Yesterday's Heroes:
Compensation and Risk at Financial Firms

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ABSTRACT

Many believe that compensation, misaligned from shareholders' value due to managerial entrenchment, caused financial firms to take creative risks before the Financial Crisis of 2008. We argue instead that even in a classical principal-agent setting without entrenchment and with exogenous firm-risk, riskier firms may offer higher total pay as compensation for the extra risk in equity stakes born by risk-averse managers. We confirm our conjecture by using lagged stock return volatility to measure exogenous firm risk and showing that riskier firms are also more productive and are more likely to be held by institutional investors, who are most able to influence compensation.

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Many blame Wall Street compensation for the most significant economic crisis since the Great Depression. In his testimony (June 6, 2009) to Congress on the Treasury budget, Treasury Secretary Geithner argues, "I think that although many things caused this crisis, what happened to compensation and the incentives in *creative risk taking* did contribute in *some* institutions to the vulnerability that we saw in this financial crisis" (emphasis added). To address this issue, the US has promoted reforms to tie pay to long-term performance and increase the say of shareholders in approving compensation and electing directors on compensation committees. The view that incentive misalignment contributed to the crisis is shared by many other governments.[1]

In this narrative, pay, misaligned from long-term shareholder value because of managerial entrenchment, caused creative risk-taking. Firms like Bear Stearns, Merrill Lynch and AIG had poorer governance and more misaligned pay packages than other firms and ended up taking excessive risks with disastrous consequences. Increasing shareholder rights and reforming the distorted incentives, by clawing back pay to tie it to long-term firm performance, will lead to less of this behavior. Indeed, anecdotes on the behavior of CEOs of Bear Stearns and Lehman Brothers lend some credence to this view. There is also support in academic research for managerial entrenchment and short-termism as a potentially important factor in corporate behavior (see Becht, Bolton and Röell, 2003 and Stein, 2003 for reviews). But this research typically focuses on non-finance firms and pre-dates the financial crisis. There is also very little direct evidence at this point for this entrenchment perspective among finance firms.

Given the importance of this issue, we believe it valuable to ponder an alternative, non-entrenchment perspective on the relationship between pay and risk among financial firms. We point out that a strong relationship between pay and risk can also emerge naturally in a classical principal-agent setting (e.g., as in Holmstrom and Milgrom, 1987 and Holmstrom, 1979) in which investors are optimally setting incentive contracts, entrenchment is absent, and where the riskiness of the firm or project is taken as exogenous and out of the control of the manager. Indeed, there is anecdotal evidence, which we confirm in our analysis below, that savvy institutional investors such as Bill Miller of Legg Mason, one of the largest mutual fund companies in the United States,

[1] For example, in the UK, a parliamentary committee investigating the crisis "found that bonus-driven remuneration structures encouraged reckless and excessive risk-taking and that the design of bonus schemes was not aligned with the interests of shareholders and the long-term sustainability of the banks." (UK House of Commons, 2009)

have over-weighted and supported the most risky companies like Bear Stearns in their portfolios (Lauricella, 2008). Such institutional investors with large blocks of shares of a company have typically been viewed in the literature as having more power to act like a principal to shape and incentivize their agent's effort and as less subject to behavioral biases than individual investors. So entertaining a neoclassical set-up would seem to be a reasonable exercise ex-ante.

In our narrative, pay and risk are correlated not because misaligned pay leads to creative risk-taking. Rather, this correlation arises because principal-agent theory predicts that riskier firms have to pay more total compensation to provide the same incentives for a risk-averse manager than less risky firms. To induce a manager to put in effort and maximize firm value, the principal must give that manager incentives or an ownership stake in the firm. For the same level of incentive provision or ownership stake, the manager working at a riskier firm faces much more uncertainty in his wealth since his firm's stock price will be more volatile. Since the manager is risk-averse, she prefers a less risky firm all else equal unless of course she is compensated for bearing the additional risk that comes from working for a riskier firm. As such, to give the risk-averse manager the same incentives, a riskier firm has to pay more total compensation than a firm that is less risky.

Of course, if it is more expensive for riskier firms to align managerial incentives using insider ownership stakes, then riskier firms may optimally not want, all else equal, to give as big an insider ownership stake as less risky firms. But in practice, there are several reasons, which we elaborate on below, for why even very risky financial firms want their managers to have ownership stakes as large as less risky firms. One important reason is that these firms rely on people with specialized skills such as managing complex portfolios and who have significant influence over outcomes. When an agent has significant influence over outcomes, it is optimal to keep her working hard through strong incentives, as the gains to doing so offset the cost of paying her more. There is plenty of anecdotal evidence that agents work hard at risky firms; investment-banking jobs in particular have a reputation for long hours and difficult work conditions (Oyer, 2008).

Using data on executive compensation and risk for finance firms from 1992 to 2008, we attempt to test this hypothesis. We begin by establishing that there is substantial cross-sectional heterogeneity in residual compensation, which is defined as the total pay of top-5 managers controlling for firm size and finance sub-industry effects, where the sub-industries are primary dealers, bank holding companies and insurance companies. We adjust pay by these two factors as it is well known that size scales with pay (Gabaix and Landier, 2008), and, as we show below, compensation varies considerably across these finance sub-industries. We find that residual compensation is highly persistent over time, suggesting the presence of a firm fixed effect in pay levels. Firms with persistently high residual compensation include Bear Stearns, Lehman Brothers, Countrywide, and AIG. Low or moderate residual compensation firms include firms such as Wells Fargo and Berkshire Hathaway.

We then establish that risk, measured either with a lag or in the year of its origin (ideally the year the firm first had an IPO or was newly listed), significantly explains the cross-sectional variation in contemporaneous risk. In other words, there are also fixed differences in the riskiness of finance firms. In addition to stock return volatility, we use a firm's stock market beta to capture the heterogeneous risk profiles of financial firms. For instance, a firm's propensity to effectively sell out of the money puts or insurance on the stock market (i.e., to engage in tail risk) may not be entirely captured by stock return volatility. Ex post stock market betas in this instance may better gauge a firm engaging in tail risk since the firm is fine when the market does well and goes bust when the market does poorly.

We use lagged risk of the firm, especially its origin risk, to capture the exogenous and permanent component of firm risk.[2] The thought experiment is one in which we are comparing the compensation at time t of firms born with high risk with compensation at time t of firms born with low risk, holding size and industry constant. Importantly, we show that lagged or origin firm risk explains little of the variation in insider ownership, or the degree of incentive provision, across firms.[3] As a result, the manager at the riskier firm has a similar level of incentive provision as his counterpart at a less risky firm and so faces much more uncertainty in his wealth.

[2] Graham, Li and Qiu (2009) also find large firm fixed effects for managerial compensation as well as manager fixed effects. Our analysis here on firm origin volatility helps us further isolate the role of firm fixed effects as opposed to manager effects on pay.

[3] In a review by Prendergast (2002), only 4 of 26 studies of various contractual settings find a negative relationship between risk and ownership. A notable exception is Aggarwal and Samwick (1999). Garen (1994) finds a weak negative effect relating slope and risk while a slightly positive effect for salary and risk. Kaplan and Stromberg (2005) find small effects of exogenous risk on venture capital contracts while Becker (2006) finds higher wealth CEOs receive stronger incentives among Swedish firms. Among finance firms, Fahlenbrach and Stulz (2010) find that finance firms

Consistent with classical principal-agent theory, we then find that, although insider ownership stakes are not correlated with firm riskiness, our residual compensation measure is strongly correlated with our lagged and origin measures of risk in the cross-section. For instance, a one-standard deviation increase a firm's lagged stock market beta in the direction orthogonal to size is associated with a 0.27-standard deviation increase in residual compensation.

We then verify auxiliary implications of this classical theory. As we demonstrate in a variation of the principal-agent model below, one reason higher risk firms give their managers the same incentive provisions (i.e., same insider ownership) as less risky firms in equilibrium, even though it is more costly, is that the riskier firms might be more productive or profitable. We verify this rationale by showing that riskier firms are more productive using a variety of measures such as return on assets, asset turnover, and total factor productivity. Indeed, in a multiple regression of compensation on both firm riskiness and these measures of productivity, we find that both variables have significant explanatory power. It appears that risk and productivity are inextricably linked in financial services.[4]

Moreover, the fact that riskier firms are more profitable and provide the same incentives as less risky firms implies that a higher fraction of managerial pay at riskier firms is variable as opposed to fixed. We also verify this implication of classical theory for pay composition. In short, it appears that the key predictions of the classical theory of principal-agent contracting are verified in the data. Career rewards for working at high-risk firms are turbulent, and so risk and pay are correlated not because pay causes risk but because risk-averse managers require pay to keep them working at firms with higher risk. In this view, management teams of Bear Stearns, Lehman Brothers, Countrywide and AIG are paid more than management at other firms as the strategies demanded by shareholders are fundamentally riskier.

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with higher insider ownership stakes had poorer performance during the crisis, suggesting little relationship between insider ownership and firm risk. Mehran and Rosenberg (2008) show stock option grants lead CEOs to take less borrowing and higher capital ratios but to undertake riskier investments. Laeven and Levine (2009) find that bank risk is higher among banks that have large owners with substantial stakes.

[4] One reason might be measurement error of productivity. As we argue below, another interpretation is that firm risk is a natural measure of firm growth options, which are tied to productivity and hence should lead to steeper incentives for managers.

We also show that our pay-risk relationship is not due to entrenchment by finding that both pay or risk are not correlated with ex-ante measures of managerial power or entrenchment such as the Gompers, Ishii and Metrick (2003) G Index and Bebchuk, Cohen and Ferrell (2009) E Index, as well as director independence. However, these proxies are imperfect as they mostly deal with takeover provisions, and there are other mechanisms for entrenchment. To address this limitation, we show that there is more institutional ownership for high risk and high residual compensation firms, and that they receive similar if not higher levels of analyst coverage as other firms. The idea is that entrenchment is more feasible when there is less transparency, for example, as in Kuhnen and Zwiebel (2008). As greater institutional presence and analyst coverage is typically thought to bring about more transparency, this suggests that our observed cross-sectional correlation between pay and risk is not driven by entrenchment. This institutional investor result also points to some investors understanding that these finance firms were risky.

Moreover, in the entrenchment narrative, entrenched firms consistently underperform in the cross-section since managers divert cash flows (Gompers, Ishii and Metrick, 2003; Bebchuk, Cohen and Ferrell, 2009). If high pay firms are entrenched firms, then we would see these firms consistently underperform. In contrast, if pay reflects compensation for risk, then we should either see no systematic underperformance, or overperformance during booms and underperformance during busts, depending on whether pay reflects idiosyncratic or systematic risk. Consistent with our idea that high residual compensation firms are also high beta firms in the cross-section, high residual compensation firms are more likely to be in the tails of performance, with extremely good performance when the market did well – "yesterday's heroes" – and extremely poor performance when the market did poorly.[5]

Our approach complements the existing literature in that it goes beyond providing evidence as to whether there is too little pay-for-performance, such as Bebchuk, Cohen and Spamann (2010) and Fahlenbrach and Stulz (2010). We build on the insight from the classical theory of contracting with risk averse agents that incentive provision is more expensive for riskier firms. In equilibrium, agents are paid their outside option plus the so-called compensating differential, the sum of the

[5] In follow-up work to ours, Fahlenbrach, Prilmeier, and Stulz (2012) find fixed differences in which financial firms do poorly in crises. Our paper instead focuses on fixed differences in compensation and how these are explained by differences in risk and productivity.

disutility of effort and the utility cost of risk borne by the agent. In the verbiage of contracting theory, the participation constraint adjusts so that the incentive compatibility constraint is satisfied. To induce managers to participate in riskier firms with the same incentive provision as less risky firms, they need to be given higher total compensation. This generates the reverse causality of risk causing pay as opposed to pay causing risk.

We are not the first to use the individual rationality constraint to explain some puzzling empirical findings on compensation. Oyer (2004) and Oyer and Schaefer (2005) show that the participation constraint is important to understanding why there is pay for luck in the time series and why there is broad-based used of employee stock option plans, as outside opportunities may co-vary with the market. But their analysis is very different from ours. Our contribution focuses on a different phenomenon – that incentive provision is more costly for higher risk firms. The role of risk aversion and compensation for bearing on the job risk in generating a positive correlation between total pay and risk has been largely understudied in the literature.

Our paper is organized as follows. We discuss the theoretical background in Section I to motivate our empirical analysis and the data in Section II. We present the results in Section III and conclude with some thoughts on future research in Section IV.

I. Hypothesis Development

To make our conjecture more precise, we recast a simple version of a static moral hazard model a la Holmstrom and Milgrom (1987) and Holmstrom (1979) while allowing for heterogeneity in the underlying productivity of different firms. Consider a firm whose output $\tilde{x}$ is a linear function of an agent's effort, a, and Gaussian noise, $\tilde{\varepsilon} \sim N(0, \sigma^2)$:

$$\tilde{x} = ha + \tilde{\varepsilon}. \tag{1}$$

The parameter h reflects the agent's marginal productivity of effort, which may be a function of the risk of the firm, σ^2, as well as other sources of heterogeneity. The agent cares about total pay less a positive, increasing, convex cost of supplying effort, $c(a)$, with $c(0) = 0$, and has exponential utility with constant absolute risk aversion γ. Effort is unobserved to the principal, but all other parameters are common knowledge. If we let $s(\tilde{x}) = \alpha + \beta\tilde{x}$ denote a linear sharing rule between the principal and the agent, this implies that the agent maximizes:

$$\max_{a} \left\{\alpha + \beta h a - c(a) - \frac{\gamma}{2}\beta^2\sigma^2\right\}. \tag{2}$$

Optimal effort is governed by the incentive compatibility constraint, which requires:

$$c'(a) = \beta h. \tag{3}$$

Participation requires that the expected utility is at least the agent's reservation utility $\bar{u}$. Assuming this binds, total pay is given by:

$$T \equiv E[s(\tilde{x})] = \alpha + \beta h a = \bar{u} + c(a) + \frac{\gamma}{2}\beta^2\sigma^2. \tag{4}$$

The principal maximizes output net of payments to the agent subject to these two constraints, which leads to the familiar equilibrium piece rate,

$$\beta^* = \frac{1}{1 + \gamma\sigma^2 c''(a^*)/h^2}. \tag{5}$$

Our insight is that, if the equilibrium piece rate is insensitive to changes in the risk, then the expected total compensation T must increase with the risk; that is, if $\partial\beta^*/\partial\sigma^2 = 0$, then $\partial T^*/\partial\sigma^2 > 0$. This situation arises in our model when the marginal productivity of the agent is positively correlated with the risk of the firm. For example, one may conjecture that for risky firms like Bear Stearns, traders have a higher marginal impact on outcomes.

For concreteness, consider the classic case where the cost of effort is quadratic, $c(a) = a^2/2$. A necessary and sufficient condition for $\partial\beta^*/\partial\sigma^2 = 0$ is then:

$$\frac{\partial h/h}{\partial\sigma^2/\sigma^2} = \frac{1}{2}. \tag{6}$$

If the elasticity of the marginal productivity of effort with respect to risk is one-half, then we expect equilibrium incentive slopes not to vary with risk. High-risk firms are also high productivity firms, and although it is optimal to incentivize the manager to work hard at these firms through a higher slope β, the higher risk tempers this in equilibrium.

More generally, whenever $\partial\beta^*/\partial\sigma^2 = 0$, then, for a wide range of effort disutility functions c, total dollar compensation T must rise with σ^2, for two reasons. First, from the participation constraint, the principal must compensate the risk-averse agent more from a classical insurance motive. (If $\partial\beta^*/\partial\sigma^2 < 0$, this may not hold in equilibrium since the equilibrium slope may fall as firm risk rises.) Second, the principal needs to compensate the agent to work harder at the high marginal productivity firm. Formally, we have the following proposition:

PROPOSITION 1. (i) *Suppose the disutility of effort satisfies $c'' > 0$, $c' > 0$, and $\frac{c'''}{c''} < 2\frac{c''}{c'}$. If $\frac{\partial\beta}{\partial\sigma^2} = 0$, then $\frac{\partial a}{\partial\sigma^2} > 0$ and $\frac{\partial T}{\partial\sigma^2} > 0$.*

(ii) If, in addition, $c'''(a) \geq 0$, then $\partial\beta^*/\partial\sigma^2 \geq 0$ suffices.

Proof: See the Appendix. Note that the conditions on the cost function in (i) are satisfied if $c = da^n$ for $n > 1$ and $d > 0$. In addition, the stronger conditions in (ii) are satisfied provided $n \geq 2$ or $c = \exp(da)$ with $d > 0$. ■

Of course, if incentives increase with risk ($\partial\beta^*/\partial\sigma^2 \geq 0$), then total pay levels must rise even more strongly with risk.[6]

This is the first set of empirical tests (Prediction 1) that we examine in this paper. Our strategy is to relate size and industry-adjusted measures of total compensation T and slope β to lagged or origin measures of risk in the cross-section, as the prediction is primarily a cross-sectional prediction about how firm risk explains pay. Adjusting for size and industry is important since the prediction of the model only holds for firms of equal scale or capital.

Our second test (Prediction 2) examines whether the marginal productivity of the agent is positively correlated with the risk of the firm by correlating measures of firm productivity with various proxies for lagged firm risk and origin risk. A positive correlation indicates that

[6] This prediction is robust across a wide class of models as it emanates from the cost of providing incentives. For example, principals may be more able to directly monitor effort in environments with less risk, so that riskier environments induce higher-powered incentives (Prendergast, 2002). Alternatively, agents may influence output a great deal, so that principals of both risky and less-risky firms may find it optimal to always induce maximum effort, as in Edmans and Gabaix (2011). In their model, where output is multiplicative in agent effort and the agent has CRRA preferences over consumption, large firms may find it optimal to always induce maximum effort from the agent, making slope independent of risk so that pay rises with risk. Axelson and Bond (2014) show that high pay combined with firing incentives may be the cheapest way for a principal to incentivize an agent in high-stakes industries, in an argument similar to the classical efficiency wage argument.

productivity rises with risk in the finance industry, and provides support to the reasoning of why ownership is uncorrelated with risk in finance firms.

The third testable implication (Prediction 3) is that a higher fraction of total pay at riskier firms is variable as opposed to fixed when ownership is uncorrelated with risk because of productivity. The intuition is that, if riskier firms are also higher productivity and more profitable, and they provide the same incentives as less risky firms, then the high value of those incentives drives down the fraction of pay that is fixed. We prove this for the quadratic effort case in the Appendix and state it as the following proposition:

PROPOSITION 2. *Suppose the disutility of effort is quadratic and* $\frac{\partial \beta}{\partial \sigma^2} = 0$. *Then the fraction of pay that is fixed declines with risk:* $\frac{\partial(\alpha/T)}{\partial \sigma^2} < 0$.

Finally, our fourth set of predictions (Prediction 4) centers around the entrenchment theory, which posits that high pay and high risk are rooted in governance problems. The premise of this model is that managers have subverted the optimal contracting process by capturing the board. Managers extract rents by setting the level of pay as high as possible, at least without invoking public outrage, divert cash flows to private benefits, and insulate their pay from outside forces that are informative about effort.

This view has found popularity both among policy makers and academics, for example, in Bebchuk, Fried, and Walker (2002), and more recently, in Bebchuk, Cohen and Spamann (2010). We phrase this view in terms of our model by noting that the participation constraint may not bind; more generally, the total pay of the manager equals:

$$T = \bar{u} + c(a) + \frac{\gamma}{2}\beta^2\sigma^2 + V \times \pi, \tag{7}$$

where V measures the surplus value and π is a measure of the agent's power. In the entrenchment theory, more entrenched managers have higher power π and pay themselves more, generating a positive relationship between total pay T and proxies of managerial power. If this is the first-order determinant of pay in the cross-section, we should see, all else equal, a positive correlation between measures of power and total pay, while measures of monitoring and transparency such as institutional ownership and analyst coverage should be negatively correlated with total pay.

Furthermore, if powerful managers take more risk (if π is positively correlated with σ^2), a positive correlation between total pay and risk σ^2 would actually reflect an omitted variable of entrenchment. In this case, proxies for entrenchment should mediate the observed correlation between total pay and risk.

II. Data and Variables

Our sample consists of financial firms in the intersection of ExecuComp and CRSP-Compustat from 1992 to 2008. We identify three groups of financial firms. We first construct a group of primary dealers by hand-matching a historical list from the Federal Reserve Bank of New York with PERMCOs from our CRSP file. We then use SIC codes to classify firms into a second group of banks, lenders, and bank-holding companies which do not have primary dealer subsidiaries. This group comprises firms from SIC 60 commercial banks, SIC 61 non-deposit lenders, SIC 6712 bank holding companies, and a limited number of SIC 6211 securities brokers who are not primary dealers. Our third and last group of financial firms are insurers from SIC 6331 (fire, marine and casualty insurance) and SIC 6351 (surety insurance). This group of insurers contains firms such as AIG and monoline insurers such as MBIA.[7] We exclude Fannie Mae and Freddie Mac from our analysis since they are effectively government enterprises. When a primary dealer is a subsidiary of a larger company in CRSP, we group the firm with the primary dealers. Among firms without primary dealer subsidiaries, if the firm is a bank holding company with an insurance arm, we group it with bank holding companies.

Our primary variables of interest are compensation, size, and risk. We would ideally like to obtain a measure of the total dollar compensation paid to the manager. We focus on the total level of *flow* compensation to the manager as the best proxy for this ideal. Intuitively, measuring the flow pay to the manager best captures compensation practices of the principal, which is the spirit of the IR constraint. Alternatively, one can think of the cross-sectional variation in flow compensation as a proxy for cross-sectional variation of the total pay received in annuity over the

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[7] Our data on SIC codes comes from both CRSP and Compustat. We include a firm as a financial firm if either its CRSP or Compustat SIC code indicates it is a financial firm. However, a number of the SIC codes obtained from CRSP and Compustat do not exactly match the SIC classification in the SIC Manual, particularly for bank holding companies. We worry that we might have misclassified some financial firms. We supplement this list by hand checking the descriptions of firms in our sample found in their 10-K annual statements.

tenure of firm managers. Another potential measure could be the dollar value of the manager's accumulated cash payouts plus accumulated ownership stake in the firm. But this measure is potentially contaminated by the manager's individual portfolio decisions and hence could be subject to managerial behavioral biases (Malmendier and Tate, 2005).

We measure total flow compensation by averaging the total direct compensation (TDC1 in ExecuComp) across the top five executives at each firm, and we label this variable Executive Compensation.[8] Total direct compensation includes bonus, salary, equity and option grants, and other forms of annual compensation. We exclude pay in years associated with IPOs since pay during those periods often involve one-time startup stock grants that are less relevant for persistent compensation practices.

We measure effective insider ownership as the total effective number of shares owned by the top five executives, where we include delta-weighted options using the method described in Core and Guay (1999), divided by the total number of shares outstanding. This corresponds to the Jensen and Murphy (1990) dollar-dollar measure of incentives, and is labeled Total Insider Ownership.[9] We compute Market Capitalization in a year as shares outstanding times price as of the fiscal year-end reported in Compustat. Total Assets are the total book assets of the firm.

In addition to compensation and size, we also calculate risk variables for every firm-year. We compute two main measures of risk: the annual beta of the firm's stock (Beta), and the firm's annualized stock return volatility (Return Volatility). We compute a firm's market beta and return

[8] Firms occasionally report the compensation of more than five people, in which case we take the top five highly paid executives. Occasionally, firms report compensation of fewer than five people as well. Because firms who report less than five executives may not be strictly comparable to firms who report compensation of the top five (the vast majority of the sample), we also re-do our analysis using top 5 compensation only when five executives report compensation. Results are very similar.

[9] The literature has suggested many different functional forms of incentive slopes. Jensen and Murphy (1990) use effective inside ownership (share ownership plus delta-weighted options) as a measure of incentives, which corresponds to the dollar gain in executive wealth per dollar increase in shareholder value. One concern is that different measures of incentives may be appropriate under alternative assumptions. Baker and Hall (2004) and Hall and Liebman (1998) suggest using the market value of insider equity as a measure of incentives, a "dollar-percent" measure. We check this measure as well although do not report these for brevity. Results are consistent.

volatility using the CRSP Daily Returns File, and take our market return to be the CRSP value-weighted index return including dividends. Our data on the risk-free return comes from Ken French's website. In computing betas and volatility, we require sixty days of returns, and we follow Shumway (1997) in our treatment of delisting returns. For firms with dual-class stock such as Berkshire Hathaway, we compute a firm-level measure of risk by first value-weighting returns across stocks each day.

To be in our final panel, we require that a firm-year have a full set of data for executive compensation, total insider ownership, market capitalization, and total assets for the fiscal year, as well as beta and volatility from the previous fiscal year.[10] With the exception of variables that have clear upper and lower bounds such as institutional ownership and the G-Index, we winsorize our variables at the 1 and 99% levels within each cross-section to mitigate the effect of outliers.

Summary statistics for these compensation and size variables for our full panel are reported in Table I. The mean of Executive Compensation is 2.82 million dollars with a standard deviation of 4.76 million dollars. The mean of Total Insider Ownership is around 4% with a standard deviation of 7%. The mean of Market Capitalization in our panel is 9 billion dollars with a standard deviation of 23 billion dollars. The mean of Total Assets is 55 billion dollars with a standard deviation of around 150 billion dollars. All dollar amounts are adjusted to real December 2000 dollars using the Consumer Price Index All Items series.

[INSERT TABLE I NEAR HERE]

The summary statistics for these risk variables are also reported in Table I. The mean of Beta in our panel is 0.92 with a standard deviation of 0.42. The mean of Volatility is 0.30 with a standard deviation of 0.13. We also use leverage to examine whether compensation is related to financial risk or asset risk. Following Adrian and Shin (2009), we compute leverage for our

[10] Our timing is based on a variation of that in Fama and French (1992). We match Compustat records for fiscal year *t* with betas and volatilities computed using returns from July of calendar year *t-2* to June of calendar year *t-1*. Our convention is conservative in that it ensures that the betas and volatilities matched to fiscal year *t* are based on returns before the first possible set of 12 contiguous calendar months ending in that fiscal year. Given the Compustat convention of fiscal years, this set is July of calendar year *t-1* through June of calendar year *t*.

finance firms as the book assets-to-equity ratio, where we measure book equity as total stockholder equity in Compustat. The mean leverage is 10.8 with a standard deviation of 5.6.

Table I also summarizes a series of standard productivity variables. Return on Assets is income before extraordinary items plus depreciation over total book assets, which averages 2%. Asset Turnover (revenue divided by total assets) measures the revenue-generating efficiency of assets and averages 16%.[11]

We follow Bertrand and Mullainathan (2003) in our computation of total factor productivity (TFP) by regressing the log of total revenue on the log of the total wage bill (less total payouts to executives) and the log of total assets within each finance sub-industry-year, and retaining the percentile rank of the residuals of this regression within each industry-year as our TFP measure. By construction, the median of this measure is 50%.

We obtain data on corporate governance from RiskMetrics, including the G index (Gompers, Ishii and Metrick, 2003) and the percentage of directors that are outsiders (classified as "Independent" by RiskMetrics). The fraction of outside directors averages 67%, although this data only goes back to 1997. We obtain data on the Entrenchment Index (Bebchuk, Cohen and Ferrell, 2009) from Lucian Bebchuk's website.

Our data on analyst coverage and institutional ownership come from I/B/E/S and the Thomson Reuters 13F data, respectively, where we match those data to CRSP using CUSIPs. For Thomson data, we take care to ensure that holdings and shares outstanding both reflect stock splits when necessary. The average number of analysts covering a firm-year in our panel is 13, and institutional ownership averages 51%.

We also report the average fraction of total pay represented by each type of pay from ExecuComp. On average, salary is 36% of total pay, while option grants and bonuses represent 24% and 20%, respectively.[12] The fraction of total insider ownership captured through share

[11] A very small number of firm-years in our sample have negative revenue due to the accounting of losses for financial firms. For example, AMBAC had negative revenue in both 2007 and 2008 due to substantial losses on credit derivatives. Results using revenue net of interest costs are similar.

[12] The percentages reported do not sum to one because we omit the "other compensation" category in the table.

ownership and option ownership (delta-weighted) is also reported. On average, shares represents 57% of inside ownership, while options represent 43%.

In Panel B, we report Executive Compensation and Market Capitalization by finance sub-industry to get a handle on the heterogeneity of firms in our sample. These statistics clearly reveal that Primary Dealers have much higher pay and are much larger than Banks, Lenders and BHC's and Insurers. For instance, the mean Executive Compensation for Primary Dealers is 13 million dollars compared with 2 million dollars for the other two types of financial firms. Not surprisingly, Market Capitalization is also much larger, at 44 billion dollars compared with 6 billion for Banks, Lenders and BHCs and 10 billion for Insurers. We will be careful to control for this sub-industry heterogeneity in our analysis below.

In Panel C, we report summary statistics for our origin risk measures--firm risk ideally measured in the year that the firm first went public. Our data on IPO dates come from Jay Ritter's website. Since this data covers only a subset of the financial firms in our sample, we supplement this by taking the first date the stock is available in the CRSP files, following Fama and French (2004), taking care to avoid the dates when CRSP began coverage for different exchanges.[13] We compute the firm's beta with the CRSP Value-Weighted Index and stock return volatility using daily data in the 365 calendar days starting with the IPO date. The mean and median IPO year of firms in our sample is 1987. The oldest firm has an IPO year of 1933 and the youngest firm has an IPO year of 2006. We are able to compute origin risk measures using the procedure above for 260 firms. The average origin beta is 0.56 while the average origin volatility is 0.34 on an annualized basis.

III. Results

[13] This is an imperfect proxy for a firm's date of actual IPO, as a firm may go public on markets not covered by CRSP during certain time periods. A firm may go public on a market not covered by CRSP and then list on a major exchange covered by CRSP later in its life, as discussed by Fama and French (2004). Our approach measures risk as far back in time as possible. We discard the extreme cases in which the first date a firm appears in CRSP is the date (plus or minus one day) in which CRSP begins coverage of a major exchange. For example, a number of firms first appear in CRSP on December 14, 1972 – the date when CRSP added Nasdaq to its coverage – even though they went public before that date. Including the "origin year" of these firms would result in a clustering of its distribution around years such as 1972. This is the main reason we compute origin risk for 260 firms instead of the full sample.

A. Calculating Residual Compensation and Residual Risk

In Table II, we regress firms' executive compensation on their size and finance sub-industry in the cross-section, where we use the market capitalization of each firm's equity as a proxy for its size. We obtain residual compensation from this regression, which will be our dependent variable of interest. Controlling for heterogeneity in size and industry is important since our predictions about pay levels only hold for firms of equal scale or capital within an industry.

Ideally, we would like to control for heterogeneity by not only allowing average pay to vary across finance sub-industries, but also by allowing the linear slope of compensation and size to vary across each of the three sub-industries.[14] Unfortunately, the limited number of primary dealers per year does not allow us to reliably estimate the relationship between compensation and size separately for this group.[15] Instead, we assume that the slope between compensation and size is the same for primary dealers and banks. For each cross-section, we estimate the following using OLS:

$$LogComp_i = \alpha + \gamma_{industry(i)} + \delta_0 LogSize_i + \delta_1 (LogSize_i \times Insurer_i) + \epsilon_i, \quad (8)$$

where $LogComp_i$ is the log of executive compensation, $industry(i)$ is the industry of firm i (primary dealer, bank, or insurer, with bank as the omitted category), $LogSize_i$ is the log of market capitalization at the end of the fiscal year, and $Insurer_i$ is an indicator for whether the firm is an insurer. This specification allows for heterogeneity in the average level of pay across sub-industries and for an insurer-specific slope in the relationship between compensation and size within each cross-section.

[INSERT TABLE II NEAR HERE]

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[14] Murphy (1999) documents that there is substantial heterogeneity in how pay scales with size across non-financial industries. We view our three groups as a rough split among firms that engage in investment banking and intensive trading activity, other banks that operate more as commercial banks and lenders, and, finally, financial insurers.

[15] In particular, the estimate of the slope of compensation and market capitalization fluctuates depending on the year in which the regression is run due to changes in the composition of the primary dealer group. Consistent with this, running a regression that allows for slopes and intercepts to vary across all sub-industries yields a large standard error on the slope for primary dealers.

Columns 1-3 of Table II, Panel A report OLS estimates for three cross-sections: 1994, 2000, and 2006.[16] Pay scales with size, as suggested by talent assignment models such as Gabaix and Landier (2008) and Edmans and Gabaix (2011), and estimates of the elasticity of pay with size are stable in all three cross-sections: 0.50 in 1994, 0.47 in 2000, and 0.58 in 2006. The elasticity for insurers is consistently slightly lower.[17] Column 4 pools together all cross-sections from 1992 to 2008 and estimates a regression with pooled coefficients. Consistent with the stable relationship observed in the three cross-sections, the pooled coefficient on size is 0.49, with a pooled R-squared of 0.62. Overall, we conclude that we are able to reasonably purge out size and sub-industry effects on executive compensation.

We measure the residual of compensation after estimating equation (8) separately for each cross-section from 1992 to 2008, as in Columns 1-3 of Table II, Panel A, but within every year. This residual compensation measure has a mean of zero in the panel by construction and a standard deviation of 0.62 in the panel. Figure 1, which plots the fit of equation (8) in the 1994 and 2000 cross-sections, illustrates our approach. Within each year, residual compensation is the vertical deviation of each firm's compensation from the industry-specific line estimated for that year.

[INSERT FIGURE 1 NEAR HERE]

We also report in these plots the ticker symbol of some of the well-known finance firms in our sample. Focusing especially on the recent sample in Panel B, we see that Bear Stearns (BSC), Lehman brothers (LEH) and AIG are among the high residual compensation firms. Table II, Panel B reports cross-sectional quintile rankings for several large financial firms, now averaged across all years a firm appears in our sample. High residual compensation firms include Bear Stearns, Lehman Brothers, Countrywide, and AIG. The low residual compensation firms include JP

[16] Heteroskedasticity is an *a priori* major concern since we suspect substantial heterogeneity among banks, insurers, and primary dealers. We use HC3 standard errors, which are robust to heteroskedasticity but have much better small-sample properties than the usual Huber-White sandwich estimator, as documented in MacKinnon and White (1985) and Long and Ervin (2000). For pooled regressions, we cluster standard errors by firm.

[17] Dropping Berkshire Hathaway, an influential observation, from our analysis reduces the magnitude of the difference between the insurer-size coefficient and the primary dealer/bank-size coefficient, although the statistical significance of this difference increases in column (4). The remaining results in the paper are nearly identical.

Morgan Chase and Berkshire Hathaway. At least superficially, our residual compensation measure seems to be informative of the firms which performed poorly in the crisis (e.g. Bear Stearns) versus those which performed better (e.g. JP Morgan Chase). It is perhaps this superficial correlation that might be guiding the view that pay caused risk.

We also compute analogous measures of residual beta and volatility by replacing the left-hand side variable of equation (8) with each of our risk measures, including the origin risk measures.[18] For brevity, we do not report the details of these calculations as we did for compensation in Panel A. The logic of calculating residual risk for each firm is the same as for compensation as our theory applies to firms of equal scale and sub-industry type.

Correlations of these residual compensation and risk measures in Table II, Panel C illustrate the flavor of our results. Residual compensation is strongly correlated with residual compensation in the previous year, with a correlation of 0.70. Residual risk measures are also strongly persistent. The correlation of residual beta (volatility) with residual beta (volatility) in the previous year is 0.67 (0.61); even with beta (volatility) measured at origin, this correlation persists at 0.36 (0.26). As we will show further, this suggests that pay and risk are largely permanent firm effects.

More importantly, residual compensation is correlated with residual risk in the previous year; this correlation is 0.30 for beta and 0.25 for volatility. Residual compensation is also correlated with residual origin beta and volatility, with correlations of 0.22 and 0.20, respectively. These correlations motivate our empirical analysis below. They suggest that one should not be hasty in jumping to the conclusion that pay causes risk on the basis that firms which performed poorly in the crisis, like Bear Stearns, had high residual compensation. The fact that residual origin risk and residual risk and in the previous year are correlated with residual compensation today suggest that causality might run the other way.

B. Persistence in Residual Compensation and Residual Risk

[18] It is useful to distinguish residual risk from residual lagged risk. The former substitutes time-*t* risk as the left-hand side variable in (1), while the latter substitutes risk from *t-1* instead. In establishing the persistence of residual risk in Section III.B, we rely on the former as residual risk relies only on time-*t* information. When turning to our analysis relating compensation to lagged risk in subsequent sections, it is more useful to rely on the latter notion.

In Table III, we begin to build our case that causality might actually run the other way by establishing the premise of our model, which is that there are fixed firm differences in risk, even going back to when the firms were first born. This can be done by showing that there is persistence in residual compensation and residual risk (that is, current values of compensation and risk are highly correlated with lagged values, measured even at firm origin). In our analysis, we set our bar a bit higher by running a horse race between these lagged values with other factors that might explain compensation such as CEO turnover and firm performance.

[INSERT TABLE III NEAR HERE]

The baseline coefficient in Column 1 of a regression of residual compensation on previous year's residual compensation is 0.71 with an R-squared of 0.491. This is very similar to the correlation reported in Table II, Panel C, indicating that the standard deviation of residual compensation is very similar across cross-sections.[19] Column 2 adds an indicator for whether there was CEO turnover in the previous year and the previous year's excess stock return over the CRSP value-weighted index return as additional control variables, where we measure CEO turnover using dates when CEOs left office recorded in ExecuComp.[20] CEO turnover has a statistically significant coefficient of -0.096 while excess returns have a statistically significant positive coefficient of 0.067. These effects have an economic significance of 0.16 and 0.04-standard deviations of residual compensation, respectively. When using forced CEO turnovers as indicated by ExecuComp (Column 3), the magnitude of the effect of turnover is similar, although statistical significance is weakened. However, in both cases, the increase in R-squared over column (1) is marginal. Furthermore, columns 4 through 7 demonstrate that although CEO turnover and returns can have effects on changes (and absolute changes) in residual compensation, they explain very little of the overall variation in these changes.

Figure 2, Panel A illustrates this point in more detail. We sort firms each year into deciles of residual compensation and then compute the average residual compensation for each decile in the next year. The figure reveals a monotonic increasing pattern. After double-sorting

[19] Due to noise in the data, the correlation will never be 1 due to regression to the mean even in the presence of a true fixed effect in compensation.

[20] In computing the previous year's returns, and in classifying whether a firm experienced CEO turnover in the previous year, we follow the same timing convention as used to compute beta and volatility noted above.

independently by residual compensation and CEO turnover, this pattern persists both within the set of firms that did not experience CEO turnover and those that did experience CEO turnover. After double-sorting independently by residual compensation and excess returns, average residual compensation in the next year is monotone increasing across deciles of residual compensation in the current year, both within firms in the lowest and highest deciles of excess returns. The Internet Appendix tabulates the means underlying Figure 2 and shows that within each of these sets of firms, the spread of residual compensation the following year between the 1^{st} and 10^{th} deciles of residual compensation in the current year is significant at the 1% level.

[INSERT FIGURE 2 NEAR HERE]

We conclude that, while CEO turnover and stock price performance have some explanatory power for changes in residual compensation, the bulk of explanatory power for today's residual compensation is provided by past residual compensation. As such, we interpret our residual compensation measure as being largely a permanent effect and that there is substantial cross-sectional variation in this residual compensation measure. Our results are consistent with Fee, Hadlock and Pierce (2013), which suggests that firm effects dominate the variation in a number of corporate policies, and that, to the extent managerial effects can be detected in the data through CEO turnover, they too are largely explained by endogenous changes in corporate policies requiring new management.

We also examine the persistence of our risk-based variables in Table III, Panel B, where we relate residual risk to residual risk from the previous year. The evidence strongly suggests that risk is correlated with risk in the previous year, as well as with origin risk. Figure 3 plots average risk residuals (beta and volatility) the following year for firms sorted into risk residual deciles. These values are also tabulated in the Internet Appendix. For both beta and volatility, there is a monotone increasing pattern. Our results suggest that both pay and risk are persistent effects and that each variable is a source of substantial cross-sectional heterogeneity.

[INSERT FIGURE 3 NEAR HERE]

C. Residual Compensation and Residual Lagged or Origin Risk

With the premise of our model established, we turn to testing our first prediction (Prediction 1): firms with higher lagged or origin risk should have higher total compensation when the degree of incentive provision (i.e., insider ownership) does not vary with lagged or origin risk. We relate residual compensation, incentive provision and residual lagged risk by estimating the following in the full panel using OLS:

$$LogComp_{i,t} = \beta\, Risk_{i,t-1} + \alpha_t + \gamma_{industry(i,t),t} + \delta_{0,t} LogSize_{it} + \delta_{1,t}(LogSize_{it} \times Insurer_{it}) + \epsilon_{it}, \quad (9)$$

where $Risk_{i,t-1}$ is either beta or volatility measured in the previous year. Our coefficient of interest, β, measures the cross-sectional relationship between risk in the previous year and compensation, where the effect is pooled across cross-sections in the panel, net of interacted size and industry effects within each year. This approach is equivalent to a univariate regression of residual compensation as the left-hand side variable on residual lagged risk as the right-hand side variable, where residuals are computed using equation (8) for each cross-section.[21] We also estimate equation (9) where we substitute insider ownership as the left-hand side variable. We cluster standard errors by firm.

[INSERT TABLE IV NEAR HERE]

Table IV, Panel A highlights that there is little evidence of a negative relationship between inside ownership and lagged risk, yet a strong positive relationship exists between compensation and lagged risk. Columns 1 and 2 show a relationship between compensation and lagged risk that is statistically significant at the 1% level for both beta and volatility. The economic magnitude of these relationships is 0.27 and 0.24-standard deviations of compensation per standard deviation of beta and volatility, respectively.[22] These relationships hold consistently throughout our panel, as shown by Figure 4, which plots the relationship between residual compensation and residual

[21] The specification focuses on residual lagged risk (see Footnote 18) as it ensures that effects are not due to correlation between risk in *t-1* and size at time *t*. Results are equivalent if we focus on lagged residual risk, which is not surprising given the persistence of risk and our results using origin risk.

[22] We compute economic significance by taking our coefficient and multiplying it by the unconditional standard deviation of residual lagged risk and dividing by the unconditional standard deviation of residual compensation. This measures a one-standard deviation association in the direction orthogonal to size and industry.

lagged beta (Panel A) and volatility (Panel B) for two cross-sections, 1994 and 2000. Columns 3 and 4 show little evidence of a relationship between ownership and risk. If anything, the relationship between ownership and volatility is positive, not negative.

[INSERT FIGURE 4 NEAR HERE]

Importantly, these relationships continue to hold even substituting origin risk for lagged risk in equation (9), as shown in Columns 5 through 8. The economic significance of the relationship between compensation and origin risk is 0.23-standard deviations for beta and 0.21-standard deviations for volatility, respectively. The relationship between ownership and origin risk is also positive and statistically significant, rather than negative.

The results in Panel A are consistent with our hypothesis that, since exogenously riskier firms provide similar incentives for their managers (insider ownership does not vary significantly with lagged risk), their managers face more stock price risk and hence require higher total pay to offset the risk they are bearing relative to working at a less risky firm.

We check the robustness of our linear specifications in Panel A by conducting a more non-parametric analysis in Table IV, Panel B, where we compute average residual compensation in year $t+1$ and residual ownership in year $t+1$ by deciles of residual risk sorted in year t. Residual compensation exhibits an increasing pattern, suggesting that these results are not an artifact of linearity. Consider the first column, where average residual compensation is computed by deciles of residual beta. Residual compensation is -0.258 in the lowest decile and rises almost monotonically (except for deciles 4-6 where Residual Compensation is near zero) to 0.402 in decile 10. In contrast, there is no noticeable pattern in residual insider ownership across residual beta deciles in the second column. Similar patterns exist for risk measured using volatility in columns (3) and (4), respectively. In the Internet Appendix, we show that there is an increasing pattern in compensation over deciles of origin risk, and a relatively flat relationship for ownership.

D. Robustness Checks

Table V performs a number of robustness checks for these baseline results. First, we redo our analysis by measuring size using book asset values rather than the market value of equity on the idea that book asset values will reflect both debt plus equity and is thus a better proxy for the scale of the firm. Results are very similar.

[INSERT TABLE V NEAR HERE]

Second, we add leverage as an additional variable in our regressions. To the extent that leverage increases the risk of equity, leverage may have a positive effect on compensation, which naturally leads us to ask whether our effects are being driven by leverage and financial risk or the risk associated with the firm's assets. Leverage has a weak positive effect on compensation, statistically significant at the 10% level for volatility. This suggests financial and asset risk may both influence compensation, although asset risk has a much larger effect in our data.[23]

Next, we find that non-CEO compensation and ownership is influenced by risk. Even after excluding the CEO, the economic significance of the relationship between compensation and risk in the previous year is 0.27-standard deviations. While ideally we would have data on compensation of other employees at financial firms (e.g., traders), whether our result would flip if we had such data on non-executive employees depends on whether the relative ranking order of average pay would change substantially if we measured pay of employees lower down rather than executives. Either way, the persistence in residual compensation and the positive association between non-CEO executive compensation and risk suggest that residual compensation is more indicative of an overall firm effect.

Fourth, we do the same exercises for non-financial industries as an out-of-sample check since the principal-agent theory relating compensation and risk should apply to non-financial industries as well. We focus on manufacturing industries as these span many sub-industries that encompass a large portion of firms in Compustat. We estimate a variation of equation (9) where the sub-industries are defined by the two-digit SIC codes between 20 and 39 and where size effects are fully interacted with sub-industry group effects. We find a strong positive relationship between compensation and risk. We find a slight negative relationship between inside ownership and beta, although the economic significance is only -0.03-standard deviations. Although we are wary of

[23] In the Internet Appendix, we also tabulate results where we regress compensation on leverage not as an additional control variable but as the primary risk variable of interest. Our results show a weak positive relationship with leverage similar to that in Table V.

the interpretation of our results since there is so much heterogeneity among non-financial firms, it appears that our insight regarding the relationship between total pay and firm risk holds generally.

Finally, in the Internet Appendix, we repeat our analysis where we successively drop different groups of financial firms to see how our results vary across different sub-industries. First, we exclude the primary dealers from our analysis and find consistent results across all our measures of risk. Second, because we are also concerned that the results may be driven by the insurance companies, we repeat the analysis dropping insurers and again find similar results. Finally, we run our results using only banks and bank holding companies, excluding both insurers and the primary dealers. Point estimates are remarkably stable across these different samples and show a statistically significant positive relationship between compensation and risk. Our results are not just due to primary dealers or insurers.

E. Relating Risk and Productivity

We next turn to our second prediction (Prediction 2), that the productivity and riskiness of finance firms are positively related in the cross-section. We relate the accounting return on assets, asset turnover, and total factor productivity to our lagged risk measures, by re-estimating equation (9) but with these productivity measures as left-hand side variables. Table VI, Panel A reports these results.

[INSERT TABLE VI NEAR HERE]

The accounting return on assets measures the profitability of the firm per dollar of assets. Columns 1-4 show that return on assets is positively related to risk in the previous year and even origin risk. The coefficients on risk and origin risk are significant at the 5% level or better, with economic significance in the 0.15 to 0.21 range for volatility and origin volatility. Examining asset turnover in columns 5-8 shows that much of the productivity gain of higher risk firms is that they earn more revenue per dollar of assets. Figure 5, Panel A plots asset turnover residuals (net of sub-industry and size factors) in year $t+1$ across deciles of risk in year t, and shows that very risky firms have very high asset turnover. Overall, firms with higher stock price risk are also more profitable, consistent with the theory that high risk firms incentivize their agents just as strongly as low risk firms.

[INSERT FIGURE 5 NEAR HERE]

We also look at the cross-sectional ranking of total factor productivity (TFP) of each finance firm, measured as the percentile ranking of the residual from a cross-sectional within-sub-industry regression of the log of sales on the log of total wages paid (less executive pay) and the log of total assets each year. The idea is that the effect of CEO effort may be captured as a multiplicative effect on the contribution of employees and capital to production. Columns 9-12 report the results of regressing this percentile ranking on lagged risk and origin risk. Consistent with our above results, the relationship between TFP and risk is positive and statistically significant at the 1% level when measuring risk using lagged beta, lagged volatility, and origin beta. The point estimate for origin volatility is positive but not statistically significant. Figure 5, Panel B also confirms that these TFP rankings in year *t+1* are increasing in risk deciles computed in year *t*. In the Internet Appendix, we tabulate average return on assets, asset turnover, and TFP rankings by risk and origin risk deciles and consistently find an increasing relationship.

We next consider a multiple regression of compensation on risk and productivity. There are two potential outcomes from this regression. The first outcome is that risk displays a negative coefficient when controlling for our productivity measures. Assuming that risk residualized for current productivity is noise, it ought to be negatively correlated with ownership and compensation. The second outcome is that both risk and productivity measures come in with a positive sign if firms pay managers to manage growth options. Why? While growth options are a bit outside the scope of our model, the literature has supported a link between growth options, stronger incentives, and higher pay levels (Gaver and Gaver, 1995), and has also emphasized that variation in firm risk is strongly correlated with variation in firm growth options (Bernardo, Chowdhry, and Goyal, 2007 provide a review).

Intuitively, productivity is required not only today, but also in the future to manage growth opportunities, so high pay, high risk and high future productivity may also go hand-in-hand. The difficulty in monitoring how agent effort influences uncertain outcomes then leads principals of growth firms to offer stronger incentives (Prendergast, 2002).

Growth options tend to increase total and systematic risk due to the longer duration of their cash flows (Dechow, Sloan, and Solimon, 2004), their compound decision-making structure (Berk, Green and Naik, 2004), and their general nature as an option on real assets (Chung and Charoenwong, 1991). Indeed, the link between risk and growth options is robust across many classes of theories, even though there has been substantial empirical debate about whether traditional measures such as market-to-book or Tobin's q adequately captures growth options.

In our sample, we find that (1) ownership has a statistically insignificant yet positive coefficient with risk, and (2) compensation is positively correlated with both risk and current productivity, as shown in Table VI, Panel B. The coefficient on risk is statistically stronger than that for current productivity measures, which suggests that the second force – future productivity and growth – is a dominant factor in firms' pay-setting policies.

One possible interpretation of the correlation between growth options and risk in the context of finance firms is that expansion into subprime mortgage securitization and trading represented a growth option for firms such as Countrywide and Lehman Brothers. Panayi and Trigeorgis (1998) provide a case study how expansion decisions by banks operate as a growth option.

However, we should caveat that mis-measurement of productivity is another possibility which explains these findings. The productivity measures we have, in contrast to volatility of stock prices, are accounting-based and hence might be more subject to measurement error. With this caveat in mind, the evidence in Panel B of Table VI does strongly suggest an interpretation that risk and productivity are inextricably linked in financial services. Overall, we conclude that our analysis supports the notion that risk is intrinsically tied to firm output leading to its positive association with compensation, as opposed to compensation causing risk.[24]

F. Residual Lagged Risk and the Components of Pay

In Table VII, we test our third prediction (Prediction 3) about how the components of compensation are related to risk. If compensation increases with risk because of the higher marginal productivity of agents at high risk firms, the high value of their incentive shares should

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[24] We have also tried to add in traditional valuation ratios such as Tobin's q and market-to-book as measures of growth options along with our risk measures to explain ownership levels and compensation. Results vary depending which ratios are used, but we still find that risk comes in with a positive sign, which is consistent with the idea that valuation ratios are noisy and also associated with other concepts such as mis-pricing.

drive down salary as a fraction of total pay compared to agents at low-risk, low-productivity firms. We re-estimate equation (9) and relate risk (beta and volatility) to the fraction of compensation represented by salary, bonus, total cash (salary plus bonus), restricted stock grants, and option grants.

[INSERT TABLE VII NEAR HERE]

Columns 1 and 2 show that higher beta and volatility firms have lower salaries as a fraction of total pay. Economically, a one-standard deviation increase in residual risk is associated with a reduction of 0.20-standard deviations, or 3%, in salary as a fraction of total pay. Bonuses are a larger fraction of pay at high risk firms (columns 3 and 4), so that the total cash pay (salary plus bonus) is flat with respect to risk (columns 5 and 6). Restricted stock grants show little relationship to risk as well (columns 7 and 8). In contrast, option grants show a strongly increasing relationship with both beta and volatility (columns 9 and 10).

When using origin risk, the relationship between option grants and risk is not statistically significant. However, there is a statistically significant negative relationship between the fraction of pay that is salary and origin risk, and a positive relationship between the fraction of pay that are bonuses and risk. These results are tabulated in the Internet Appendix.

Our mechanism emphasizes heterogeneity in firm risk, holding risk preferences the same across managers. Another mechanism on top of ours also arises if we are willing to assume that there is heterogeneity in risk preferences across managers. Then there will be an additional matching mechanism in which less risk averse CEOs work for more risky firms, as it is less costly to incentivize less risk averse CEOs with variable compensation. There is some support for this perspective in Graham, Harvey and Puri (2013), who find that risk-averse CEOs (elicited through survey questions) are more likely to be compensated by salary and less likely to be compensated by performance-related packages.

G. Accounting for Entrenchment Proxies

Table VIII tests whether the cross-sectional pattern in total pay and risk is explained by the entrenchment hypothesis (Prediction 4). First, we test whether standard proxies for managerial power π are correlated with total pay and risk by estimating equation (9) with compensation and risk as left-hand side variables, and with lagged measures of governance and power as the right-hand side variable of interest, maintaining all other controls, in separate equations. A positive coefficient on the managerial power variable would suggest that entrenchment has cross-sectional explanatory power for total pay; if it is also positively correlated with risk, it would suggest that our previous results are driven by an omitted variables bias. Our measures of power are the Gompers, Ishii and Metrick (2003) G Index and the Bebchuk, Cohen and Ferrell (2009) E Index, and the percentage of independent directors on the board (Hermalin and Weisbach, 1998). For the board independence measure, entrenchment would suggest a negative coefficient.[25] Of these, none show any correlation with compensation or risk.

[INSERT TABLE VIII NEAR HERE]

We also test whether measures of monitoring and transparency are negatively related to compensation and risk. Ceteris paribus, entrenchment is more likely in firms where there are low levels of monitoring or transparency. Motivated by this thought, we relate compensation and risk to measures of institutional ownership and analyst coverage instead of measures of shareholder rights. To the extent that institutional ownership may mitigate entrenchment, high pay and high risk firms should have lower institutional ownership.[26] If higher analyst coverage yields more transparency at a firm, then high pay and high risk firms should have lower analyst coverage. Institutional ownership exhibits a strongly positive, not negative, relationship with compensation and risk. Analyst coverage also exhibits a positive, yet slightly weaker, relationship with compensation and risk.

Second, we test whether including the "kitchen sink" of these measures mitigates the observed correlation between risk and compensation in Table VIII, Panel B. If entrenchment was driving our correlation between risk and compensation, including these measures should mitigate

[25] Another potential measure of entrenchment is CEO Pay / Top 5 Total Pay (Bebchuk, Cremers, and Peyer, 2011). The numerator is included in our left-hand side variable while the denominator of this fraction is a scaled version of our left-hand side variable and we thus do not include it in our analysis as it will exhibit a mechanical relationship with average executive compensation. In our sample, this measure is uncorrelated with beta and volatility.

[26] The theme of institutional investors wanting certain firms to take more risks and having to give them incentives to do so is also echoed in Froot, Perold and Stein (1992) and Bolton, Scheinkman and Xiong (2006).

the previously estimated correlations in Table IV. We include the G Index, the percentage of independent directors, analyst coverage, and institutional ownership addition to risk on the right-hand side.[27] The point estimates for risk are remarkably consistent with those in Table IV, and risk displays a strong economic and statistical significance. The additional explanatory power comes from analyst coverage and institutional ownership, which have positive, not negative, signs.

We also do not find that including the kitchen sink of these measures changes the relationship between ownership and risk. Consistent with Table IV, the relationship between ownership and risk is if anything positive. The strongest relationship between ownership and governance is through the board independence variable, which comes in with a negative sign in both origin risk and lagged risk specifications. This suggests that better governed firms with more independent directors are associated with weaker, not stronger, incentives.[28] Overall, our previous results are not being driven by entrenchment or monitoring.

Finally, we consider the prediction of the entrenchment theory that firms with entrenched mangers should underperform as managers divert cash flows. If high pay reflects entrenchment, then high pay firms should consistently underperform in the cross-section. Figure 6 tests this insight by examining whether residual compensation is related to subsequent cumulative excess returns. We condense our panel into two periods: an early period, where we relate residual average compensation in 1992-1994 with residual cumulative excess buy-and-hold returns from 1995 to 2000, and a late period, where we relate average compensation in 1998 to 2000 with cumulative excess buy-and-hold returns from 2001 to 2008.[29] The figure shows that high residual

[27] We include only one of either the G Index and E Index since they are highly correlated by construction (E Index covers a subset of measures in the G Index). Substituting the E Index for the G Index does not change the result.

[28] The G Index and analyst coverage results are weaker, and suggest conflicting results: worse governance (high G Index) is associated with lower ownership, but worse transparency (less analyst coverage) is also associated with more ownership. Neither of these survive the stronger specification of using origin risk instead of lagged risk.

[29] Cumulative excess returns are computed by subtracting the CRSP Value Weighted Index return (including dividend distributions) from the cumulative return of the firm over the period for which the firm is alive. For the early period, we residualize both average compensation and the cumulative excess return against average end-of-fiscal-year market capitalization in 1992-1994, and do so similarly using 1998-2000 average fiscal-year-end market capitalization for the late period. To account for the timing of fiscal year-ends, we compute returns for the early period from June 1995 through May 2001, and returns for the late period from June 2001 through May 2009.

compensation firms – “yesterday’s heroes” – tended to do well over the 1995 to 2000 period, a period when the market boomed, while they did poorly from 2001 to 2008, a period when the market did poorly. This is largely a consequence of high pay firms also being higher beta firms in the cross section; including their beta during these periods as a control variable in this regression eliminates the statistical relationship between compensation and subsequent returns**.**

[INSERT FIGURE 6 NEAR HERE]

IV. Conclusion

The debate about the relationship between compensation and risk has often focused on whether entrenchment led to managers with misaligned pay packages taking excessive risks. We point out that total pay and risk can be naturally correlated even in a classical principal-agent model with exogenous firm risk where managers are implementing the optimal effort on behalf of shareholders, and where entrenchment is absent. Our main insight is that, when the degree of incentive provision does not vary with firm risk, perhaps because agents in high risk finance firms have to work just as hard if not harder than those in low risk firms, then agents in high risk firms face greater wealth uncertainty and have to be compensated with higher total pay. In short, our results suggest that firm risk seems to be a first-order determinant in the cross-section of which firms compensate their agents highly.

This alternative narrative emphasizes that managers must be compensated for working at high-risk firms. The entrenchment narrative generally implies that improving governance and reducing the wedge between the interests of management and shareholders would have helped limit risk in the system, and perhaps even have helped avoid the financial crisis. Our results have a dramatically different implication. Our paper suggests a need for broadening the scope of research on pay and risk beyond the pay-for-performance dimension into how contracts as a whole are related to risk in accordance with principal-agent theory. Intuitively, the optimal contract reflects both the incentive and participation constraint. Further work along these lines is likely to yield considerable insights.

Appendix

Proposition 1. (i.) *Suppose the disutility of effort satisfies* $c'' > 0$, $c' > 0$, *and* $\frac{c'''}{c''} < 2\frac{c''}{c'}$. *If* $\frac{\partial\beta}{\partial\sigma^2} = 0$, *then* $\frac{\partial a}{\partial\sigma^2} > 0$ *and* $\frac{\partial T}{\partial\sigma^2} > 0$.

(ii) If, in addition, $c'''(a) \geq 0$, *then* $\partial\beta^*/\partial\sigma^2 \geq 0$ *suffices.*

Proof. If $\frac{\partial\beta}{\partial\sigma^2} = 0$ then direct computation shows that

$$\frac{\partial h}{\partial\sigma^2} = \frac{hc''}{\sigma^2\left[2c'' - \frac{c'''}{c''}c'\right]}.$$

By supposition, $c', c'' > 0$, so the sign of $\frac{\partial h}{\partial\sigma^2}$ is determined by the sign of $2\frac{c''}{c'} - \frac{c'''}{c''}$. For cost functions such that $\frac{c'''}{c''} < 2\frac{c''}{c'}$, we have that $\frac{\partial h}{\partial\sigma^2} > 0$ is then a necessary condition for $\frac{\partial\beta}{\partial\sigma^2} = 0$. From the equilibrium condition $c'(a) = \beta h$, direct computation shows that

$$\frac{\partial a}{\partial\sigma^2} = \frac{1}{c''}\left[\beta\frac{\partial h}{\partial\sigma^2} + h\frac{\partial\beta}{\partial\sigma^2}\right] > 0.$$

Direct computation also shows that $\frac{\partial T}{\partial\sigma^2} = c'(a)\frac{\partial a}{\partial\sigma^2} + \frac{\gamma}{2}\beta^2 > 0$. Notice that $a > 0$ in equilibrium so we do not have to worry about the denominator going to zero.

More generally for the case where $\frac{\partial\beta}{\partial\sigma^2} \geq 0$, we have

$$\frac{\partial h}{\partial\sigma^2} = \frac{\left[\frac{1}{\gamma}\left(1 + \frac{\gamma\sigma^2}{h^2}c''\right)^2 + \frac{\sigma^2}{h^2}\frac{c'''}{c''}h\right]h^2\frac{\partial\beta}{\partial\sigma^2} + hc''}{\sigma^2\left[2c'' - \frac{c'''}{c''}c'\right]}$$

If $\frac{\partial\beta}{\partial\sigma^2} \geq 0$, with the additional assumption that $c''' \geq 0$, then $\frac{\partial h}{\partial\sigma^2} > 0$. Since $\frac{\partial a}{\partial\sigma^2} = \frac{1}{c''}\left[\beta\frac{\partial h}{\partial\sigma^2} + h\frac{\partial\beta}{\partial\sigma^2}\right] > 0$ and

$$\frac{\partial T}{\partial\sigma^2} = c'(a)\frac{\partial a}{\partial\sigma^2} + \frac{\gamma}{2}\left(\beta^2 + \sigma^2 2\beta\frac{\partial\beta}{\partial\sigma^2}\right) > 0,$$

the conclusion follows. ■

Proposition 2. *Suppose the disutility of effort is quadratic and* $\frac{\partial\beta}{\partial\sigma^2} = 0$ *. Then the fraction of pay that is fixed declines with risk:* $\frac{\partial(\alpha/T)}{\partial\sigma^2} < 0$.

Proof. Since $\alpha = T - \beta h a$, and $a = \beta h$, we have that:

$$\frac{\partial(\alpha/T)}{\partial\sigma^2} \propto \beta h \frac{\partial T}{\partial\sigma^2} - 2T\left(\beta \frac{\partial h}{\partial\sigma^2} + h \frac{\partial\beta}{\partial\sigma^2}\right).$$

If $\frac{\partial\beta}{\partial\sigma^2} = 0$, then $\frac{\partial h}{\partial\sigma^2} = \frac{1}{2}\frac{h}{\sigma^2}$, and $T = \bar{u} + \frac{1}{2}h^2\beta$, so that $\frac{\partial T}{\partial\sigma^2} = \frac{1}{2}\frac{h^2}{\sigma^2}\beta$. Substituting into the right-hand side of the above,

$$\begin{aligned}\frac{\partial\left(\frac{\alpha}{T}\right)}{\partial\sigma^2} &\propto \frac{1}{2}\frac{h^2}{\sigma^2}\beta^2 h - 2\left(\bar{u} + \frac{1}{2}h^2\beta\right)\beta\frac{1}{2}\frac{h}{\sigma^2} \\ &= -\frac{\bar{u}\beta h}{\sigma^2} \\ &< 0,\end{aligned}$$

and the conclusion follows. ■

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Table I: Summary Statistics

This table reports summary statistics for measures of compensation, size, risk, productivity, and governance for financial firms. Panel A reports summary statistics across the whole panel from 1992 through 2008. Panel B reports compensation and size by finance sub-industry. Panel C reports origin risk measures. Variables are winsorized annually at the 1% and 99% levels. Dollar amounts are computed in constant December 2000 dollars adjusted using the Consumer Price Index All Items series.

Panel A: Panel Statistics

	Mean	SD	Min	Median	Max	N
Compensation and Size						
Executive Compensation ($M)	2.82	4.76	0.17	1.27	73.25	2631
Total Insider Ownership	0.04	0.07	0.00	0.02	0.46	2631
Market Capitalization ($B)	9.03	23.11	0.00	2.10	256.45	2631
Total Assets ($B)	55.04	149.81	0.05	10.35	1816.85	2631
Risk Variables (*t-1*)						
Beta	0.92	0.42	-0.07	0.87	2.46	2631
Volatility	0.30	0.13	0.11	0.27	1.26	2631
Leverage	10.76	5.56	1.51	11.06	35.16	2629
Productivity Variables						
Return on Assets	0.02	0.03	-0.26	0.02	0.17	2629
Asset Turnover (Revenue / Assets)	0.16	0.14	-0.03	0.10	0.86	2625
TFP Percentile Ranking	0.50	0.29	0.00	0.50	1.00	1918
Governance Variables (*t-1*)						
G Index	9.58	2.81	2.00	10.00	17.00	1644
E Index	1.71	1.25	0.00	2.00	5.00	1644
% Outside Directors	0.67	0.16	0.13	0.70	1.00	1195
Number of Analysts Covering	13.35	8.41	2.00	11.00	42.00	2449
Institutional Ownership	0.51	0.20	0.02	0.51	0.99	2480
Pay Components						
Salary	0.36	0.20	0.01	0.34	0.94	2631
Bonus	0.20	0.16	0.00	0.19	0.81	2631
Restricted stock grant	0.08	0.13	0.00	0.00	0.77	2109
Option grant	0.24	0.19	0.00	0.22	0.86	2109
Total insider ownership fraction, shares	0.57	0.28	0.00	0.55	1.00	2631
Total insider ownership fraction, options	0.43	0.28	0.00	0.45	1.00	2631

Table I, Continued

Panel B: Statistics by Finance Sub-Industry

		Exec. Comp. ($M)	Market Cap ($B)
Primary Dealers	Mean	13.31	43.77
	SD	11.25	54.83
	N	171	171
	N/year	10.69	10.69
Banks, Lenders and BHCs	Mean	2.07	5.56
	SD	2.90	11.12
	N	1828	1828
	N/year	114.25	114.25
Insurers	Mean	2.14	9.67
	SD	2.03	26.38
	N	632	632
	N/year	39.50	39.50

Panel C: Origin Risk Statistics

	Mean	SD	Min	Median	Max	N
Beta	0.56	0.49	-0.27	0.47	2.22	260
Volatility	0.34	0.16	0.06	0.32	1.59	260
IPO Year	1987	10.9	1933	1987	2006	260

Table II: Residual Compensation

Panel A reports results from cross-sectional regressions of log executive compensation as the dependent variable on industry-specific size and level effects for three sample years, 1994, 2000, and 2006, as well as a pooled panel regression with year effects. Panel B reports the time-series average of the cross-sectional quintile ranking of residual compensation for firms prominent in the financial crisis. Panel C reports correlations of residuals computed from projecting the listed variables on industry- specific size and level effects, within each sample year. T-statistics are reported in brackets. Standard errors are computed using HC3 robust standard errors for the first three columns of Panel A. Standard errors are clustered at the firm level in column 4. */**/*** indicate statistical significance at the 10, 5, and 1% levels, respectively.

Panel A: Executive Compensation and Size

	1994	2000	2006	Pooled
Log Executive Compensation	(1)	(2)	(3)	(4)
Log Market Cap	0.502	0.469	0.583	0.491
	[10.11]***	[5.50]***	[15.85]***	[19.69]***
Log Market Cap x Insurers	-0.257	-0.184	-0.238	-0.216
	[-1.43]	[-1.26]	[-1.33]	[-1.92]*
Primary Dealer	0.429	1.080	0.804	0.792
	[2.30]**	[2.38]**	[2.63]***	[4.38]***
Insurer	1.637	1.401	2.200	1.753
	[1.38]	[1.27]	[1.54]	[2.15]**
Constant	3.307	3.686	2.660	3.099
	[9.33]***	[5.24]***	[8.83]***	[17.11]***
Year effects	N/A	N/A	N/A	Y
N	150	141	175	2631
R-squared	0.575	0.583	0.703	0.615
Firms	150	141	175	349

Panel B: Average Quintile Ranking of Residual Compensation

Primary Dealers		**Banks/BHCs**	
Bank of America	1.8	Countrywide Financial	4.9
Bear Stearns	4.9	Wells Fargo	3.5
JP Morgan Chase	2.2	Washington Mutual	3.1
Citigroup	3.2	**Insurers**	
Goldman Sachs	4.1	AIG	4.4
Lehman Brothers	4.3	AMBAC	3.8
Merrill Lynch	4.1	Berkshire Hathaway	1.0
Morgan Stanley	3.9	MBIA	4.4

Panel C: Residual Correlations

	Comp. *t*	Comp. *t-1*	Beta *t*	Vol. *t*	Beta *t-1*	Vol. *t-1*	O.Beta *t*	O.Vol. *t*
Compensation, *t*	1.00							
Compensation, *t-1*	0.70	1.00						
Beta, *t*	0.32	0.33	1.00					
Volatility, *t*	0.29	0.29	0.62	1.00				
Beta, *t-1*	0.30	0.32	0.67	0.43	1.00			
Volatility, *t-1*	0.25	0.28	0.51	0.61	0.60	1.00		
Origin Beta	0.22	0.22	0.36	0.29	0.34	0.27	1.00	
Origin Volatility	0.20	0.20	0.18	0.26	0.16	0.26	0.40	1.00

Table III: Persistence in Compensation and Risk

Panel A reports results from a pooled regression of residual compensation on previous year residual compensation, CEO turnover, and excess returns. Panel B reports results from a pooled regression of residual beta and residual volatility on lagged residuals as well as residual origin beta and residual origin volatility measured in the origin year of the firm. T-statistics are reported in brackets. Standard errors are clustered at the firm level in both panels. */**/*** indicate statistical significance at the 10, 5, and 1% levels, respectively.

Panel A: Compensation Persistence

Residual Compensation, *t*		Levels		Changes		Absolute changes	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Residual Compensation, *t-1*	0.712	0.713	0.710				
	[16.13]***	[16.05]***	[15.97]***				
CEO Turnover, *t-1*		-0.096		-0.143		0.091	
		[-2.54]**		[-3.13]***		[3.08]***	
Excess Returns, *t-1*		0.067	0.071	0.036	0.042	0.005	0.001
		[2.35]**	[2.51]**	[1.16]	[1.35]	[0.17]	[0.02]
Forced CEO Turnover, *t-1*			-0.096		-0.074		0.017
			[-1.12]		[-0.71]		[0.25]
Constant	0.005	0.006	0.000	0.015	0.005	0.326	0.332
	[0.52]	[0.58]	[0.03]	[2.22]**	[0.90]	[27.72]***	[28.63]***
N	2250	2250	2250	2250	2250	2250	2250
R-Squared	0.491	0.494	0.493	0.007	0.001	0.005	0.000
Firms	336	336	336	336	336	336	336

Panel B: Risk Persistence

Dependent variable, *t*	Beta Residual, *t*	Volatility Residual, *t*	Beta Residual, *t*	Volatility Residual, *t*
	(1)	(2)	(3)	(4)
Beta Residual, *t-1*	0.656			
	[30.41]***			
Volatility Residual, *t-1*		0.636		
		[23.80]***		
Origin Beta Residual			0.276	
			[6.38]***	
Origin Volatility Residual				0.159
				[3.84]***
Constant	0.006	0.000	0.038	0.006
	[1.07]	[0.05]	[2.30]**	[1.14]
N	2250	2250	1465	1465
R-Squared	0.448	0.372	0.125	0.053
Economic significance	0.669	0.610	0.354	0.230
Firms	336	336	249	249

Table IV: Compensation and Lagged and Origin Risk

Panel A reports results from pooled regressions where the dependent variables are compensation and ownership, and the independent variables are measures of lagged and origin risk. Panel B reports average residual compensation and residual ownership in year *t+1* based on a decile sort of residual risk in year *t*. T-statistics are reported in brackets. Standard errors are clustered at the firm level in both panels. */**/*** indicate statistical significance at the 10, 5, and 1% levels, respectively.

Panel A: Regression Analysis

	Risk, *t-1*				**Origin Risk**			
Dependent variable, *t*	Compensation		Ownership		Compensation		Ownership	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Beta	0.503		0.005		0.316		0.025	
	[6.46]***		[0.54]		[4.54]***		[2.50]**	
Volatility		1.584		0.037		0.789		0.061
		[7.41]***		[1.82]*		[5.63]***		[2.16]**
Constant	2.289	2.659	0.128	0.120	3.795	3.401	0.125	0.095
	[4.44]***	[5.51]***	[3.49]***	[3.84]***	[6.51]***	[5.54]***	[3.03]***	[2.00]**
Year, Sub-Ind, Size *t* Effects	Y	Y	Y	Y	Y	Y	Y	Y
Full interactions	Y	Y	Y	Y	Y	Y	Y	Y
N	2631	2631	2631	2631	1744	1744	1744	1744
R-Squared	0.661	0.656	0.102	0.105	0.672	0.669	0.130	0.125
Economic significance	0.270	0.241	0.032	0.055	0.228	0.207	0.176	0.158
Firms	349	349	349	349	260	260	260	260

Panel B: Decile Sorts

	Beta		**Volatility**	
Residual Risk Ranking, *t*	Residual Compensation, *t+1*	Residual Ownership, *t+1*	Residual Compensation, *t+1*	Residual Ownership, *t+1*
1	-0.258	0.008	-0.234	-0.006
	[-2.27]**	[0.75]	[-4.66]***	[-1.17]
2	-0.146	0.005	-0.192	-0.001
	[-3.27]***	[0.80]	[-5.13]***	[-0.22]
3	-0.169	-0.003	-0.023	0.001
	[-4.13]***	[-0.63]	[-0.47]	[0.10]
4	-0.037	0.000	-0.172	-0.010
	[-0.95]	[0.03]	[-3.62]***	[-2.08]**
5	-0.046	-0.007	-0.038	0.000
	[-1.15]	[-1.29]	[-0.87]	[0.05]
6	-0.043	-0.007	-0.011	0.001
	[-0.91]	[-1.64]	[-0.20]	[0.14]
7	0.027	-0.001	0.029	0.000
	[0.60]	[-0.17]	[0.58]	[0.05]
8	0.077	-0.007	0.054	0.004
	[1.59]	[-1.42]	[0.81]	[0.59]
9	0.219	0.001	0.233	0.002
	[4.14]***	[0.26]	[4.70]***	[0.34]
10	0.402	0.013	0.378	0.013
	[5.53]***	[1.58]	[5.47]***	[1.97]*
10-1 Spread	0.660	0.005	0.612	0.020
	[4.89]***	[0.34]	[7.10]***	[2.36]**

Table V: Robustness

This table reports results from robustness exercises. Columns 1-4 use the book value of assets instead of market capitalization as controls. Columns 5-8 include an additional a control for leverage. Columns 9-12 use compensation and ownership of non-CEO executive officers. Columns 13-16 examine manufacturing firms. T-statistics are reported in brackets. Standard errors are clustered at the firm level. */**/*** indicate statistical significance at the 10, 5, and 1% levels, respectively.

	Size as Assets				**Controlling for leverage**			
Dependent variable, *t*	Compensation		Ownership		Compensation		Ownership	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Beta, *t-1*	0.563		0.006		0.496		0.005	
	[6.56]***		[0.66]		[6.43]***		[0.55]	
Volatility, *t-1*		1.396		0.037		1.576		0.037
		[5.19]***		[1.72]*		[6.97]***		[1.83]*
Leverage, *t-1*					0.012	0.013	0.000	0.000
					[1.59]	[1.70]*	[0.04]	[0.04]
Constant	1.048	1.725	0.101	0.095	2.041	2.373	0.127	0.119
	[1.49]	[2.66]***	[3.00]***	[3.27]***	[3.89]***	[4.91]***	[3.12]***	[3.54]***
Year, Sub-Ind, Size *t* Effects	Y	Y	Y	Y	Y	Y	Y	Y
Full interactions	Y	Y	Y	Y	Y	Y	Y	Y
N	2631	2631	2631	2631	2629	2629	2629	2629
R-Squared	0.635	0.618	0.093	0.095	0.663	0.659	0.102	0.104
Economic significance	0.290	0.205	0.032	0.055	0.266	0.241	0.032	0.055
Firms	349	349	349	349	349	349	349	349

	Non-CEO compensation & ownership				**Manufacturing industry**			
Dependent variable, *t*	Compensation		Ownership		Compensation		Ownership	
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Beta, *t-1*	0.494		0.005		0.109		-0.005	
	[6.85]***		[0.54]		[6.83]***		[-2.06]**	
Volatility, *t-1*		1.592		0.037		0.432		0.004
		[8.12]***		[1.82]*		[7.95]***		[0.37]
Constant	2.330	2.676	0.128	0.120	3.915	3.860	0.164	0.153
	[4.36]***	[5.25]***	[3.49]***	[3.84]***	[34.38]***	[32.68]***	[7.99]***	[7.43]***
Year, Sub-Ind, Size *t* Effects	Y	Y	Y	Y	Y	Y	Y	Y
Full interactions	Y	Y	Y	Y	Y	Y	Y	Y
N	2631	2631	2631	2631	11641	11641	11641	11641
R-Squared	0.658	0.654	0.102	0.105	0.633	0.636	0.105	0.103
Economic significance	0.266	0.243	0.032	0.055	0.110	0.134	0.032	0.000
Firms	349	349	349	349	1306	1306	1306	1306

Table VI: Risk and Productivity

Panel A reports results from pooled regressions where the dependent variables are productivity measures and the independent variables are measures of risk. Columns 1-4 report results where the dependent variable is the accounting return on assets. The dependent variable in columns 5-8 is asset turnover (revenue / assets); in columns 9-12, the dependent variable is the cross-sectional percentile ranking of total factor productivity. Panel B reports results regressing compensation and ownership as dependent variables on both lagged productivity measures and risk. T-statistics are reported in brackets. Standard errors are clustered at the firm level. */**/*** indicate statistical significance at the 10, 5, and 1% levels, respectively.

Panel A: Productivity

	ROA				Asset Turnover				TFP Percentile Ranking			
Dependent variable, *t*	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Beta, *t-1*	0.007				0.059				0.110			
	[1.99]**				[3.40]***				[2.93]***			
Volatility, *t-1*		0.040				0.252				0.450		
		[3.59]***				[3.63]***				[2.86]***		
Origin Beta			0.009				0.042				0.212	
			[2.21]**				[2.25]**				[4.56]***	
Origin Volatility				0.040				0.228				0.188
				[4.65]***				[4.60]***				[1.07]
Constant	-0.015	-0.019	-0.012	-0.036	-0.025	-0.016	0.109	-0.039	-0.162	-0.132	-0.374	-0.358
	[-1.00]	[-1.46]	[-0.48]	[-1.51]	[-0.35]	[-0.24]	[1.23]	[-0.43]	[-0.66]	[-0.55]	[-1.21]	[-1.07]
Year, Sub-Ind, Size *t* Effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Full interactions	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
N	2629	2629	1743	1743	2625	2625	1742	1742	1918	1918	1251	1251
R-Squared	0.194	0.206	0.204	0.228	0.367	0.377	0.290	0.333	0.099	0.102	0.196	0.122
Econ. Significance	0.089	0.152	0.134	0.217	0.170	0.207	0.141	0.281	0.130	0.141	0.305	0.095
Firms	349	349	260	260	349	349	260	260	267	267	195	195

Panel B: Compensation, Risk, and Productivity

Dependent variable.:	Compensation, *t*						Ownership, *t*					
Risk measure:	Beta			Volatility			Beta			Volatility		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Risk, *t-1*	0.506	0.492	0.463	1.669	1.608	1.779	0.003	0.000	0.010	0.040	0.027	0.037
	[6.14]***	[5.76]***	[5.67]***	[7.55]***	[7.44]***	[5.73]***	[0.36]	[0.01]	[1.16]	[1.81]*	[1.02]	[1.27]
ROA, *t-1*	1.816			1.765			0.168			0.150		
	[1.73]*			[1.70]*			[1.33]			[1.21]		
Asset Turnover, *t-1*		0.460			0.436			0.069			0.065	
		[1.76]*			[1.78]*			[1.94]*			[1.80]*	
TFP, *t-1*			0.202			0.199			0.019			0.020
			[1.62]			[1.60]			[1.50]			[1.49]
Constant	2.266	2.250	2.602	2.602	2.586	2.768	0.130	0.129	0.135	0.117	0.116	0.140
	[4.37]***	[4.38]***	[5.19]***	[5.38]***	[5.40]***	[5.68]***	[3.47]***	[3.44]***	[3.00]***	[3.71]***	[3.66]***	[3.40]***
Year, Sub-Ind, Size *t* Effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Full interactions	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
N	2496	2491	1628	2496	2491	1628	2496	2491	1628	2496	2491	1628
R-squared	0.659	0.659	0.726	0.655	0.655	0.725	0.101	0.112	0.148	0.103	0.113	0.147
Firms	347	346	255	347	346	255	347	346	255	347	346	255

Table VII: Components of Pay

This table examines how the components of compensation are related to risk variables in the cross-section. The dependent variables examined are salary, bonus, total cash (salary plus bonus), restricted stock grants, and option grants, as a fraction of total compensation, and the independent variables are risk measures. T-statistics are reported in brackets. Standard errors are clustered at the firm level. */**/*** indicate statistical significance at the 10, 5, and 1% levels, respectively.

Compensation fraction, *t*	Salary		Bonus		Total Cash		Restricted stock grant		Option grant	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Beta, *t-1*	-0.094		0.072		-0.020		0.015		0.042	
	[-5.46]***		[3.96]***		[-1.08]		[1.26]		[2.23]**	
Volatility, *t-1*		-0.301		0.213		-0.083		0.029		0.180
		[-5.84]***		[4.01]***		[-1.28]		[0.80]		[3.28]***
Constant	1.337	1.271	0.330	0.389	1.662	1.657	1.447	1.435	-0.243	-0.282
	[11.99]***	[12.24]***	[2.72]***	[3.33]***	[11.57]***	[11.89]***	[1.43]	[1.43]	[-0.64]	[-0.75]
Year, Sub-Ind, Size *t* Effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Full interactions	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
N	2631	2631	2631	2631	2631	2631	2109	2109	2109	2109
R-Squared	0.430	0.426	0.252	0.246	0.346	0.346	0.178	0.177	0.227	0.231
Economic significance	0.202	0.184	0.173	0.148	0.045	0.045	0.045	0.032	0.084	0.110
Firms	349	349	349	349	349	349	297	297	297	297

Table VIII: Entrenchment

Panel A reports results from pooled regressions of compensation, beta, and volatility on measures of governance, analyst coverage, and institutional ownership, including fully interacted year, sub-industry, and size controls. Each cell is a separate regression from the dependent variable indicated in the column header on the independent variable indicated in the row label including year, sub-industry, and size effects, as well as full interactions of all three. Within each cell, the first line reports the point estimate, the second line reports the t-statistic, the third line reports the number of observations / firms, while the fourth line reports the economic significance of the coefficient. Panel B reports results from a multiple regression of compensation and ownership as dependent variables with risk, governance, analyst coverage, and institutional ownership as independent variables. T-statistics are reported in brackets. Standard errors are clustered at the firm level in both panels. */**/*** indicate statistical significance at the 10, 5, and 1% levels, respectively.

Panel A: Governance Regressions

	Compensation, *t*	**Beta, *t***	**Volatility, *t***
G index, *t-1*	0.013	0.002	-0.000
	[0.82]	[0.30]	[-0.10]
	1644 / 264	1644 / 264	1644 / 264
	0.055	0.000	0.000
E index, *t-1*	-0.007	-0.013	-0.003
	[-0.22]	[-1.01]	[-0.87]
	1644 / 264	1644 / 264	1644 / 264
	0.000	0.000	0.000
Independent directors %, *t-1*	0.304	-0.127	-0.049
	[1.11]	[-1.45]	[-1.54]
	1195 / 221	1195 / 221	1195 / 221
	0.077	0.077	0.084
Analyst coverage, *t-1*	0.197	0.040	0.025
	[1.82]*	[1.27]	[2.45]**
	2449 / 343	2449 / 343	2449 / 343
	0.145	0.055	0.118
Institutional ownership, *t-1*	1.071	0.406	0.098
	[4.80]***	[5.45]***	[3.93]***
	2480 / 348	2480 / 348	2480 / 348
	0.295	0.224	0.184

Table VIII, Continued

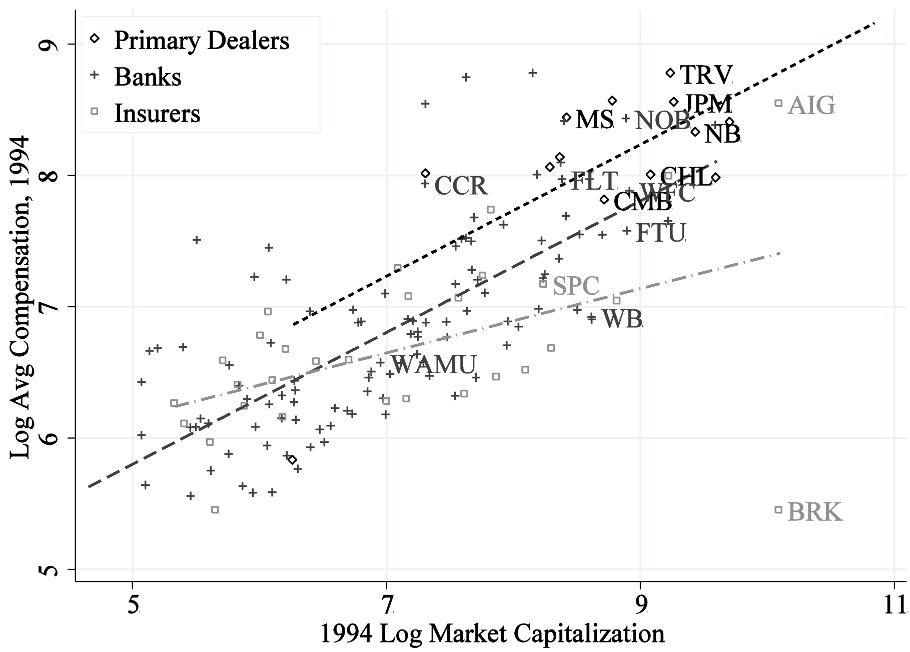
Panel B: Multiple Governance Measures

Dependent Variable:	Compensation, *t*				Ownership, *t*			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Beta, *t-1*	0.639				0.008			
	[5.03]***				[0.68]			
Volatility, *t-1*		1.510				0.069		
		[3.28]***				[1.92]*		
Origin Beta			0.176				0.025	
			[1.54]				[1.64]	
Origin Volatility				0.650				0.055
				[2.19]**				[1.72]*
G index, *t-1*	0.006	0.007	0.008	0.013	-0.003	-0.003	-0.003	-0.002
	[0.48]	[0.52]	[0.39]	[0.65]	[-2.22]**	[-2.27]**	[-1.58]	[-1.34]
Independent directors %, *t-1*	0.205	0.180	-0.284	-0.216	-0.108	-0.105	-0.111	-0.111
	[0.94]	[0.81]	[-1.16]	[-0.77]	[-3.83]***	[-3.73]***	[-3.77]***	[-3.27]***
Analyst coverage, *t-1*	0.013	0.012	0.021	0.020	-0.002	-0.002	-0.001	-0.001
	[1.71]*	[1.58]	[2.03]**	[1.98]**	[-2.29]**	[-2.41]**	[-0.70]	[-0.83]
Institutional ownership, *t-1*	0.720	0.773	0.425	0.428	-0.024	-0.030	-0.057	-0.047
	[3.37]***	[3.54]***	[1.81]*	[1.90]*	[-0.80]	[-1.01]	[-1.17]	[-1.08]
Constant	2.057	2.634	4.771	4.263	0.246	0.232	0.323	0.280
	[3.08]***	[4.07]***	[6.33]***	[5.33]***	[3.57]***	[3.45]***	[3.42]***	[2.86]***
Year, Sub-Ind, Size t Effects	Y	Y	Y	Y	Y	Y	Y	Y
Full interactions	Y	Y	Y	Y	Y	Y	Y	Y
N	1046	1046	635	635	1046	1046	635	635
R-Squared	0.715	0.705	0.712	0.713	0.236	0.243	0.254	0.244
Economic significance, risk	0.276	0.210	0.114	0.134	0.032	0.095	0.161	0.114
Firms	201	201	137	137	201	201	137	137

Figure 1: Residual Compensation

The figure plots the log of average executive compensation on the vertical axis against log market capitalization on the horizontal axis, and overlays a linear fit for each finance sub-industry. Panel A plots this relationship for 1994 and Panel B plots this relationship for 2000. Slopes and intercepts are calculated using a model where all three groups (primary dealers, banks, insurers) have their own intercepts and insurers have a distinct slope from banks and primary dealers. The short-dashed line represents the fitted line for primary dealers, the long-dashed line represents the fitted line for banks, and the dash-dotted line represents the fitted line for insurers. Tickers significant to the crisis are labeled.

Panel A



Panel B

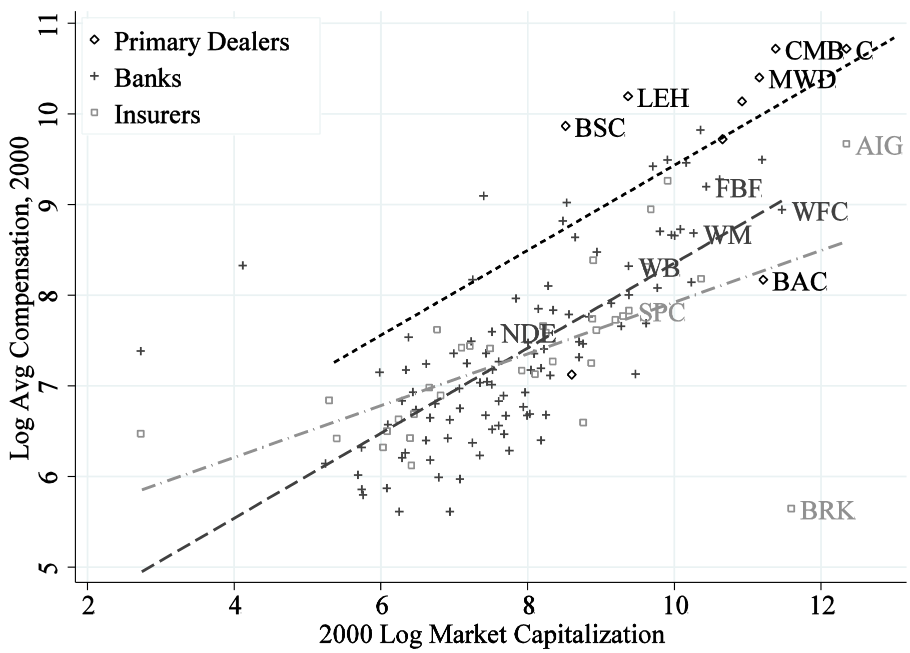


Figure 2: Compensation Persistence

This figure plots average residual compensation in year *t+1* across deciles of residual compensation in year *t*. Within each decile, the first bar is an unconditional sort. The second and third bars are values from a two-way independent sort on residual compensation and CEO turnover in year *t*. The fourth and fifth bars are values from a two-way independent sort on residual compensation and excess returns in year *t*. Values for this table are reported in the Internet Appendix.

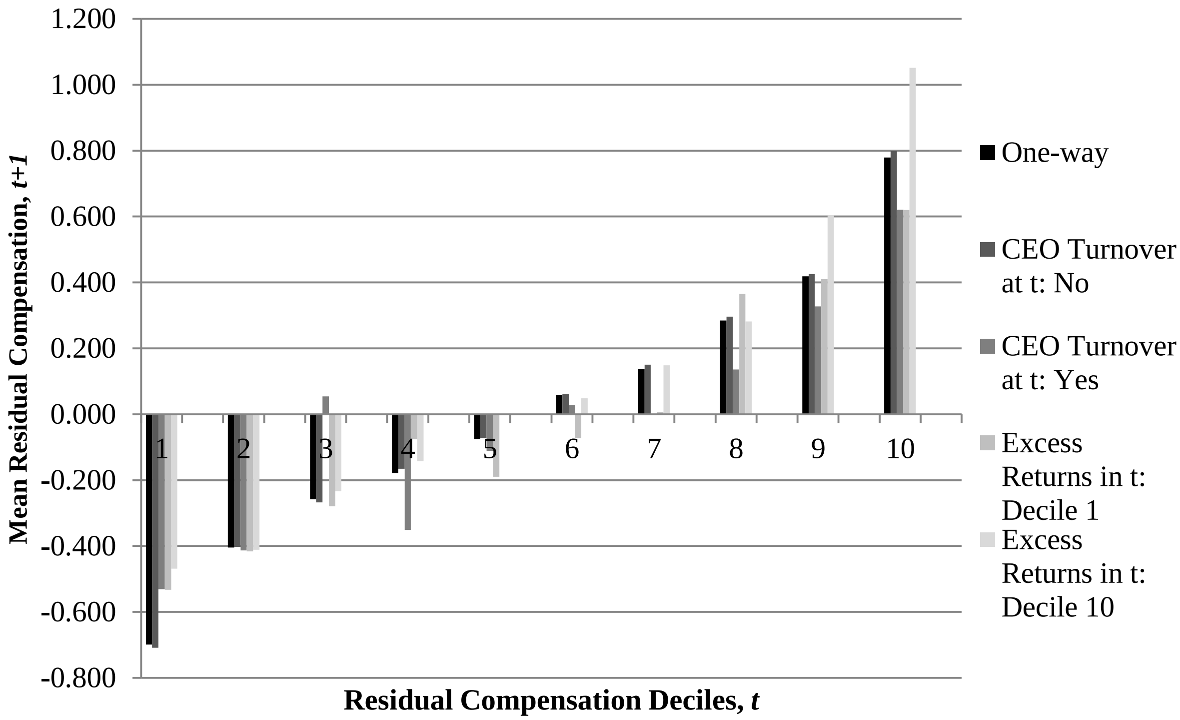


Figure 3: Risk Persistence

This figure plots the average risk residual in year *t+1* across deciles of risk residuals in year *t*. Values for this figure are reported in the Internet Appendix.

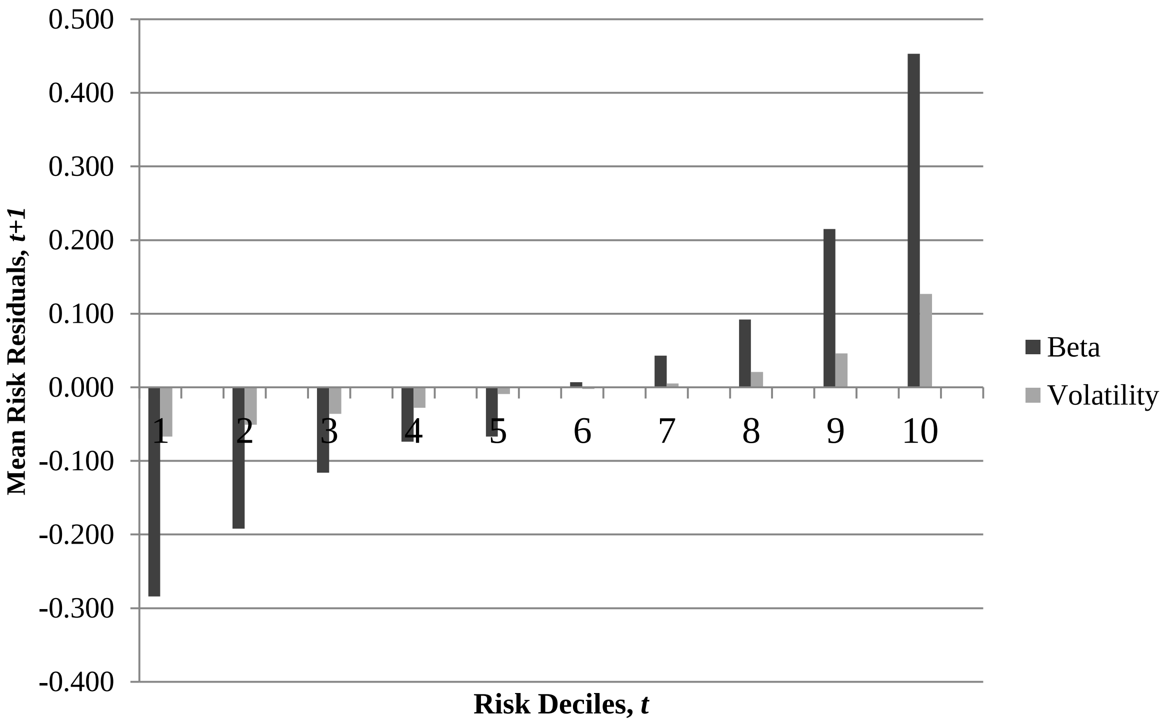
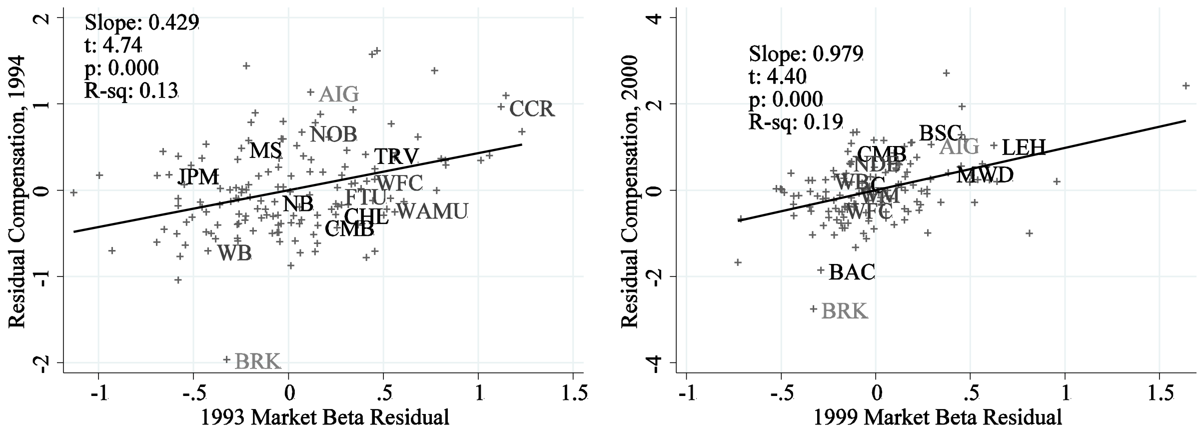


Figure 4: Compensation and Risk

This figure plots residual compensation on the vertical axis against measures of risk on the horizontal axis for two sample years, 1994 and 2000. Panel A plots residual compensation on the vertical axis against lagged beta (residualized against time-*t* fully-interacted size and industry effects) on the horizontal axis for two sample years, 1994 and 2000, while Panel B plots the same but with lagged return volatility (similarly residualized) on the horizontal axis. T-statistics are calculated using HC3-robust standard errors with an adjustment to account for the degrees of freedom absorbed by computing residuals. Tickers significant to the crisis are labeled.

Panel A



Panel B

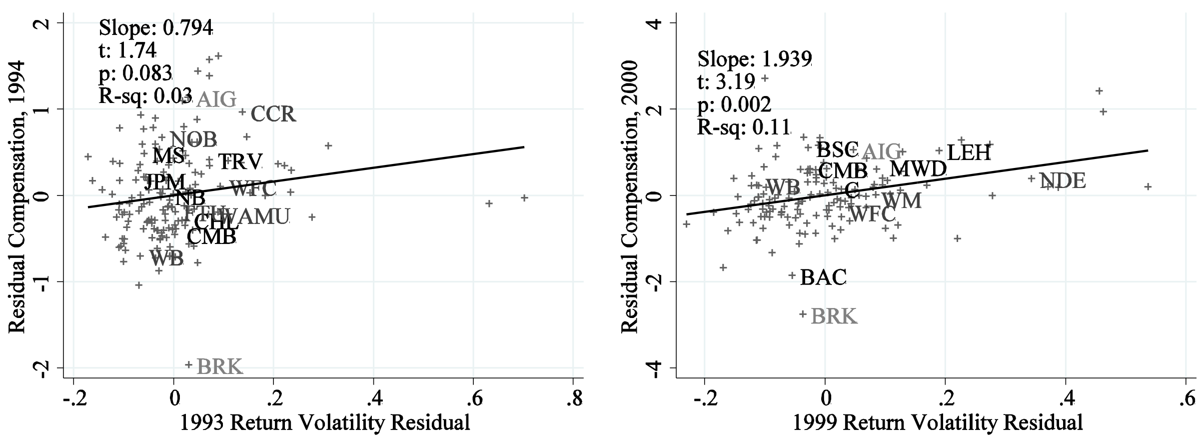
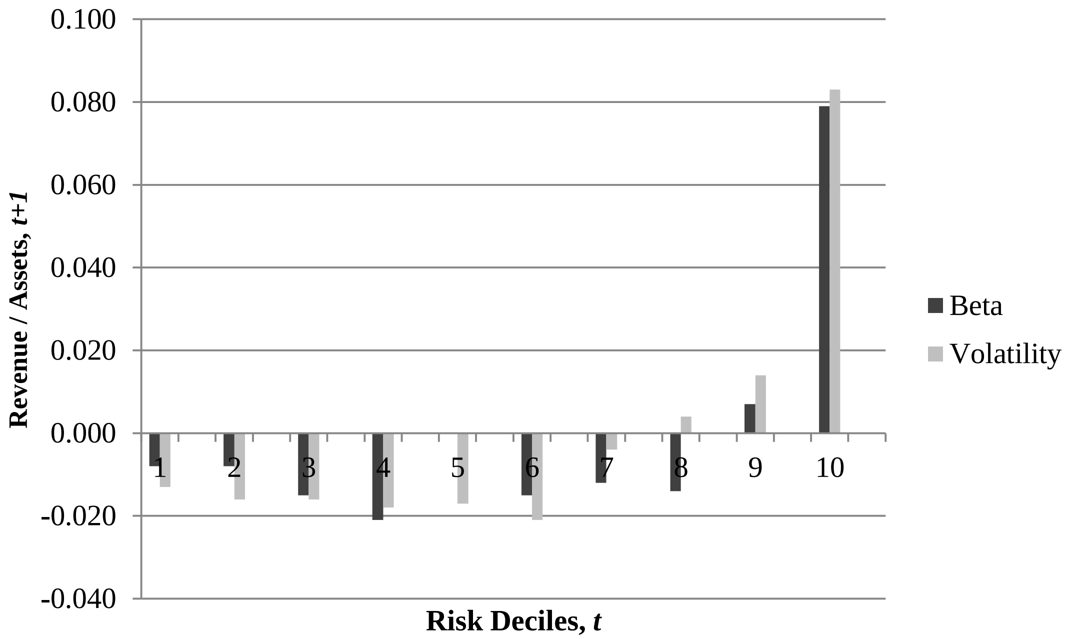


Figure 5: Risk and Productivity

Panel A plots the average asset turnover residual in year *t+1* across deciles of risk residuals in year *t*. Panel B plots the average TFP percentile ranking (minus 50) in year *t+1* across the same deciles. Values for both panels are reported in the Internet Appendix.

Panel A: Revenue / Assets



Panel B: TFP Percentile Rankings

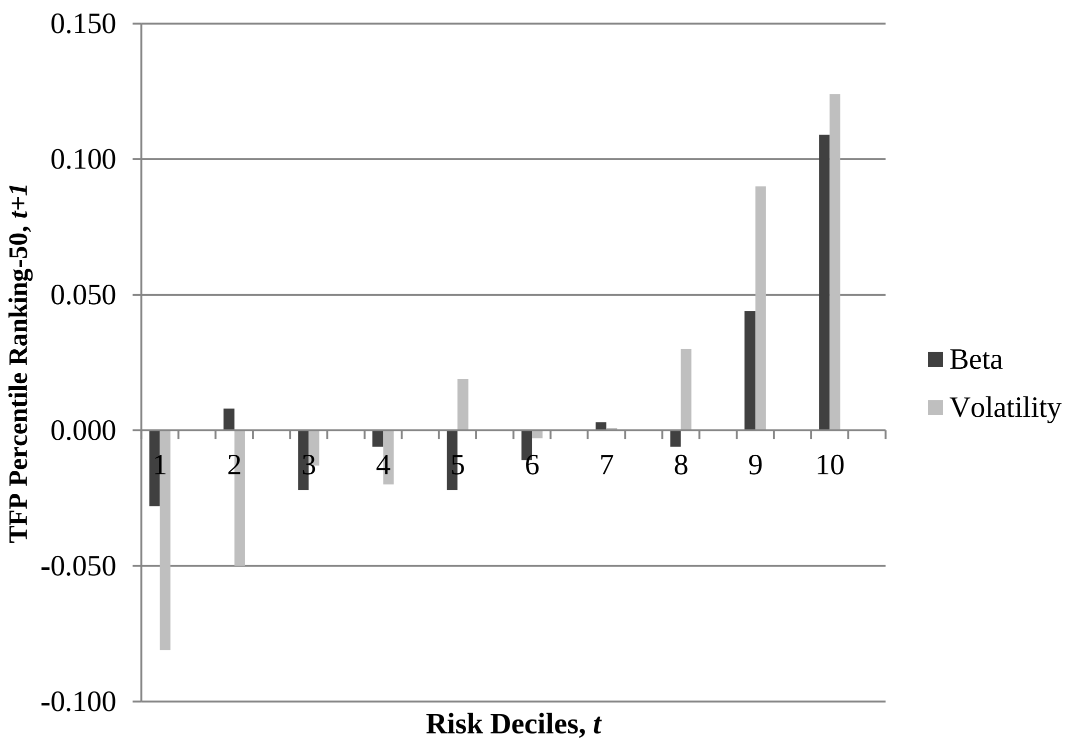


Figure 6: Compensation and Buy-and-Hold Returns

This figure plots residual compensation on the vertical axis against ex post return outcomes on the horizontal axis, where we condense our panel into two periods as described in the text. The left-hand panel shows the results for the early period and the right-hand panel shows the results for the late period. Each variable is a residual adjusted for size and industry. T-statistics are calculated using HC3-robust standard errors with an adjustment to account for the degrees of freedom absorbed by computing residuals. Tickers significant to the crisis are labeled.