR). We note also that the large number of insignificant results matches the difficulty in the literature of establishing a link between effort/risk incentives that also led us to look at gambling incentives.

Table C2 shows that effort and risk incentives positively affect bank performance and CEO value. (Note that the coefficient on squared CEO Δ is negative, suggesting this holds for effort incentives only up to a critical value. Also note that w.r.t. the squared term is positive.) As both work in the same direction, the overall effect of GR remains unclear when looking exclusively at this Table.

In Table C3, the coefficients for Delta have the same sign as in Table 7, supporting a U-shape for the impact of Delta on gambling risks. The coefficients for Vega are mostly insignificant, with the exception of the regression (4), which suggests a decrease. The overall effect of GR remains unclear when looking exclusively at this Table.

C.2 Residuals

The two regressions in Table C4 provide the basis for calculating the respective performance residual that we use in columns (7, 8) of Table 6.

C.3 Outsiders

Our focus in this paper is on the impact of gambling incentives on risk taking. Therein, we attribute CEO gambling ratios to outsider ratios. To provide some insights and for potential further analysis, we now look briefly into insiders, since they are the ones being displaced by outsiders when the OR increases.

For our analysis here, we calculate insider gambling ratios analogous to CEO gambling ratios based on ExecuComp (via Lalitha Naveen's public database), i.e., as the ratio of (insider) Vega over (insider) Delta. Also, we take from that database insider related wealth. An important caveat to note, however, is the following: the SEC requires and hence ExecuComp only reports data for the five top executives. This includes the CEO and allows our analysis in the main body of the paper. Thus for insiders we do not necessarily have data on all executive directors. We also note that our insider variables are averages across the reported insiders.

Columns (5-8) in Table 2 study how bank risk affects *CEO* wealth. Analogously, Panel A in Table C5 studies how bank risk affects *insider* wealth. (The Table, including control variables is structured analogously and we refer to Table 2 for a discussion.)

Panel A of Table C5 finds the same insights that we saw previously in Section 3 for the CEO: increasing risk is beneficial but only up to a maximum risk level (hump-shape) that is at a bank risk with (-Z) at $-1.632/(2 \cdot 0.327) = -1.55$ (according to regression 3). This optimal risk level (of insiders) is higher than that of the CEO, -2.65 see our discussion of Table 2.

Panel B in Table C5 carries out Tobit regressions of the outsider ratio on CEO/insider gambling ratios. (The Tobit regression here reflects explicitly that outsider ratios are bounded by zero below and by one above. Unfortunately, the Tobit regression here is cross-sectional, only. We do not have access to a version of Tobit regression that takes account of the Panel structure.) Columns (1-2) look at CEO gambling ratios, while columns (3-4) consider insider gambling ratios.

We see that increases in either CEO gambling ratios or increases in insider gambling ratios do increase the outsider ratio. However, the interaction of both in regression (4) is negative, i.e., decreasing either gambling ratio — e.g., decreasing executives GR — means that the outsider ratio increases. Regression (2) adds the squared CEO GR as an explanatory variable and the sign is negative, but the associated maximum is at $0.133/(2 \cdot 0.0463) = 1.44$, which is close to the largest CEO GR that we observe in our sample.

Table C6 revisits Panels B and C of Table 6. Whereas there we looked in Panel B how the gambling ratio and risk affects CEO pay, here we look at insider pay in two Panels A and B; for further understanding, Panel C here and in Table 6 looks at the impact on business risk and residual pay. (Both are the residuals from the regression in Table C4; we introduce these variables after Table 6 in the main body of the paper.)

First we look at Panel A. We mentioned in the main body that we cannot find an impact of CEO's gambling ratio on CEO direct compensation. For completeness, Column (4) provides the underlying regression result. Interestingly, we find here that the insider gambling positively affects insider direct compensation, which is in line with our insights about gambling ratios, in general. Bank risk taking (-Z) does not affect insider direct compensation, whereas it does affect CEO direct compensation. Bank performance, potentially driven by (excessive) risk taking, does positively affect insider (here) and CEO direct compensation (Table 6).

Panel B of Table C6 studies changes in the (total) value of the insider/CEO (the value of stock and options). Both study the insider GR and CEO GR as explanatory variables. Column (1) revisits column (6) in Table 6 but now adds the insider GR as an explanatory variable. Our previous result remains unchanged (positive), where the insider GR negatively affects the (total) value of the *CEO*. We then find the opposite for insider (total) value: CEO GR negatively, but insider GR positively affects *insider* value. This shows a wedge between CEO GR and insider GR, akin to the wedge that we noted on the interaction term in column

(4), Panel B of Table C5.

Panel C of Table C6 confirms our insights from Panel C of Table 6: increasing OR increases bank business risk and decreases risk-adjusted performance (albeit insignificant in column 4 here). Moreover, we find that increasing gambling ratios (here for insiders, previously for CEO) decreases risk-adjusted performance.

Overall, our preliminary results here provide further support that for the CEO to have higher GR/pay/value it is beneficial to decrease insider GR and increase OR.

Table A1: Description of our Variables.

Description	Definition/Calculation	Source	Shortcut
	Panel A: Board Characteristics and Incentives		
Outsider Ratio	# Outside Board Members/# Board Members	BoardEx	OR
Effort incentives	dollar change in wealth associated with a 1% change in the bank's stock price	Naveen	Δ
Risk incentives	dollar change in wealth associated with a 0.01 change in the standard deviation of the bank's stock returns	Naveen	Vega
Bank rel. wealth	current value of stock and option portfolio in the bank	Naveen	
Gambling Ratio	Vega/Δ		GR
	Panel B: Value/Accounting Measures		
bank market value (m$)	stock price times # outstanding shares	CRSP	
net income	BHCK 4340	BHC	
common equity (k$)	BHCK 3210	BHC	
return on equity	net income/(lagged) equity	BHC	ROE
return on assets	net income/(lagged) assets	BHC	ROA
total assets (k$)	BHCK 2170	BHC	
T1 Capital (k$)	BHCK 8274 (up to Q4 2014); BHCA 8274 (since Q1 2015)	BHC	
Financial derivatives=Total interest rate, exchange rate and credit derivatives (except hedging purposes)	BHCK A126 + BHCK A127 + BHCK 8723 + BHCK 8724 + BHCK 8725 + BHCK 8726 + BHCK 8727 + BHCK 8728 + BHCK C969 + BHCK C971 + BHCK C973 + BHCK C975 - BHCK C968 - BHCK C970 - BHCK C972 - BHCK C974	BHC	
	Panel C: Risk Measures		
leverage	ratio of total assets to equity	BHC	**LEV**
capital ratio	ratio of Tier 1 capital to risk-weighted assets	BHC	**T1**
asset volatility	standard deviation of assets	BHC	σ_A
z/Z-score, distance-to-default	$z = (ROA + LEV^{-1})/\sigma_A$, $\mathbf{Z} = \ln(z)$	BHC	z, $\mathbf{Z}$
probability of default	$1/z$	BHC	**PD**
derivatives' usage	ratio of financial derivatives (interest, FX, credit derivatives) to total assets	BHC	**DER**
stock return tail risk	95%-Value-at-Risk	CRSP	ST

Table B1: Revisiting Table 2 with other risk measures (-T1, LEV, PD). This table studies how bank risk affects firm value and CEO wealth, presenting Panel regressions with bank fixed effects of logarithmic market value/CEO wealth on bank risk. All explanatory variables are lagged one year. Coefficient statistics are calculated using robust methods; *t*-statistics are reported in parentheses; significance levels refer to * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	(1) Mkt Val	(2) CEO wlth	(3) Mkt Val	(4) CEO wlth	(5) Mkt Val	(6) CEO wlth
-T1	-0.111***	0.0454*				
	(-8.24)	(1.76)				
-T1 × -T1	-0.00233***	0.000436				
	(-6.42)	(0.72)				
LEV			-0.130***	0.0207		
			(-13.38)	(0.75)		
LEV × LEV			0.00116***	-0.00122*		
			(4.40)	(-1.72)		
PD					-0.0542***	-0.0269***
					(-10.37)	(-3.14)
PD × PD					0.000342***	0.0000351
					(4.90)	(0.48)
Observations	4994	1526	5078	1583	4809	1501
Adjusted R^2	0.903	0.735	0.914	0.739	0.910	0.739
F	48.88	4.152	143.5	2.725	88.58	18.97

Table B2: Revisiting Table 3 with other risk measures (-T1, LEV, PD). This table studies how incentives affect bank risk, presenting Panel regressions with bank fixed effects of bank risk on (log) CEO effort incentives (log (Δ)), on (log) CEO risk incentives (log (Vega)), and on CEO gambling incentives (GR). All explanatory variables are lagged one year. Coefficient statistics are calculated using robust methods; t-statistics are reported in parentheses; significance levels refer to * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	(1) -T1	(2) -T1	(3) -T1	(4) LEV	(5) LEV	(6) LEV	(7) PD	(8) PD	(9) PD
log(Δ)	0.802***			0.309**			0.544**		
	(6.46)			(2.42)			(2.24)		
log(Δ) $\times$ log(Δ)	0.0442			0.0709*			0.249***		
	(1.58)			(1.86)			(3.06)		
log(Vega)		0.331***			0.201***			0.133	
		(5.94)			(3.84)			(0.91)	
log(Vega) $\times$ log(Vega)		0.00446***			0.00256***			0.00245	
		(5.80)			(3.48)			(1.32)	
GR			-0.475			0.484			-0.348
			(-1.00)			(0.53)			(-0.23)
GR $\times$ GR			0.597**			0.383			2.917***
			(2.33)			(0.56)			(3.24)
Observations	1577	1301	1281	1620	1334	1314	1574	1298	1279
Adjusted R^2	0.670	0.669	0.655	0.441	0.409	0.412	0.399	0.408	0.433
F	41.06	17.92	4.153	2.958	7.384	5.038	4.671	2.870	15.41

Table B3: Revisiting Panel A of Table 4 with other risk measures (-T1, LEV, PD). This table studies how the outsider ratio affects CEO gambling incentives (GR) and bank risk, presenting Panel regressions with bank fixed effects. All explanatory variables are lagged one year. Coefficient statistics are calculated using robust methods; t-statistics are reported in parentheses; significance levels refer to * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	(1)	(2)	(3)
	-T1	LEV	PD
OR	1.916	6.512**	29.48***
	(0.63)	(2.42)	(3.17)
OR × OR	-2.226	-4.926***	-20.31***
	(-1.06)	(-2.60)	(-3.11)
Year	-0.0877***	-0.164***	-0.103***
	(-9.87)	(-19.31)	(-4.48)
Observations	4941	4981	4805
Adjusted R^2	0.648	0.493	0.346
F	59.69	184.3	13.21

Table B4: Revisiting Table 5 with other risk measures (-T1, LEV, PD). This table studies how the excess values drive their change over the following year, respectively. The excess value of a variable is here its value beyond that of the average of their peers in a given year (in our sample). We present Panel regressions with bank fixed effects, controlling for yearly trend. Coefficient statistics are calculated using robust methods; t-statistics are reported in parentheses; significance levels refer to * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	(1) Δ (-T1)	(2) Δ LEV	(3) Δ PD
Exc (-T1)	-0.261***		
	(-12.60)		
Exc (-T1) × Exc (-T1)	0.00245		
	(0.64)		
Exc LEV		-0.271***	
		(-6.12)	
Exc LEV × Exc LEV		-0.00828***	
		(-2.89)	
Exc PD			-0.150**
			(-2.36)
Exc PD × Exc PD			-0.00365***
			(-2.65)
Year	0.0255***	0.0167***	0.00190
	(5.58)	(3.31)	(0.15)
Observations	4832	4923	4645
Adjusted R^2	0.198	0.145	0.139
F	86.10	26.40	11.49

Table B5: Revisiting Table 6 with other risk measures (-T1, LEV, PD). This table studies the drivers of bank performance. All three Panels A-C carry out Panel regressions with bank fixed effects. The dependent variable in columns (1, 3, 5) is bank performance, measured through ROE (in excess of the current risk-free rate) and in columns (2, 4, 6) is CEO compensation, measured either through direct compensation. Coefficient statistics are calculated using robust methods; t-statistics are reported in parentheses; significance levels refer to * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	(1) ROE	(2) Direct	(3) ROE	(4) Direct	(5) ROE	(6) Direct
-T1	-0.224***	65.05***				
	(-2.81)	(3.41)				
LEV			-0.336	34.03*		
			(-1.47)	(1.77)		
PD					-0.382***	5.655
					(-4.40)	(1.29)
Observations	4774	1657	4925	1716	4668	1631
Adjusted R^2	0.180	0.570	0.183	0.574	0.208	0.565
F	7.873	11.62	2.166	3.126	19.35	1.673

Table C1: Studying in Panel A how the outsider ratio affects CEO incentives (effort, Δ, risk, Vega). Panel B presents the average treatment effect on treated banks in a difference-in-difference analysis of SOX. Both Panels use Panel regressions with bank fixed effects. All explanatory variables are lagged one year. In Panel B the treatment is based on year 2003, assumed to be effective in year 2005. Coefficient statistics are calculated using robust methods; t-statistics are reported in parentheses; significance levels refer to * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	Panel A: Panel Regressions with bank FE			
	(1)	(2)	(3)	(4)
	log(Δ)	log(Δ)	log(Vega)	log(Vega)
OR	-1.798***	-2.700	-0.0135	2.610
	(-5.00)	(-1.11)	(-0.01)	(0.42)
OR × OR		0.632		-1.875
		(0.38)		(-0.44)
Year	-0.00925	-0.00941	-0.152***	-0.151***
	(-1.45)	(-1.48)	(-6.54)	(-6.50)
Observations	1620	1620	1335	1335
Adjusted R^2	0.752	0.752	0.504	0.504
F	22.80	15.22	21.48	14.33

	Panel B: Average Treatment Effect of SoX			
	(1)	(2)	(3)	(4)
	log(Δ)	log(Δ)	log(Vega)	log(Vega)
DiD	-0.146	-0.139	0.466*	0.113
	(-0.42)	(-0.38)	(1.86)	(0.26)
OR	-1.555***	-1.691	-3.545***	3.246
	(-4.46)	(-0.68)	(-2.83)	(0.51)
OR × OR		0.0943		-4.792
		(0.06)		(-1.10)
Post 2005	-0.251***	-0.250***	-0.129	-0.140
	(-2.85)	(-2.84)	(-0.79)	(-0.87)
Observations	1620	1620	1335	1335
Adjusted R^2	0.753	0.753	0.484	0.484
F	17.35	13.33	5.831	5.266
p(pll trends)	0.0431	0.0400	0.130	0.165

Table C2: Studying the drivers of bank performance and CEO pay, using Panel regressions with bank fixed effects. The dependent variable in columns (1, 2) is bank performance, measured through ROE (in excess of the current risk-free rate) and in columns (3, 4) is CEO compensation, measured through change in value of CEO wealth in the bank. Coefficient statistics are calculated using robust methods; t-statistics are reported in parentheses; significance levels refer to * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	(1) ROE	(2) ROE	(3) Value Inc.	(4) Value Inc.
CEO Δ	0.625***		-0.110***	
	(2.81)		(-3.45)	
CEO Δ × CEO Δ	-0.0109***		0.00142***	
	(-3.32)		(2.96)	
CEO Vega		4.161*		-0.678***
		(1.76)		(-2.65)
CEO Vega × CEO Vega		-0.807		0.162**
		(-0.90)		(1.99)
Year	-0.129***	-0.228***	0.00813*	0.0101*
	(-2.64)	(-3.71)	(1.84)	(1.86)
Observations	1619	1332	1475	1237
Adjusted R^2	0.188	0.187	-0.003	-0.034
F	6.464	9.948	6.061	5.263

Table C3: Studying how incentives affect gambling risk (derivatives usage and tail/VaR of stock returns). We present Panel regressions with bank fixed effects of tail risk on CEO incentives in columns (1-4) on the CEO gambling ratio in columns (5-6) and of CEO gambling incentives (vega) on CEO effort incentives (Δ) in column (7). Coefficient statistics are calculated using robust methods; t-statistics are reported in parentheses; significance levels refer to * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	(1) DER	(2) DER	(3) Tail Risk	(4) Tail Risk
CEO Δ	-0.440***		-0.659***	
	(-3.11)		(-3.50)	
CEO Δ × CEO Δ	0.00614***		0.0102***	
	(2.85)		(3.22)	
CEO Vega		0.414		-3.733**
		(0.25)		(-2.00)
CEO Vega × CEO Vega		-0.581		0.855
		(-1.04)		(1.31)
Year	-0.0291*	-0.0186	-0.184***	-0.0815**
	(-1.83)	(-1.23)	(-6.41)	(-2.15)
Observations	1478	1217	1620	1335
Adjusted R^2	0.931	0.927	0.296	0.293
F	3.383	1.519	16.80	2.546

Table C4: Decomposing (observed) bank risk into its (unobserved) optimal level and gambling (regression 1) and decomposing bank performance (ROE beyond the risk-free rate) on bank risk (regression 2). We use Panel regressions with bank fixed effects. Coefficient statistics are calculated using robust methods; t-statistics are reported in parentheses; significance levels refer to * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	(1) -Z	(2) Exc. ROE
-Z		-1.864**
		(-2.46)
CEO GR	0.0787*	
	(1.74)	
Outsider Ratio (OR)		
Exc ROE		0.319***
		(7.46)
Year	-0.0276***	
	(-11.92)	
Observations	1279	4667
Adjusted R^2	0.637	0.225
F	80.00	27.95

Table C5: Studying in Panel A how bank risk affects insider wealth and in Panel B how gambling ratios of the CEO/insiders affect the outsider ratio in the years leading to the subprime crisis (up to 2009). Panel A presents Panel regressions with bank fixed effects of logarithmic insider wealth on bank risk. Panel B presents Tobit regressions with lower (upper) limit 0 (1) of the dependent variable. Coefficient statistics are calculated using robust methods; t-statistics are reported in parentheses; significance levels refer to * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	Panel A: Insider Wealth			
	(1) Ins wlth	(2) Ins wlth	(3) Ins wlth	(4) Ins wlth
-Z	-0.121*	-1.632***	0.181***	-0.436
	(-1.75)	(-4.94)	(3.39)	(-1.61)
-Z × -Z		-0.327***		-0.129**
		(-4.52)		(-2.19)
ROE			0.0196***	0.0108*
			(4.38)	(1.91)
ROE × -Z			-0.0133***	-0.0186***
			(-5.35)	(-2.63)
ROE × -Z × -Z				-0.000692
				(-0.27)
Observations	1563	1563	1563	1563
Adjusted R^2	0.721	0.731	0.791	0.792
F	3.072	13.33	82.39	57.92

	Panel B: Outsider Ratios			
	(1) OR	(2) OR	(3) OR	(4) OR
CEO GR	0.0692***	0.133***		0.0708***
	(5.86)	(5.42)		(3.02)
CEO GR × CEO GR		-0.0463***		
		(-3.19)		
Ins. GR			0.0669***	0.0701***
			(5.45)	(4.17)
CEO GR × Ins. GR				-0.0433*
				(-1.87)
Year	0.0153***	0.0156***	0.0174***	0.0148***
	(7.35)	(7.59)	(8.27)	(6.87)
Observations	680	680	736	674
F	59.93	46.16	76.31	39.98

Table C6: Studying the drivers of Insider/CEO pay and bank performance. All three Panels A-C carry out Panel regressions with bank fixed effects. The dependent variable in Panels A and B is Insider/CEO compensation, measured either through direct compensation or change in value of wealth in the bank. The dependent variable in Panel C is either bank business risk or the risk-adjusted performance (Alpha). Bank business risk is calculated as the residual in a Panel regression with bank fixed effects of bank risk on the gambling ratio (not reported). Alpha is calculated as the residual in a Panel regression with bank fixed effects of performance (ROE in excess of riskfree) on the bank risk (-Z). Coefficient statistics are calculated using robust methods; t-statistics are reported in parentheses; significance levels refer to * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	Panel A: Direct Compensation (Salary and Bonus)			
	(1) Ins. Direct	(2) Ins. Direct	(3) Ins. Direct	(4) CEO Direct
-Z	14.94	58.57		
	(0.30)	(1.10)		
Ins. GR			139.7**	
			(2.04)	
CEO GR				158.0
				(0.79)
ROE		6.473***	6.851***	19.14***
		(3.17)	(2.93)	(3.42)
Observations	1667	1667	1435	1263
Adjusted R^2	0.813	0.815	0.819	0.554
F	0.0887	5.042	4.364	6.054

	Panel B: Value Increases		Panel C: Residuals	
	(1) Value Inc. (CEO)	(2) Value Inc. (Ins.)	(3) Bs. Risk	(4) Alpha
CEO GR	0.622***	-0.421***		
	(4.68)	(-3.38)		
Ins. GR	-0.395***	0.653***		-12.12***
	(-2.90)	(5.52)		(-8.92)
OR			0.425***	-4.988
			(3.07)	(-1.27)
CEO Delta			0.00680***	0.166
			(2.60)	(1.16)
Ins. Delta			0.0518**	0.369
			(2.25)	(0.71)
Year			-0.00406	-0.298***
			(-1.61)	(-4.95)
Observations	1217	1235	1273	1347
Adjusted R^2	-0.011	0.008	-0.123	0.069
F	11.49	15.33	4.169	27.37