Incentive Pay and Bank Risk-Taking:
Evidence from Austrian, German, and Swiss Banks

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Abstract

We use payroll data on 1.2 million bank employee years in the Austrian, German, and Swiss banking sector to identify incentive pay in the critical banking segments of treasury/capital market management and investment banking for 66 banks. We document an economically significant correlation of incentive pay with both the level and volatility of bank trading income—particularly for the pre-crisis period 2003–7 for which incentive pay was strongest. This result is robust if we instrument the bonus share in the capital markets divisions with the strength of incentive pay in unrelated bank divisions like retail banking. Moreover, pre-crisis incentive pay appears too strong for an optimal trade-off between trading income and risk which maximizes the NPV of trading income.

JEL Classification: G20, G21, D22
Keywords: Trading Income, Bank Risk, Incentive Pay, Bonus Payments

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1 Introduction

In 2013 the European Parliament proposed new EU-wide legislation on bank bonuses. Likewise, executive pay was scrutinized in the U.S. in the post-crisis years (e.g. the Say-on-Pay rule included in the 2010 Dodd-Frank Act). Large bonus payments for employees in the banks' financial market divisions were allegedly responsible for excessive risk taking. Limits on bonus payments were justified as a way to curb risk-taking incentives (e.g. Dunning, 2010).

Yet there is only scarce empirical evidence about the nexus between the proportion of performance contingent pay and the amount of risk taking in financial institutions. One obstacle to such an analysis is the lack of information about the bank's internal incentive and bonus systems. Reporting requirements are typically limited only to the CEO and board members who may neither earn the highest bonuses nor make the most pertinent risk choices. This paper exploits a large payroll data set on 1.2 million bank employee years to extract incentive pay measures for 66 banks in Austria, Germany, and Switzerland in the period 2004–11. In particular, we are able to measure performance contingent pay in the most critical bank segments of *Investment Banking* and *Treasury/Capital Markets* at all levels of the bank hierarchy.

Our analysis pursues four objectives. First, we document the importance of bonus payments across bank functions and hierarchies in the Austrian, German, and Swiss banking systems for the period 2004–11. We show that the *Bonus Share* defined as the average bonus relative to the total salary decreased by roughly 20% across bank functions in the crisis period 2008–11 relative to the pre-crisis period 2004–7. The decrease is much stronger at approximately 40% for the employees in the *Investment Banking* and *Treasury/Capital Market* segments, even though overall trading income did not decrease during the crisis period 2008–11.

Second, we document the robust correlation of pay incentives with the bank's trading income and its volatility. On average, trading income in our sample amounts to 9% of the gross interest income of a bank and shows a systematic correlation with both the equally and hierarchy-weighted strengths of bonus payments in a bank. This positive correlation is particularly pronounced in the pre-crisis period and extends to the volatility of trading income. By averaging our pay incentive measure over a four-year period we attempt to mitigate concerns for reverse causality whereby favorable trading profit realizations generate higher pay-outs of performance-contingent contracts. Nevertheless, averaging the incentive pay by itself is unlikely to solve the endogeneity problem completely.

A third contribution consists in a causal analysis for which we propose two instruments: If banks vary exogenously in the degree to which they feature an "incentive culture", we can use the bonus share in other bank segments, like retail banking or corporate banking, as proxies for pay incentives in the bank's capital market segment. To further validate this instrument, we show that the bonus share in these functionally unrelated bank segments shows no significant intertemporal correlation with *annual* trading income, which suggests that bank bonus pools are indeed segment-specific. A second instrument consists in the share of employment outside the capital market divisions relative to total employment. A bank with a large retail, private, and corporate banking segment might monitor its traders with a different intensity than banks whose core business is investment banking. Previous research has found weaker bank governance to be related to higher incentive pay (Fahlenbrach, 2009) and bank risk (Hau and Thum, 2009). Our two instruments show a strong first stage correlation with the bonus share of a bank's capital market employees. The instrumental variable regressions generally produce larger coefficients for the role of incentive pay than the corresponding OLS regressions—suggesting that high incentive pay causes both a high level and a high volatility of trading income.

In a fourth step we analyze the trade-off between trading income and its volatility. It is straightforward to show that, if trading revenue is generated mostly through self-financing trading strategies without net capital requirements, the net present value (NPV) maximization of the risk-adjusted cash flow of trading is equivalent to the maximization of its Sharpe ratio. From the perspective of NPV (or asset value) maximization, the optimal incentive pay for a bank's trading operation should maximize the Sharpe ratio of trading income, defined as the ratio of trading returns and their standard deviation.

Our regression analysis suggests that bonuses paid to traders did not maximize the Sharpe ratio of trading income in the pre-crisis period. Instead, large bonus payments seem to have incentivized risk-taking that was excessive from the perspective of NPV maximization. Limited liability of shareholders in combination with high bank leverage can rationalize this finding whereby incentive pay aligns employee interests with that of shareholders in pursuit of equity value rather than bank asset value maximization. Yet we cannot exclude that risk-taking incentives in some banks may have been excessive even from a shareholder perspective.

For the crisis period 2008-11 we find that high-powered incentives are no longer associated with a lower Sharpe ratio of trading income. The moderation of incentive pay following external political pressure after 2008 may have contributed to a better value maximization of bank assets. If pay moderation increased the value of bank assets, it should have served the public interest even more so, assuming negative risk externalities under public bank guarantees.

A limitation of the analysis is that we cannot observe the exact type of speculative activity a bank engages in and compare risk-taking across a specific trading activity. We cannot exclude the possibility that banks sort into heterogeneous types of trading activity that might require different optimal incentive pay structures. Yet if such specialization across different capital market activities underlies the observed correlation between trading income (and its volatility) and incentive pay, it is unclear why our instruments of "incentive culture" in non-capital market segments should correlate strongly with such a specialization. While a more conditional analysis of bank risk-taking is certainly desirable, better microeconomic data on the speculative activity within each bank is needed to undertake it. Unfortunately, the very limited public reporting requirements of the banks in our sample do not allow such an analysis of individual bank asset positions.

The discussion of the literature in the next section and the tested hypotheses in Section 3 are followed by a description of the data in Section 4. Section 5 explores the structure of incentive pay at employee level and aggregate bank level. Section 6 begins by characterizing the correlation between pay incentives and the level and volatility of trading income. This is followed by instrumental variable regressions about the causal link, and an estimation of the marginal effect of incentive pay on the Sharpe ratio of trading income. Section 7 concludes.

2 Literature

The 2007-8 financial crisis has ignited a political debate about what is often termed “excessive” bank compensation practices. In Europe this has even resulted in EU-wide legislation to cap the bonus pay of bank executives (European Parliament, 2013, page 201). A popular referendum in Switzerland has tried to cap the highest executive pay package at 12 times the lowest salary (Federal Assembly, 2013).[1] Financial sector pay has become a particular focus of public discontent, because a substantial increase in compensation in the financial industry can be observed in the run-up to the recent crisis (e.g. Philippon and Reshef, 2012, for the U.S. banking industry). Moreover, Bell and Van Reenen (2010) document that about 60% of the increase in pre-crisis extreme wage inequalities in the U.K. was due to the financial sector.

The political debate is related to a broader academic dispute about the determinants of executive pay in general, with two opposing views. A technological explanation in defense of high remuneration focuses on changes in the marginal productivity of corporate leadership in a competitive labor market for executives (Gabaix and Landier, 2006). This view is supported by new cross-sectional evidence of CEO sorting by ability, pay, and firm size in Sweden (Adams, Keloharju and Knüpfer, 2014). Philippon and Reshef (2012) argue that increased wages in the financial industry may simply reflect changes in the working environment including an increase in skill intensity, job complexity, and earning risks. Recent theoretical research focuses on the competition for talented workers as a key factor of high salaries in the financial industry (Célérier and Vallée, 2013). Bannier et al. (2013) suggest that bonus payments are increasing in the intensity of competition for managerial talent. Moreover, companies seem to raise their executives' pay after losing executives to other firms (Gao et al., 2014). An opposing view relates executive pay to corporate governance problems and the weakness of shareholder rights. Hakenes and Schnabel (2014) suggest that bail-out expectations may induce steeper incentive schemes, whereas bonus schemes become flatter if problems of effort arise. While excessive risk-taking may only manifest itself in the long run, short-run cash payouts can be enormous and performance measures may not properly account for long-term risks. The pay of bank executives in particular seems to have largely over-compensated top managers for what turned out to be disastrous long-run equity returns (Bebchuk et al., 2010; Bhagat and Bolton, 2014).

The issue of optimal incentive pay is particularly relevant for banks because of their high leverage. Given bankruptcy costs or public guarantees for too-big-to-fail banks, even an incentive contract that is optimal from the shareholder perspective (by maximizing the bank equity value) may not maximize a bank's total asset value and thus imply excessive risk-taking from a welfare perspective (Bolton et al., 2014). While higher bank capital requirements appear to be

[1] The proposition to curb executive pay was rejected by two-thirds of the voters.

the first-best regulatory intervention (Admati et al., 2010), restrictions on bankers' equity pay component have also been considered as a means of dealing with limited liability externalities (Thanassoulis, 2012, Acharya et al., 2013, Bannier et al., 2013).

Much of the U.S. literature has focused on equity compensation for CEOs and executive board members, which generally implies a strong alignment of shareholder and executive interests. Bankers' pay outside the U.S. and the U.K., and for lower-ranked employees relies much more on performance-contingent bonus payments. These may feature pay-off functions of either higher or lower convexity than shareholder equity. In both cases, risk-taking incentives may be larger than is optimal for the maximization of bank asset value. Generally, the public interest should coincide with the objective of bank value maximization if a functioning bank resolution system can avoid public subsidies through effective creditor bail-ins.

Some research has also highlighted the role of governance frictions for a bank's incentive culture. Fahlenbrach (2009) shows that banks with weak corporate governance structures tend to allow contracts with larger pay-for-performance components. Yet, weak governance could also influence the quality of risk managements and thus impact bank risk taking and crisis performance more directly. The nexus between weak bank governance and losses during the financial crisis is examined by Hau and Thum (2009), who find considerably higher write-downs for German banks with less competent boards.

The empirical literature generally confirms a link between performance-contingent pay and corporate risk. DeYoung et al. (2013) find larger systematic and idiosyncratic risk for corporations with more performance-sensitive CEO compensation and Hagendorff and Vallascas (2011) show that they are more likely to engage in risk-inducing mergers. The evidence of correlation may reflect a causal link between incentive pay and risk-taking or alternatively follow from optimal contracts that stipulate more high-powered incentives in a high-risk environment. Evidence of this correlation is also available for the financial sector: Cheng et al. (2010) show that total executive compensation is positively correlated with pre-crisis subprime market exposure; Chesney et al. (2012) document that the pre-crisis incentive structures of CEOs of U.S. financial institutions significantly affected bank write-downs during the crisis. Fahlenbrach and Stulz (2011) point out that stronger equity incentives for the CEO before the crisis are (weakly) associated with worse performance during the crisis. At the very least, more high-powered equity incentives for CEOs do not seem to correlate with better management of downside risks.

Most of the literature has focused on CEO and board compensation in U.S. companies. Yet, it is far from clear that most risk choices in the financial sector are made by top executives. Empirical evidence for non-financial industries suggests that non-executive incentives matter for corporate outcomes (Oyer, 1998; Bova et al., 2013; Gill et al., 2013; Larkin, 2014). Non-executive incentives may matter even more in finance where success is predicated upon information asymmetries. Acharya et al. (2014) show that higher non-executive compensation elasticities are associated with higher subsequent bank risk and lower subsequent bank value. Bogaard and Svejnar (2013) examine the link between incentive pay and productivity in a Central-East European bank. They find a positive correlation between differentiated incentive pay and productivity, although the evidence for the quality of sales is mixed. Two special financial functions have received extensive research about the link between incentive pay and risk-taking, namely bank loan officers and fund managers. The introduction of volume-based pay for loan officers is found to be associated with higher output and default rates (Agarwal and Wang, 2009; Agarwal and Ben-David, 2013). Tzioumis and Gee (2013) reveal that non-linear incentive designs for lower-level employees influence their actions, with adverse effects on organizational efficiency. On the other hand, Cole et al. (2011) point out that loan officers facing high-powered incentives are more likely to outperform statistical credit-scoring models. Empirical evidence on fund performance suggests that higher incentives correlate with riskier investment strategies (Massa and Patgiri, 2009) as well as with superior performance (Agarwal et al., 2009; Massa and Patgiri, 2009).

3 Hypotheses

This study focuses on the incentives of non-executives in the two bank functions of *Treasury/Capital Markets* and *Investment Banking*. Considerable regulatory effort is exerted to isolate and limit the risk in these two functions from ordinary deposit-taking activity (e.g. Dodd-Frank-Act, Chapter VII; or EU Regulation No. 648/2012). While the trading profits are on average large, they also feature a high degree of volatility. Recurring large losses by "rogue traders" have invited additional public scrutiny of these bank functions and have also triggered new theoretical work on optimal incentives for bank traders (Bijlsma et al., 2012; Glode and Lowery, 2013).[2] Yet, to our knowledge, there has been no empirical examination of the relationship between non-executive incentives in capital market divisions and trading profits.

In a first step, we explore the existence of a positive relationship between high-powered incentives and the level of bank trading income and distinguish two possible underlying channels. First, high-powered incentives may be required in a trading environment in which work performance is highly dependent on effort levels. Unlike effort, trading income can be measured and serve as a contractible outcome for the incentive contract. Second, bank incentive cultures can vary for exogenous reasons related to bank governance, labor market characteristics of the employees or the bank's risk management quality. Any exogenous determinant of a bank's incentive culture should simultaneously influence the bonus shares in other (non-capital market related) bank segments like retail banking, corporate banking and private banking. We can measure the latter and use it as an instrument to capture a bank's incentive culture. We expect to find a positive effect on the average trading income.

Hypothesis 1: Pay incentives and average trading income

a) Bonus payments in the capital market segment correlate positively with higher average trading income.

b) A stronger incentive culture in a bank increases average trading income.

The relationship in part a) between profitability-contingent incentive pay and trading profitability is certainly influenced by reverse causality. High and highly variable trading income will generally raise the measured bonus payments for almost any option-like incentive contract. We seek to exclude (or at least reduce) such reverse causality in part b) by instrumenting the *Bonus Share* in the capital market segment with the corresponding bonus share in the non-capital market segments and the relative size of the non-capital market segments in the same bank (see Section 6.3).

[2] For example, the French bank Société Générale lost approximately €4.8 billion through the gambling of one of their traders in 2008. Three years later, the Swiss bank UBS similarly lost approximately CHF 1.7 billion.

In a second step, we explore the existence of a positive relationship between high-powered incentives and the volatility of bank trading income.

Hypothesis 2: Pay incentives and volatility of trading income

a) Bonus payments in the capital market segment correlate positively with a higher volatility of trading income.

b) A stronger incentive culture in a bank increases the volatility of trading income.

Optimal contracting in a high-risk trading environment might necessitate higher pay incentives to ensure that employees stay vigilant and curb the risk to the corporation. This explanation is consistent with a positive correlation predicted in part a). Alternatively, the incentive culture of a bank (proxied by the bank's *Bonus Share* outside the capital market segment) may exogenously influence if traders face high pay incentives. Those may entice traders to increase profitability not (or not only) by higher effort levels, but also by taking more risky positions, which are, on average, compensated by higher expected returns.

In a third step, we evaluate the trade-off between trading income and its volatility and explore whether incentives are excessive, in the sense that they tilt investment choices toward more risk and higher expected returns without increasing the total asset value of the bank. In the absence of externalities, value maximization of corporate asset is the socially desirable managerial choice. Let K denote the capital needed to finance the banks' trading infrastructure, which can generate (without leverage) an expected annual trading income $E(\Pi)$ growing at rate g, and a standard deviation of return on investment $\sigma_\Pi = SD(\Pi/K)$. The net present value of the trading business follows as

$$V_\Pi = \frac{E(\Pi)}{r_0 - g + \rho\frac{\sigma_\Pi}{\sigma_M}r_M}, \tag{1}$$

where r_0 and r_M denote the risk-free rate and the market premium, respectively; σ_M represents the standard deviation of market returns; and ρ characterizes the correlation between trading returns and market returns.

Writing the risk equity premium in equation (1) in terms of the return variance σ_Π illustrates that the firm value is proportional to the *Sharpe Ratio* $E(\Pi)/(K\sigma_\Pi)$ or trading income whenever the growth rate of expected trading income equals the risk free rates, hence $r_0 - g = 0$. But even if we do not want to assume $r_0 = g$, we can argue that trading operations are special compared to other corporate activity in the sense that both their expected income $E(\Pi)$ and the volatility of that income $K\sigma_\Pi$ are exceptionally large compared to either invested capital or labor costs. According to the U.S. Commerce Department, the average ratio of annual corporate income to total employment compensation for all U.S. firms has increased from 14% in 2000 to 23% in 2011.[3] Yet, the banks in our sample generate a median trading income of 119% of total employee compensation in the respective trading division. The variability of trading income relative to total compensation is also extremely volatile across years and banks.[4] Similar to most service sector activities, the physical capital required for trading operations is even more negligible than labor costs. A bank's trading position itself is generally highly leveraged: Under normal pre-crisis conditions, a dealer bank might have financed trading positions mostly with overnight repos with an average haircut of under 2%, thus allowing an effective leverage ratio of at least 50 (Duffie, 2011, page 32).

It is straightforward to show that under conditions of leverage, value maximization for the trading operation becomes equivalent to maximizing the *Sharpe Ratio* if expected trading income, along with the standard deviation σ_Π, can be scaled by a leverage factor $L \gg 1$ so that $(r_0 - g)/L \approx 0$. Using $E(\Pi^L) = L \times E(\Pi)$ and $\sigma_\Pi^L = L \times \sigma_\Pi$, we obtain

$$V_\Pi = \frac{E(\Pi)}{\frac{r_0 - g}{L} + \frac{\rho r_M}{\sigma_M}\sigma_\Pi} \approx \frac{\sigma_M}{\rho r_M}\frac{E(\Pi)}{\sigma_\Pi} = \lambda \frac{E(\Pi^L)}{SD(\Pi^L)} = \lambda \text{ } \textit{Sharpe Ratio},$$

where we define a constant term $\lambda = K\sigma_M / \rho r_M > 0$.

Value maximization of bank assets calls for pay incentives that maximize the *Sharpe Ratio* of trading income. Yet limited liability of shareholders under excessive bank leverage may imply that shareholders seek value maximization of their equity claim rather than total firm assets.[5] As a consequence, bonus incentives may feature a much larger convexity of payoffs than is socially desirable. Provided that the *Sharpe Ratio* is a concave unimodal function of incentive pay, the optimal incentive contract is characterized by a zero marginal effect of incentive pay

[3] See http://www.politifact.com/corporatewages/.

[4] The trading income relative to total compensation varies from −150% to 1920% for the 10% to the 90% quantile, respectively.

[5] Statements by bank CEOs about maximization of return on equity (rather than return on total assets) hint at this conflict of interest.

on the *Sharpe Ratio*. By contrast, a negative (positive) marginal effect of incentive pay on the Sharpe Ratio signifies excessive (insufficient) pay incentives from the social point of view:

> **Hypothesis 3: Pay incentives and bank asset value maximization**
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> Bonus incentives conflict with bank asset value maximization if the marginal effect of a bonus increase on the *Sharpe Ratio* of trading income is negative.

We highlight that the problem of excessive pay incentives may be exacerbated if banks can socialize the costs of risk-taking. For example, if a bank acquires a too-big-to-fail status and/or private bank resolution fails because of political constraints, the bank may promise larger bonuses to traders to influence their risk choices.[6] Therefore, in cases in which incentive pay appears excessive from point of view of bank asset value maximization, it is very likely to be also excessive from a welfare perspective. If the marginal effect of incentive pay on the Sharpe Ratio is negative, bonus moderation should always be in the public interest. We examine the evidence for excessive incentive pay in more detail in Section 6.4.

4 Data

4.1 Compensation Data

This paper draws on a large payroll data set from the financial service sectors of Austria, Germany, and Switzerland. The data were collected by a major international pay consulting firm from human resource departments of more than 120 banks in the three countries. The banks surveyed include most of the largest ones. In the year 2008, for instance, our sample comprises 24 Austrian, 68 German, and 31 Swiss institutions, which represent approximately 30%, 74% and 73% of all bank assets in Austria, Germany, and Switzerland, respectively.[7]

[6] See Bolton et al. (2014). Yet such non-resolvability should not apply to the large majority of banks in our sample.

[7] Our analysis observed strict confidentiality requirements; all employee-level data were analyzed only at the premises of the pay consultant in a secured data room.

The compensation data cover at least 80% of all employees in any bank and record the contractual fixed *Base Salary* as well as the short-term performance-related *Bonus* payment made to each employee. The employee data includes age, employment tenure, bonus eligibility, hierarchy level, and the bank division in which the employee works. Unfortunately, the data lack a unique employee identifier, which would allow us to track the employees from year to year. Each employee is assigned to one of seven hierarchical levels and into either one of six bank segments (*Investment Banking*, *Treasury/Capital Markets*, *Asset Management*, *Corporate Banking*, *Private Banking*, *Retail Banking*) or various bank service functions (e.g. human resources, communication, or IT services).

The original compensation data extend from 2004 to 2011 and cover more than 1.27 million bank employee years. We apply three filters to the raw data. First, we discard 681, 455 observations for employees in bank service functions like IT services, communication, human resources, etc. Second, a further 67, 960 observations were not eligible for bonus payments and are therefore ignored. These restrictions may apply to recently recruited employees in particular. By contrast, employees eligible for bonus payments are retained and their bonus is assumed to be zero if the bonus payment is recorded as missing. Third, we discard 4, 708 extremely low compensation levels with a base salary below €24, 000. These positions correspond to low-paid service functions like contact center employees and are excluded from our analysis. In order to discard data outliers that might be simple reporting errors, we also winsorize the 10 smallest and largest observations for *Age*, *Tenure*, *Base Salary*, and *Bonus*.

Table 1 reports the summary statistics for the retained sample, which covers annual observations (obs.) for Austria (31, 673), Germany (372, 151), and Switzerland (112, 662). Our analysis focuses on the two most critical banking functions from a risk management perspective, namely *Investment Banking* (12, 343 obs.) and *Treasury/Capital Market* (34, 977 obs.). We refer to these as the capital market segments; they generate a bank's trading income. By contrast, the banks' *Asset Management* segments (21, 188 obs.) manage client accounts. Other bank segments of lesser importance for a bank's risk management are *Corporate Banking* (53, 685 obs.), *Private Banking* (75, 547 obs.) and *Retail Banking* (318, 746 obs.); all three feature weaker incentive pay structures.

The yearly *Total Salary* is defined as the sum of *Base Salary* and (cash) *Bonus*. A simple proxy for the strength of incentive pay is the *Bonus Share*, as the ratio between the (end of the year) *Bonus* and the yearly *Total Salary.* The average *Bonus Share* increases from 5% for the lowest *Hierarchy Level 1* to 46% for the highest *Hierarchy Level 7.*

The *Bonus Share* varies considerably across bank segments. In *Retail Banking*, the bonus payment accounts for only 8% of the total salary, whereas the *Bonus Share* is 15% in *Corporate Banking*, 19% in *Private Banking,* and reaches an average of 23%, 23%, and 24% in the segments *Investment Banking, Treasury/Capital Markets* and *Asset Management*, respectively. We also note that the standard deviation of the *Bonus Share* is highest at 20% in the *Investment Banking* and *Treasury/Capital Markets* segments.

Unlike in the U.S., granting stock options to middle and senior bank management is not generally practiced in Austria, Germany, or Switzerland. However, some of the larger listed Swiss banks pay out part of their bonuses in bank shares at a discount. Such stock grants are not part of our *Bonus* statistics, which are defined as the annual, short-term performance-related cash component paid out. We ignore additional equity-based incentives as less than 1% of employees are entitled to pay in the form of equity shares.

During the 2007–8 financial crisis, banks faced considerable public criticism about their incentive systems. Large bonus payments in particular came under political attack. Figure 1 plots the *Bonus Share* for all 47,320 employee-year observations in the two capital market segments (i.e. *Investment Banking* and *Treasury/Capital Markets*) as a function of the *Base Salary* on a log scale. Observations for the pre-crisis years 2004–7 are plotted in blue and crisis (or post-crisis) observations in red. Two observations follow directly from visual inspection. First, the dispersion of the *Bonus Share* along with the average bonus share increases (almost linearly) in the (log) *Base Salary.* Second, two quadratic functions fitted to pre-crisis and crisis observations, respectively, show a roughly 40% lower slope for the latter period. The *Bonus Share* diminishes for all bank employees in the capital market segments in similar proportions, which amounts to a much larger total salary loss for employees with a high base salary. The 2007–8 financial crisis brought about a substantial adjustment of incentive pay in the capital market segments of banking.

Table 2, Panel A, reports aggregate statistics for capital market segments and tests for differences between the pre-crisis years 2004–7 and the crisis years 2008–11. The average *Base*

Salary increased by €8,109 or 22%, whereas the average *Bonus* decreased by €33,961 or 50%. These changes are statistically highly significant and justify a separate analysis of the nexus between incentive pay and risk-taking focused on the pre-crisis period. It is interesting to highlight that the substantial decrease in the *Bonus Share* did not occur against a decrease in trading income. Table 2, Panel B, compares the (log of the) average trading income for the pre-crisis period with the crisis years and Figure 2 provides the corresponding graphical representation. Average trading income did not decrease in spite of the drastic reduction in *Bonus Share*. This suggests, that the incentive pay moderation in *Investment Banking* and *Treasury/Capital Market* segments occurred mostly under external political pressure. In the following section, we discuss the trading income data in more detail.

4.2 Bank Trading Income and its Volatility

In this paper we focus on *Trading Income* as a function of a bank's incentive pay structure. The capital market activity of a bank provides numerous trade-offs between risk and return—hence trading income and its variability amount to a proxy of bank risk-taking in financial markets. Our initial bank sample is extracted from Bankscope and includes all reporting Austrian, German, and Swiss banks with total assets above €300 million in the year 2008. The Bankscope sample covers a slightly larger period than our payroll data set and also includes the year 2003. The sample overlap comprises 66 banks that report compensation data and annual relative trading income for at least one year in 2003–11. Table 3 provides the summary statistics on this bank sample. The relative trading income is available for a total of 365 bank years. The bank size ranges from approximately €400 million for the smallest bank to more than €1.5 trillion for the largest with an average size of €101 billion in bank assets.[8]

Trading income can be expected to increase in the scale of the financial market activity of a bank. We use the *Gross Interest Income* as denominator for *Trading Income*.[9] In the absence of any own account trading, *Trading Income* as a percentage of *Gross Interest Income* should be

[8] Reported extreme asset values here are rounded in order not to disclose the identity of the banks in our sample.

[9] The banks in our sample follow different accounting standards, which makes total bank assets a problematic denominator for comparison. The income-orientated normalization based on gross interest income should be a better procedure for scaling *Trading Income* and is applied in other recent studies (Moshirian et al., 2011).

zero. *Trading Income* is on average positive for the 365 bank-year observations in our sample, with a mean of 8.59% of *Gross Interest Income*. *Relative Trading Income* is also highly volatile, with a standard deviation of 20.96. The ratio is highly positively skewed, which suggests that a logarithmic transformation should offer better small-sample properties in a linear model that relates relative trading profits to pay incentives. We therefore define the dependent variable *Log Relative Trading Income* as the (natural) log of (*Relative Trading Income* + d), where the parameter $d = 18.24$ is chosen to reduce the skewness of the relative income ratio to zero. Table 2, Panel B, reports the test statistics for a comparison of *Log Relative Trading Income* across the pre-crisis and crisis period. The 179 yearly observations of the crisis period suggest a slightly higher average log trading income at 3.14 compared to 3.11 for 186 observations in the pre-crisis period, but the difference is statistically insignificant.

The volatility of *Trading Income* relative to *Gross Interest Income* is calculated as the standard deviation of *Relative Trading Income* over the pre-crisis period (2003–7) and the crisis period (2008–11), respectively. Any value computed on the basis of fewer than three observations is set to missing. Positive skewness of the standard deviation of relative trading income again suggests a logarithmic transformation. We thus define the *Log Standard Deviation (SD) of Relative Trading Income* as the natural logarithm of (standard deviation of *Relative Trading Income* + d), where a parameter $d = 0.05$ implies a logarithmic transformation to a zero skewness of the volatility measure.

While a higher trading income is desirable from a shareholder perspective, its volatility is clearly undesirable if the corresponding return contains a systematic component. How much systematic risk is embodied in the banks' trading income is difficult to measure because trading income for most banks is reported only at an annual frequency. We can nevertheless report a pooled estimate of 0.404 (0.530) for the correlation ρ between annual relative trading income returns and the German (European) benchmark index DAX (Eurostoxx50). Both point estimates are statistically significantly different from zero and support the assumption that trading income embodies a significant systematic risk component for which shareholders will demand a higher expected return.

5 Incentive Pay Structures

5.1 Incentive Pay at the Employee Level

Before aggregating employee level pay incentives, it is interesting to examine them across bank segments and hierarchy levels. Table 4 reports employee-level regressions for the *Bonus Share* separately for the pre-crisis years 2004–7 and the crisis (and post-crisis) years 2008–11. Columns (1) to (4) use the full sample with observations from all six bank segments, while columns (5) and (6) use only observations from the two capital market segments *Treasury/Capital Market* and *Investment Banking*.

Columns (1) and (2) estimate the relationship between the *Bonus Share* and the *Log Base Salary* for the pre-crisis period 2004–7 and the consecutive crisis years 2008–11. The specification includes the quadratic term *Log Base Salary Squared*, but no fixed effects. Specifications (3) and (4) document the incentive pay structure along fixed effects for each of the six bank segments and along bank hierarchy levels. All fixed effects capture differences in *Asset Management* and *Hierarchy Level 1* as the reference groups without a dummy. Variations of the *Bonus Share* in terms of year of observation, employee age and tenure are captured by additional dummies, not reported. During the pre-crisis period 2004-7 represented in column (3), the *Bonus Share* (relative to *Asset Management*) is more than 7.9% and 7.6% lower in the *Retail Banking* and *Corporate Banking* segments, respectively. By contrast, *Private Banking* and *Investment Banking* show statistically insignificant differences to the incentive pay in *Asset Management.* Only employment in *Treasury/Capital Markets* secured, on average, a 3.4% higher bonus share. The financial crisis changed this ranking. As column (4) shows, *Asset Management* becomes the bank segment with the highest *Bonus Share* for the period 2008–11; *Investment Banking* and *Treasury/Capital Markets* trail behind by a 4.3% and 5% lower *Bonus Share*, respectively. Yet the three latter bank segments preserve a more than 4% higher *Bonus Share* than *Retail Banking* and *Corporate Banking.* Differentiation of the *Bonus Share* is still stronger across hierarchy levels. The hierarchy fixed effects climb from 3% for *Hierarchy Level 3* to 45.7% for *Hierarchy Level 7* in the pre-crisis data. This steep hierarchical structure of incentive pay is flattened for the period 2008–11, in which the top *Hierarchy Level 7* is associated with a *Bonus Share* top-up of (only) 25.6%.

The regressions reported in columns (5) and (6) focus only on employees in the two capital market segments; only observations in *Investment Banking* are marked by a dummy. The specifications include *Log Base Salary* and its squared value as additional control variables. We note that the *Log Base Salary* is a statistically insignificant control for the *Bonus Share* after controlling for the other fixed effects listed in Table 4. A higher *Log Base Salary* translates into a higher bonus (for any given *Bonus Share)*, but not automatically into a higher *Bonus Share* conditional on the other fixed effects. A roughly 2% lower *Bonus Share* for *Investment Banking* employees relative to those in the *Treasury/Capital Markets* segment during the pre-crisis period is confirmed. However, this incentive difference vanishes during the 2008–11 period. Similarly, the average *Bonus Share* top-up associated with the highest *Hierarchy Level 7* diminishes from 14.2% to 11.1% within the reference group of employees in the capital market segment. We also note that the explanatory power of our observed variable drops from an R-squared of 44.2% in the pre-crisis period to only 25.7% for the crisis period. This suggests that incentive pay differentiation not captured by our regressors increased considerably.

5.2 Incentive Pay at the Bank and Bank Segment Level

Most of the empirical literature on bank risk-taking is based on compensation data from board members or CEOs because of the corresponding reporting requirements. Yet in practice, most material risk-taking decisions are likely to be taken at a lower level of the bank hierarchy. The data from compensation surveys used in this paper allow for a much broader measurement of incentive pay using base pay and bonus pay data from all bank hierarchy levels. Our objective is to aggregate the employee data to a sensible measure of risk-taking incentives at the bank level.

The most straightforward approach consists of defining an *Equally-Weighted Bonus Share* and an *Equally-Weighted Base Salary* as

$$EW\ Bonus\ Share(b,T) = \frac{1}{N_{b,T}} \sum_{i \in E(b,T)} Bonus\ Share(i)$$

$$EW\ Base\ Salary(b,T) = \frac{1}{N_{b,T}} \sum_{i \in E(b,T)} Base\ Salary(i),$$

respectively. The terms $Bonus\ Share(i)$ and $Base\ Salary(i)$ denote a survey observation i

from the set $E(b,T)$ of all $N_{b,T}$ bank employee observations in the *Investment Banking* and *Treasury/Capital Market* segments of bank b sampled during one of the two periods T, which represent the four pre-crisis years 2004–7 and the four (post-)crisis years 2008–11. The year-to-year variation in the bank-level bonus share may reflect less the strength of the (ex-ante) incentive system than the favorable realization of bank profits. Defining the bank-level bonus share as the time average over the four consecutive years reduces this reverse causality from bank profitability to the measured bonus share.

A second measure of the bank-level risk incentives may account for the fact that the influence on risk-taking decisions may increase with the hierarchy level of an employee. If we are willing to assume that his/her relative influence on bank risk-taking is proportional to the average hierarchy-specific total salary, we can define hierarchy weights $w(H,T)$ accordingly. For the aggregate weight sum

$$W_{b,T} = \sum_{i \in E(b,T)} w(H(i),T)$$

of all employee observations in the *Investment Banking* and *Treasury/Capital Market* segments of bank b in period T, we can define the *Hierarchy-Weighted Bonus Share* and the *Hierarchy-Weighted Base Salary* as

$$HW\ Bonus\ Share(b,T) = \frac{1}{W_{b,T}} \sum_{i \in E(b,T)} w(H(i),T) \times Bonus\ Share(i)$$

$$HW\ Base\ Salary(b,T) = \frac{1}{W_{b,T}} \sum_{i \in E(b,T)} w(H(i),T) \times Base\ Salary(i),$$

respectively. These latter definitions put more weight on the *Bonus Share* of employees at higher levels of responsibility. The underlying assumption here is that marginal influence on risk choices corresponds to the total salary of the bank employee. The following regressions use the (*EW* or *HW*) *Bonus Shares* averaged over the pre-crisis period 2004–7 and the crisis period 2008–11 as the main variable of interest. As dependent variables we use either the annual (relative) trading income or the volatility of trading income computed as its standard deviation within the two periods. To enlarge the sample by one year, we add information about trading income in 2003.

Figure 3 is a graphical representation of the bonus share in investment banking and capital management for 57 banks, with pre-crisis values on the x-axis and crisis values on the y-axis. The *Equally-Weighted (EW)* and *Hierarchy-Weighted (HW) Bonus Shares* are depicted in Figures 2a and 2b, respectively. Bank-level *Bonus Shares* are predominantly below the 45-degree line for both measures of the bonus share. Yet we find considerable persistence of the bank-level bonus share across both periods with a time correlation of 0.55 (*EW Bonus Share*) and 0.57 (*HW Bonus Share*). Also notable is the wide dispersion of the bank-level bonus share, which ranges from almost zero to a maximum above 60%. The correlation between the *Equally-Weighted* and *Hierarchy-Weighted Bonus Share* is very high at 0.97.

Most of the literature has focused on CEO or board incentives. It is therefore interesting to measure the correlation between the CEO or management board bonus share and the *Equally-Weighted* or *Hierarchy-Weighted Bank Bonus Share*. We use hand-collected data to calculate the average bonus share for a total of 24 bank CEOs and 29 management boards. The correlation of the bonus share of the management board with the *Equally-Weighted* and the *Hierarchy-Weighted Bonus Share* at the bank level is 0.47 and 0.50, respectively. For the CEO bonus share, this correlation drops to only 0.37 and 0.43 for the *Equally-Weighted* and *Hierarchy-Weighted Bonus Share* at the bank level, respectively. Hence, measuring incentive pay exclusively at the level of the management board or CEO does not proxy bank-level risk incentives very well.

5.3 Bank Incentive Culture and its Covariates

What determines the large cross-sectional variation in *Bonus Share* shown in Figure 3? This section discusses some simple hypotheses related to the covariates of a bank's bonus culture. First, we characterize the incentive culture of a bank in terms of the *EW Bonus Share* in the capital market (*Investment Banking* and *Treasury/Capital Markets*) and in non-capital markets segments (*Retail Banking*, *Corporate Banking*, *Private Banking*), respectively. In addition, we define the bank-internal standard deviation of the bonus share across all employees (*STD Bonus Share*) for both the capital market and non-capital market segments. The *STD Bonus Share* captures the differentiation of the bonus payments within a bank segment.

Table 5 reports (below the diagonal) the univariate correlations between these four dimensions of a bank's incentive culture in rows and columns (1) to (4). The number of observations for each correlation are stated in the upper triangle of the matrix and correlations significantly different from zero at the 5% level are reported in bold print. The *EW Bonus Share* in the capital market functions correlates at 0.59 strongly with the *EW Bonus Share* in the non-capital market segments. It also features a strong correlation at 0.53 and 0.60 with the variability of incentive pay across bank employees (*STD Bonus Share*) in the capital and non-capital market segment, respectively. Strong performance related pay therefore transcends bank divisions and correlates with internal differentiation of bonus pay. If bank trading desks engage in similar activities, then theories of optimal contracting are difficult to reconcile with the large observed variation of incentive pay across banks and its strong correlation across different business segments within a bank.

One plausible determinant of incentive pay is bank governance, which we characterized by a *State Bank Dummy* (row 5), by the variables *Financial Experience Supervisory Board* (row 6), *Foreign Experience Supervisory Board* (row 7), *Capital Market Experience Management Board* (row 8), share of directors with *Political Affiliations* on the executive board (row 9) and *Employment Other Segments* (row 10) as the employment share of non-trading divisions relative to total bank employment. Our proxies for *Financial Experience*, *Foreign Experience* and *Capital Market Experience* of the supervisory or management board are based on biographical information and are averaged over all board members as explained in Hau and Thum (2009). Generally, proxies for better governance correlate negatively with the *Bonus Share* in the capital market segment, which mirrors the finding in Fahlenbrach (2009). Missing observations for many banks imply that these correlations are often not statistically significant at the conventional 5% level.

Employee labor market characteristics can also influence the role of incentive pay. Younger and more mobile bank employees (with marketable skills) might command a higher bonus share either to be hired or retained. We therefore measure the *Average Age* (row 11) and *Average Job Tenure* (row 12) of all reported employees in the capital market segment. Both measures show a statistically significant negative correlation with the *EW Bonus Share* at -0.40 and -0.28, respectively.

Ellul and Yerramilli (2013, p. 1763) argue that executive incentive pay and the quality of risk management are complementary if the latter provides a hedge or insurance against excessive risk taking. We measure the influence of risk managers by their average total compensation (*Average Compensation of RM*, row 13) and their average hierarchy level (*Average Hierarchy*

Level of RM, row 14). Both variables should proxy the power of risk managers within the bank and correlate strongly with the role of incentive pay in the capital market division. Thus, we confirm the complementarity of high-powered pay incentives in trading and human capital investment in risk management.

6 Incentive Pay and Trading Income

6.1 Trading Income Levels

In a first step we seek to explore the relationship between incentive pay and the average profitability of a bank's trading operation. The dependent variable is the *Relative Trading Income,* defined as the logarithmic transformation of the ratio of annual *Trading Income* and *Gross Interest Income* in the same year. The independent variables are the bank-level *Bonus Share* and the *Base Salary.* Additional control variables are bank size, measured by *Log Assets,* and the *Net Loans/Asset* ratio as a control for bank structure. Robust standard errors are clustered at the bank level.

Table 6, Panel A, reports the regression results for the *Equally-Weighted (EW) Bonus Share* and the *Equally-Weighted (EW) Base Salary* and Panel B reports the corresponding hierarchy-weighted (HW) pay statistics. Columns (1) to (3) in Table 6 focus on the pre-crisis period 2003–7, while columns (4) and (5) use the full sample of income observations from 2003–11. As the bank-level *Bonus Share* and *Base Salary* might be measured more precisely for banks with a large number of survey observations, we also use weighted ordinary least squares (WOLS) with bank weights equal to the square root of the number of bank observations in a bank's capital market division in any period. This also amounts to giving more weight to large banks with more employees in their capital market divisions.

For the pre-crisis period 2003–7, the OLS regression in Table 6, Panel A, column (1) shows a positive and statistically significant coefficient of 2.028 for the *Equally-Weighted Bonus Share* and a negative coefficient of -1.501 for the *Equally-Weighted Base Salary.* The correlation between the *Relative Trading Income* and the *Bonus Share* is economically significant: A one-standard deviation increase in the *Equally-Weighted Bonus Share* (= 0.14) is associated with an increase in *Relative Trading Income* by more than two-thirds of one standard deviation.[10] The weighted ordinary least squares (WOLS) specification in column (2) shows a very similar coefficient of 1.91, which is also statistically significant—suggesting that the positive correlation between trading profits and pay incentives is as pronounced among larger banks. The coefficient for *Log Assets* in column (1) is statistically significantly negative with a value of -0.103. A bank size increase by one standard deviation (= 1.85) reduces the *Relative Trading Income* by almost 50% of one standard deviation. Thus, *Relative Trading Income* features decreasing economies of scale. Qualitatively similar evidence based on actual trading data is provided by Hau (2001) in a study of own-account trading by German bank dealers. This finding mirrors a negative correlation between fund size and fund performance found in some mutual fund research (Chen *et al.*, 2004).

The random effects specification in column (3) produces very similar point estimates for the coefficients even though the standard errors are slightly higher.

The regression results for the extended period 2003–11 reported in columns (4) and (5) show statistically weaker results for a positive relationship between *Relative Trading Income* and the *Equally-Weighted Bonus Share* in spite of a larger number of observations. However, the relationship remains significant at the 1% level for the weighted OLS regression in column (5). A weaker link may be due to much tighter risk controls during the crisis or diminished pay incentives documented in Section 5.

Table 6, Panel B, repeats the regressions in Panel A for the *Hierarchy-Weighted (HW) Bonus Share* and *Hierarchy-Weighted (HW) Base Salary.* The standard deviation of the *Hierarchy-Weighted Bonus Share* is at 0.16 for the period 2003–7 and approximately 14% higher than the standard deviation of the *Equally-Weighted Bonus Share,* which implies that the smaller coefficient of 1.853 in column (1) implies the same level of economic significance. Overall, the equally weighted and hierarchy-weighted incentive measures give very similar results. This is not surprising, considering their high correlation.

[10] In the pre-crisis period, the standard deviations of *EW Bonus Share* and of (Log) *Relative Trading Income* are 0.14 and 0.40, respectively. Hence: $2.028 \cdot 0.14/0.40 = 0.71 \geq 2/3$.

6.2 Variability of Trading Income

It has long been recognized that high leverage typical of banks in combination with the limited liability of shareholders implies that the latter prefer excessive bank risk (Admati et al. 2010), which no longer maximizes a bank's total asset value but shareholder value. Incentive pay is often regarded as the tool by which shareholders align their interests with those of bank employees. It is therefore interesting to examine the correlation between incentive pay for the *Log SD of Relative Trading Income*. At this stage we do not propose a causal interpretation: More risk-taking might increase the volatility of trading income, but the reverse causality of higher volatility affecting the average *Bonus Share* is also plausible. Without valid instruments for the *Bonus Share*, this section is limited to reporting conditional correlations.

Table 7, Panel A, reports the regression results for the *Equally-Weighted Bonus Share* and Panel B reports the *Hierarchy-Weighted Bonus Share*. For the pre-crisis data, columns (1) and (2) in Panel A feature the OLS and WOLS regressions, respectively. The coefficient for the *Equally-Weighted Bonus Share* is statistically significant at the 1% level in both specifications. The OLS coefficient of 12.235 implies that an increase in the *EW Bonus Share* by one standard deviation (= 0.14) increases the *Log SD of Relative Trading Income* by almost one standard deviation.[11] The *Bonus Share* therefore correlates economically even more strongly with the second moment of trading profitability than with the first. Results for the extended sample period 2003–11 imply much lower point estimates for the *EW Bonus Share* effect for both the OLS and WOLS specification; however, the statistical significance remains at least at the 5% level. A positive fixed effect for the crisis period (*Crisis Dummy*) is statistically significant and indicates that the *Log SD of Relative Trading Income* is higher by about 60% of one standard deviation relative to the pre-crisis years.

In Table 7, Panel B, the *Equally-Weighted Bonus Share* and *Equally-Weighted Base Salary* are replaced by the corresponding hierarchy-weighted measures. The coefficients for the pre-crisis period in columns (1) and (2) are again approximately twice as large as those for the full sample in columns (3) and (4). The statistical significance of the coefficient for the *Bonus Share* is very similar irrespective of whether we aggregate the employee bonus shares with equal or

[11] In the pre-crisis period, the sample standard deviations of *EW Bonus Share* and of (Log) *SD of Relative Trading Income* are 0.14 and 1.70, respectively. Hence: $12.235 \cdot 0.14/1.70 = 1$.

hierarchy weights.

6.3 Instrumental Variable Regression

Performance-contingent incentive contracts for employees should generally imply that trading income influences the *Bonus Share* as well as its variability. By averaging the *Bonus Share* over multiple years for both the equally weighted and hierarchy weighted measure, we are able to greatly attenuate this reverse causality, but it is unlikely to be eliminated. A better means of establishing a causal effect between pay incentives and risk-taking is to take an instrumental variable approach, where we seek variables Z correlated with the *Bonus Share* and the expected (or average) trading income in a period, but uncorrelated with the regression residuals.

A first instrument consists of the bonus share in other bank segments unrelated to bank trading (*EW Bonus Share Other Segments*). A bank might have a general "bonus culture" that extends to all segments of the bank business. In this case the bonus share in *Retail Banking*, *Private Banking* and *Corporate Banking* should be correlated with the bonus share in the *Treasury/Capital Market* and *Investment Banking* segments as shown in Table 5. Evidence that a bank's history might determine its bonus culture is provided by Fields and Fraser (1999), who document that the entry of U.S. commercial banks into investment banking in the late 1980s did not lead to an adjustment of pay-performance sensitivities to a level common among investment banks, but continued to resemble the bonus culture observed in commercial banking.

A second instrument relates to bank structure and governance: If employment in the bank segments unrelated to trading and investment banking is large relative to the capital market segment, then corporate boards might focus more on the non-trading divisions and the capital market division might face less supervision from the executive board and fewer constraints on its bonus share (Fahlenbrach, 2009). We therefore define *Employment Other Segments* as the employment share of non-trading divisions relative to total bank employment.

The first-stage regression, which explains the *EW Bonus Share* as a function of these two instruments and the other control variables, is reported in Table 8, Panel A. Robust standard errors are clustered at the bank level. Both instruments feature a high correlation with the *EW Bonus Share* in the pre-crisis period and in the extended sample period in columns (1)–(2) and (3)–(4), respectively. Ceteris paribus, an increase in the *EW Bonus Share Other Seg-*

ments by one standard deviation (= 0.07) in column (1) increases the *EW Bonus Share* in the *Treasury/Capital Market* and *Investment Banking* segments by 20% relative to its mean. An increase in the *Employment Other Segments* by one standard deviation (= 0.26) increases the *EW Bonus Share* by 12% relative to its mean. The conditional correlation between *Employment Other Segments* and the *EW Bonus Share* is therefore significantly positive even if the unconditional correlation reported in Table 6, row 10, is negative. The F-statistics for the excluded instruments show values ranging from 12.25 to 37.13, which suggests strong instruments.

An additional concern is that high trading profits might still influence bonus payments in non-trading related bank segments, which implies that residuals of the second stage regression cannot be orthogonal to the first instrument. This could be the case if the bonus pool is established at the bank level and not at the bank segment level. To explore this hypothesis, we regress the *Bonus Share Other Segments* onto the bank's *Relative Trading Income* for the same year, together with bank and year fixed effects. The regression coefficient $\widehat{\alpha}$ is small and statistically insignificant at the conventional 5% level. Hence, we find little evidence that year to year variation in trading income correlates with a high bonus share in the non-trading related bank segments, even if the average trading income is expected to be positively influenced by the incentive culture proxied by *EW Bonus Share other Segments.* We can still go one step further and define a filtered instrument called *Filtered Bonus Share Other Segments*, which subtracts the explained variation $\widehat{\alpha}\times$ *Relative Trading Income* from the *Bonus Share Other Segments.* Such a filtered instrument may be preferable as it is more likely to fulfill the exclusion restriction. We then repeat the first-stage regression using the filtered instrument.

In Table 8, Panels B and C present the regressions results using instrumental variables and filtered instrumental variables, respectively. For the pre-crisis period, Panel B column (1) shows a statistically significant point estimate of 3.180 compared to 2.028 for the corresponding OLS coefficient in Table 6, Panel A, column (1). The IV estimates therefore suggest an economically large effect of higher pay incentives on average trading income. An increase of *EW Bonus Share* by one standard deviation (= 0.14) implies an increase in the ratio of trading income relative to interest income by 1.1 standard deviations. The economic effect is even larger (with a coefficient of 3.865) for the weighted IV regression in column (2), which puts more emphasis on the observations for large banks. Using the alternative instrument, *Filtered Bonus Share*

Other Segments, in the instrument set produces very similar results in Panel C. This is not surprising as the filtered and raw instrument are highly correlated at 0.95. As the *EW Bonus Share* is instrumented by two variables simultaneously, we can also test the overidentification restriction. All specifications pass the test. Figure 4(a) illustrates in a scatter plot the positive relationship between the instrumented *EW Bonus Share* and the unexplained component of the *Log Relative Trading Income* after accounting for the other regressors.

The higher IV coefficients for the *EW Bonus Share* suggest that reverse causality biases the OLS coefficients downwards. This should be the case if high trading profits tend to increase the average *EW Base Salary* in the capital market segment over the four year measurement period and thereby increase the denominator of the *EW Bonus Share*. The *EW Base Salary* as a control variable has indeed a negative sign in Tables 6, columns (1)-(3), but its inclusion in the OLS regression should not eliminate the OLS estimation bias unlike the use of the instrument *Bonus Share Other Segments* in Table 8, Panels A and B. The latter variable is scaled by the average base salary in the non-capital market segments, which may not increase if the capital market segment produces high trading incomes.

We can also use the instruments to repeat the regressions for trading income volatility. Results for the corresponding IV regressions are reported in Table 9. Panel A provides the first-stage regression, while Panels B and C report the IV estimates for the raw and filtered instruments, respectively. Again we have strong instruments, as indicated by the F-test for the excluded instruments, which has F-statistics ranging from 11.68 to 28.09.

The IV estimate of 16.871 for the *EW Bonus Share* coefficient in Table 9, Panel B, column (1), is again larger than the corresponding OLS estimate of 12.235 in Table 7, Panel A. The same applies to the weighted IV regression in column (2). This suggests a strong causal effect of higher incentive pay on the volatility of trading income: A coefficient of 16.871 implies that an increase in the *EW Bonus Share* by one standard deviation (= 0.14) increases the *Log Volatility of Relative Trading Income* by 1.4 standard deviations. The IV point estimates obtained for the full period sample (2003–11) in columns (3) and (4) are smaller and statistically significant only at the 5% level. Yet, they are still larger than the corresponding OLS point estimates in Table 7, Panel A, columns (3) and (4). We also note that the overidentification test cannot reject the null hypothesis of valid instruments in any specification. Overall, we find evidence that banks with a general "incentive culture" proxied by the *Bonus Share* in other (non-capital market) segments feature economically and statistically higher volatility in their trading income, particularly in the pre-crisis period. As we dispose of at most two volatility observations (one for each period) per bank; hence Figure 4(b) shows only 74 points illustrating the positive relationship between instrumented *EW Bonus Share* and the unexplained component of the *Log Volatility of Relative Trading Income* after accounting for the other regressors.

As a robustness check, we use the LIML estimator as an alternative to the 2SLS estimator. Yet the results for the point estimates and the standard errors are almost identical to those reported in Tables 8 and 9; hence they are not reported separately. We also note that replacing the second instrument *Employment Other Segments* with the slightly weaker instrument *Average Age Capital Market Segment* (discussed in Section 4.3) produces again qualitatively similar results.

6.4 The Sharpe Ratio of Trading Income

The instrumental variable regressions in the previous section suggest that a higher *Bonus Share* increases both the level and volatility of *Relative Trading Income*. How can we evaluate the trade-off between higher income and higher risk? An incentive pay system should be optimal from a firm-value perspective if it maximizes the (risk-adjusted) present value of future trading income. As we argued in Section 3, NPV maximization under self-financing trading strategies amounts to maximizing the *Sharpe Ratio* of trading income.

While optimal incentive contracts should maximize the *Sharpe Ratio of Trading Income*, it is an empirical issue if marginal incentive pay indeed maximizes the *Sharpe Ratio* and therefore total firm value. The first-order condition implies that the change with respect to the instrumented *Bonus Share* ($\widehat{BS(T)}$) has slope zero for both periods ($T = 2003$–7, 2008-11):

$$E\left[\frac{d\ \mathit{Sharpe\ Ratio}}{d\ \widehat{BS(T)}} \mid X\right] = 0.$$

At the optimum, and conditional on the control variables X, the local average treatment effect (LATE) captured by the coefficient γ_{IV} should be zero—implying that neither an increase nor a decrease of the *Bonus Share* allows for a (locally) larger *Sharpe Ratio*.

We calculate the Sharpe ratio as the ratio of the average *Relative Trading Income* and its standard deviation for each bank and each of the two periods 2003–7 (pre-crisis) and 2008-11 (crisis). The measured Sharpe ratios are then regressed on the *EW Bonus Share,* the interaction term *EW Bonus Share* × *Crisis Dummy,* the *Crisis Dummy* itself, and the other exogenous control variables *EW Base Salary*, *Log Assets*, and *Net Loans/Assets.* As instruments for the *EW Bonus Share* and its interaction term we use a bank's *Bonus Share Other Segments*, and the interaction term *Bonus Share Other Segments* × *Crisis Dummy.* The substantial decrease in incentive pay in the capital market segment during 2008-11 might best be seen as the consequence of external political pressure to reduce bank bonus payments. This interpretation is supported by the fact that (at the bank level) *Relative Trading Income* did not significantly change during the crisis period.

Table 10 reports the first-stage OLS regressions for the two instrumented variables in columns (1) and (2) and the second-stage results in column (3). The F-statistics for the null hypothesis that both first-stage OLS coefficients for the two instruments are zero are 5.65 and 3.20, respectively. The Kleibergen-Paap Wald rk F-statistic is 4.48 and not particularly high. However, it exceeds the critical value 3.95 of the Stock-Yogo (2005) test that the instruments are strong for a maximal size of 20% (with an approximate 5% significance level). At this threshold size, we can therefore reject the weak instrument hypothesis.

In Table 10, column (3), the IV coefficient of −21.404 for *EW Bonus Share* is negative, which implies that banks with a culture of large *Bonus Shares* obtain a lower *Sharpe Ratio of Trading Income.* This is indicative of excessive incentive pay that is not in line with firm value maximization. But we note that the coefficient is estimated with a relative large error and is significant only at the 10% level. Given the low Kleibergen-Paap statistic, the coefficient is likely to be biased towards the OLS coefficient reported in column (4), which is at −2.797 higher (less negative). This suggests that the IV coefficient is likely to be estimated with a positive bias.

The IV coefficient for *EW Bonus Share* × *Crisis Dummy* is positive at 29.472 and implies that the greatly reduced pay incentive system of the crisis period eliminated the negative slope of the Sharpe ratio with respect to incentive pay increases. Comparison with the OLS coefficient of 5.253 in column (4) suggests a downward bias for the IV coefficient. We note that the *Crisis Dummy* is also positive at 7.065 which suggests a further increase in the Sharpe ratio during the crisis period. Reduced incentive pay during the crisis period appears to come closer to the first-order condition for a maximal Sharpe ratio of trading income. Again, the weak statistical significance of the point estimates due to large standard errors implies that these results need to be interpreted with caution.

The results of Table 10 are summarized graphically in the residual plots in Figure 5. The dashed blue line traces out the local average treatment effect on the unexplained variations in the Sharpe ratio for the pre-crisis period (2003–7). The negative slope indicates that local variations of the *Equally Weighted Bonus Share* are associated with a decreasing Sharpe ratio, suggesting misalignment of bonus incentives with shareholder value maximization. For the consecutive crisis period (2008-11), the corresponding slope is depicted by the unbroken red line and has a positive - though statistically insignificant - slope. Here we cannot reject the hypothesis that incentive pay is correctly aligned with NPV maximization.

7 Conclusion

Empirical research on bank risk-taking is often constrained by the lack of appropriate compensation data to measure bankers' incentive pay. This paper draws on a large new data set on bank compensation in Austria, Germany, and Switzerland and extracts the performance-related bonus payments in the critical bank segments of investment banking and treasury/capital market management.

We contribute to a better understanding of bank pay incentives in four ways: First, we document a substantial reduction in incentive pay that occurred in 2008-11 relative to much larger bonus shares in 2004–7. At 40% the reduction in the *Bonus Share* (bonus relative to total compensation) was particularly strong in the investment banking and treasury/capital market segments. This substantial reduction occurred despite of the fact that the overall trading income in our bank sample did not decrease in the crisis period. Second, trading income as well as its volatility are positively correlated with incentive pay. These correlations are observable for the entire sample period, but are particularly significant (both statistically and economically) in the pre-crisis period. Third, we pursue an instrumental variable approach to explore a possible causal relationship between the strength of pay incentives and bank risk-taking. We use the bonus share in bank segments unrelated to the capital market activity, like retail banking, corporate banking, and private banking, as instruments to capture the "bonus culture" of a bank. We find that a higher predicted bonus share in capital markets causes both a higher *Relative Trading Income* and a higher *Log Standard Deviation (SD) of Relative Trading Income*. Inversely, the bonus share in the non-capital market segments is serially uncorrelated with the bonus share in the capital market segment. Fourth, we ask if the observed incentive pay maximizes the Sharpe ratio of trading returns and, thereby, the value of total bank assets. This requires the local average treatment effect (LATE) of the Sharpe ratio with respect to the (instrumented) Bonus Share to be zero. Instrumented incentive pay shows a negative and weakly significant effect on the Sharpe ratio of trading returns for the pre-crisis period, which vanishes for the later crisis period. External constraints on incentive pay in the banks' capital market segments after 2007 appear to have increased the Sharpe ratio of trading returns. Pre-crisis incentive pay in the capital market segments of Austrian, German, and Swiss banks therefore appears to have been misaligned with NPV (or asset value) maximization and by extension even more so with the public interest.

Finally, we highlight that the last of these four results has only moderate statistical significance. Future empirical work needs to combine the microeconomic measures of incentives proposed in this paper with corresponding micro data on the banks' speculative trading portfolios. Unfortunately, insufficient public reporting standards on the banks' asset holdings limit the scope for an insightful analysis in this respect. This opacity of the asset side of bank balance sheets contrasts with the detailed public reporting requirements of equity funds and indicates in itself a failure of bank regulation.

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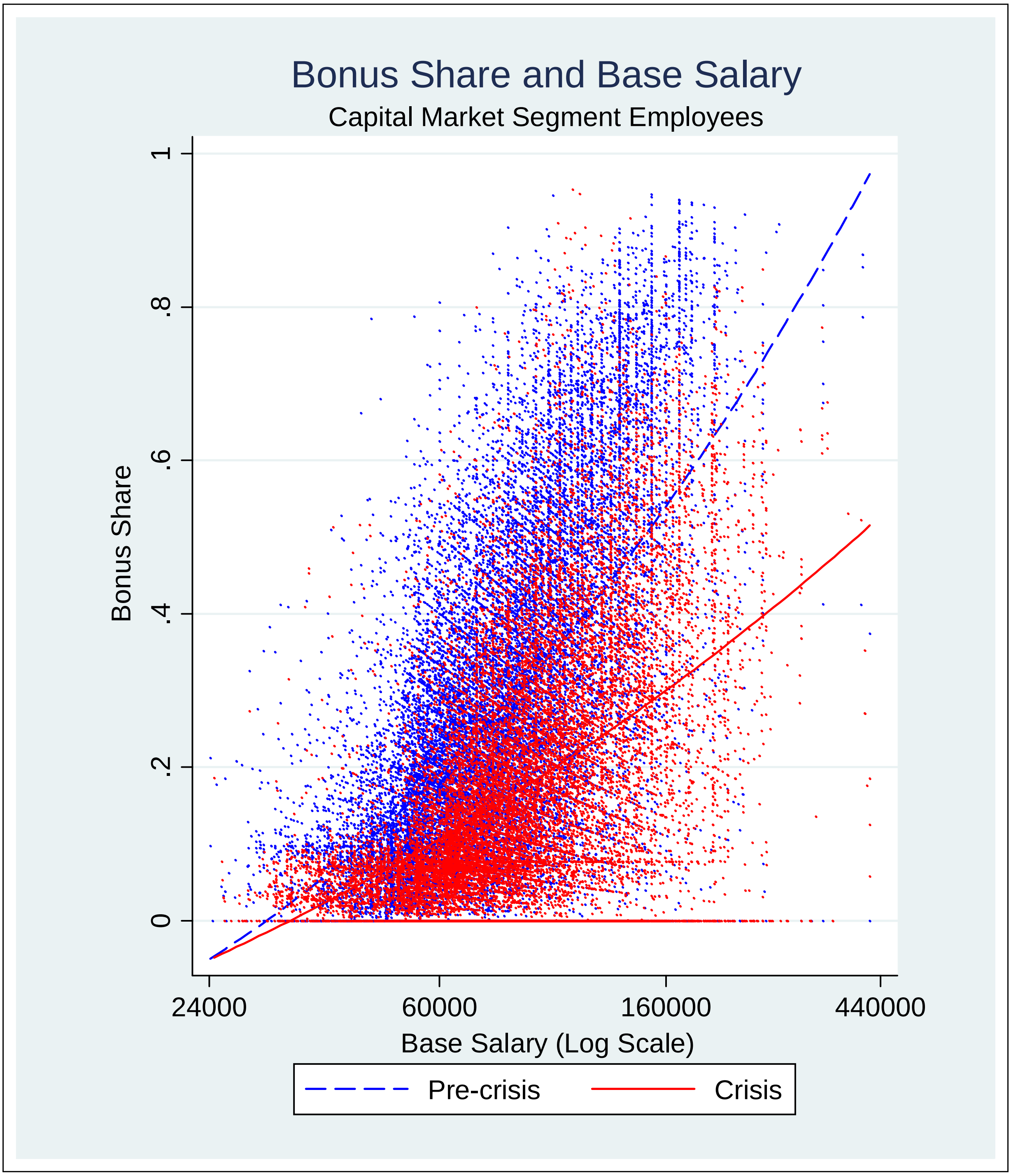

Figure 1: Plotted is the *Bonus Share* against *Base Salary* (on a Log scale) for 47,320 employee-year observations of bank employees in the capital market segments (treasury/capital management and investment banking) of 66 Austrian, German, and Swiss banks. Observations for the pre-crisis years 2004-7 are plotted in blue and those recorded in the crisis years 2008-11 are depicted in red. We also fit the quadratic function from Table 4, columns (1) and (2), to the observations of each period separately.

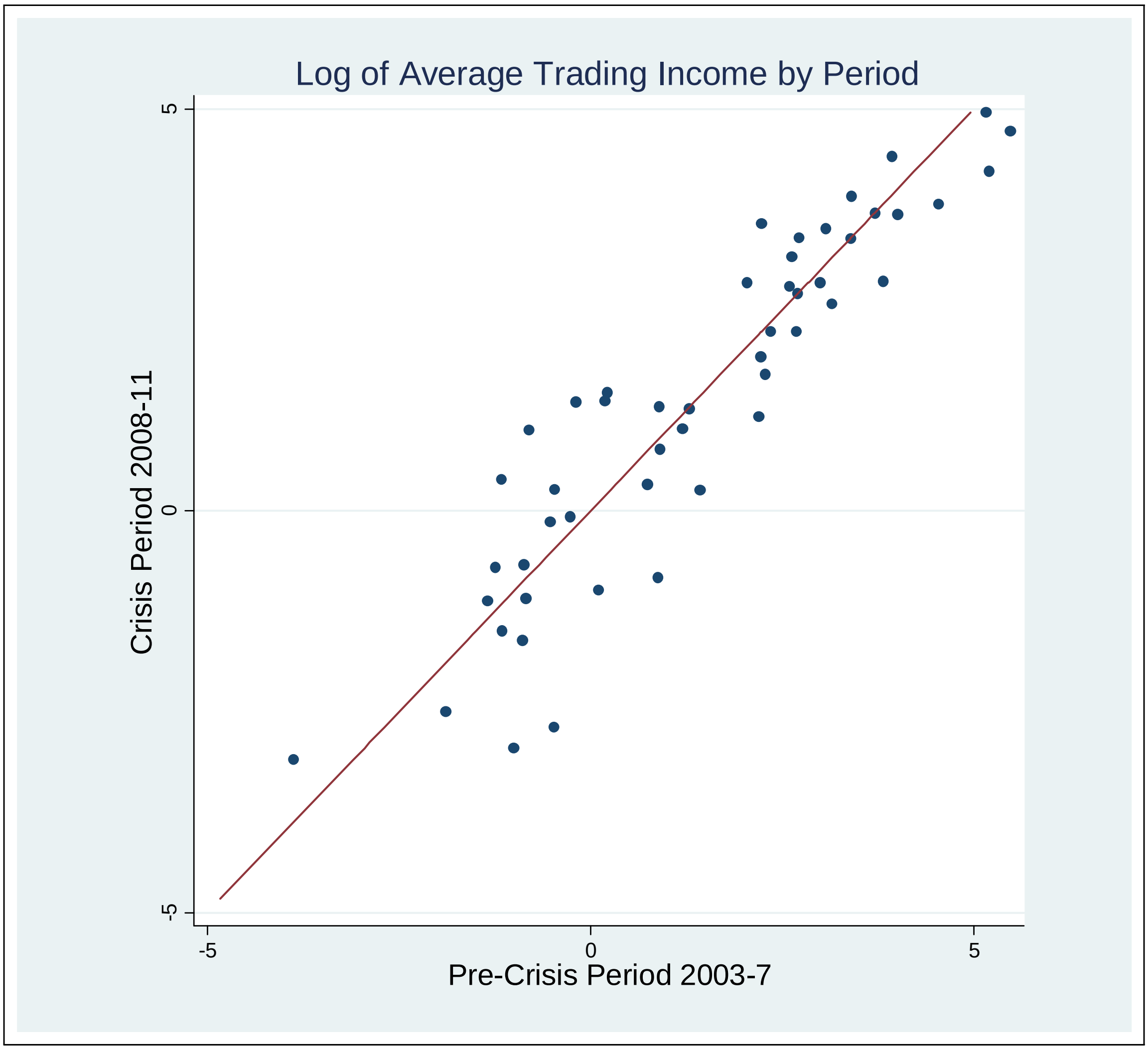

Figure 2: Plotted are the Log of the average (absolute) trading income for each bank in the pre-crisis period 2003–7 against the corresponding Log average (absolute) trading income for the crisis period 2008–11.

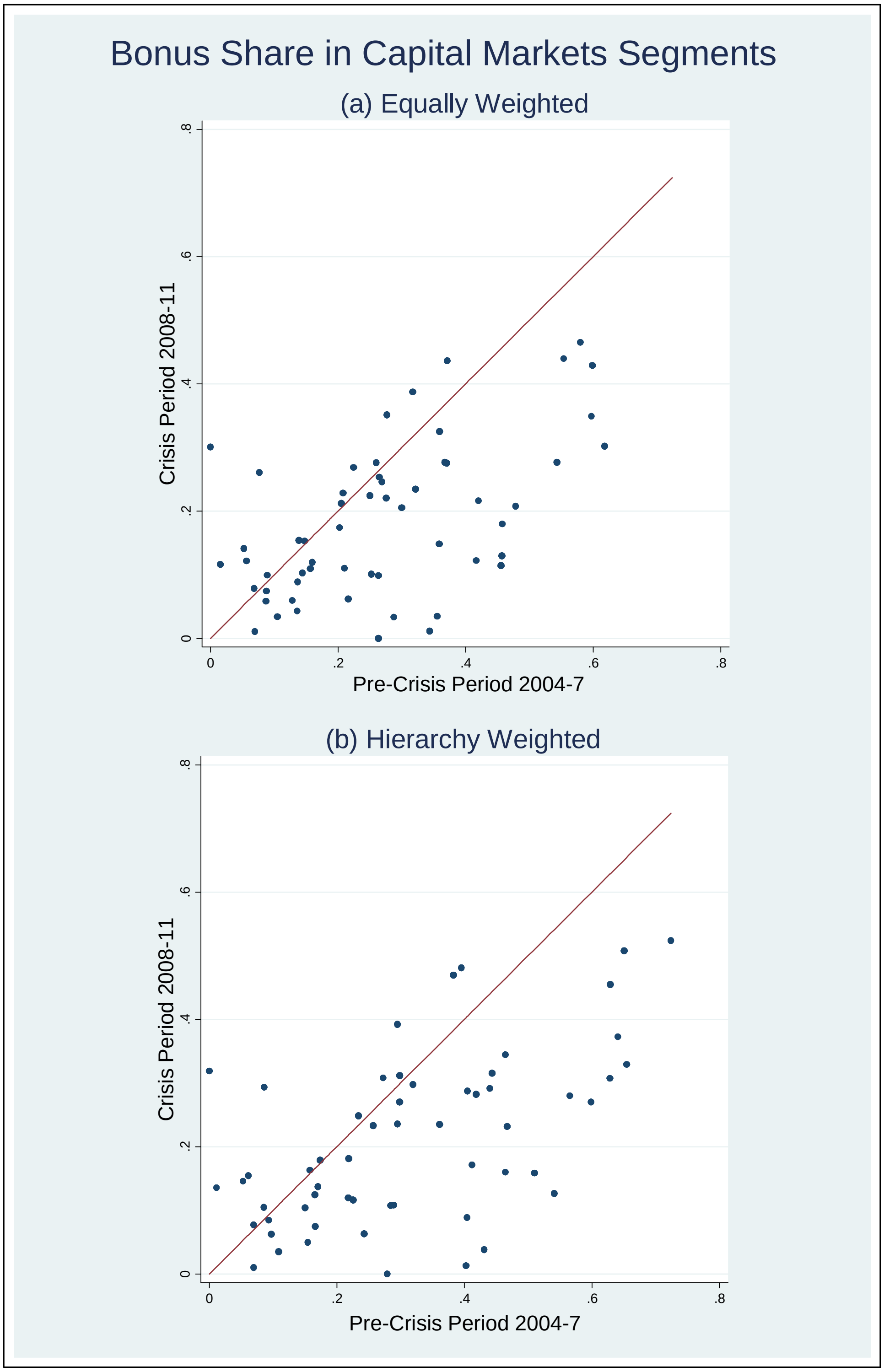

Figure 3: The (a) *Equally Weighted* and the (b) *Hierarchy-Weighted Bonus Share* (defined as the ratio of bonus to total compensation) for the capital market segment employees in each bank is plotted (as average) for the pre-crisis period 2004-7 (x-axis) against the corresponding *Bonus Share* in the crisis period 2008-11 (y-axis).

Figure 4: The components of (a) the *Log Relative Trading Income* and (b) the *Log Standard Deviation of Relative Trading Income* that are unexplained by the control variables are plotted against the predicted (instrumented) *Equally Weighted (EW) Bonus Share* (in the *Investment Banking* and *Treasury/Capital Market* segments) of each bank. The residual plots represent the 2SLS regression of Table 7, Panel B, column (1) and Table 8, Panel B, column (1), respectively.

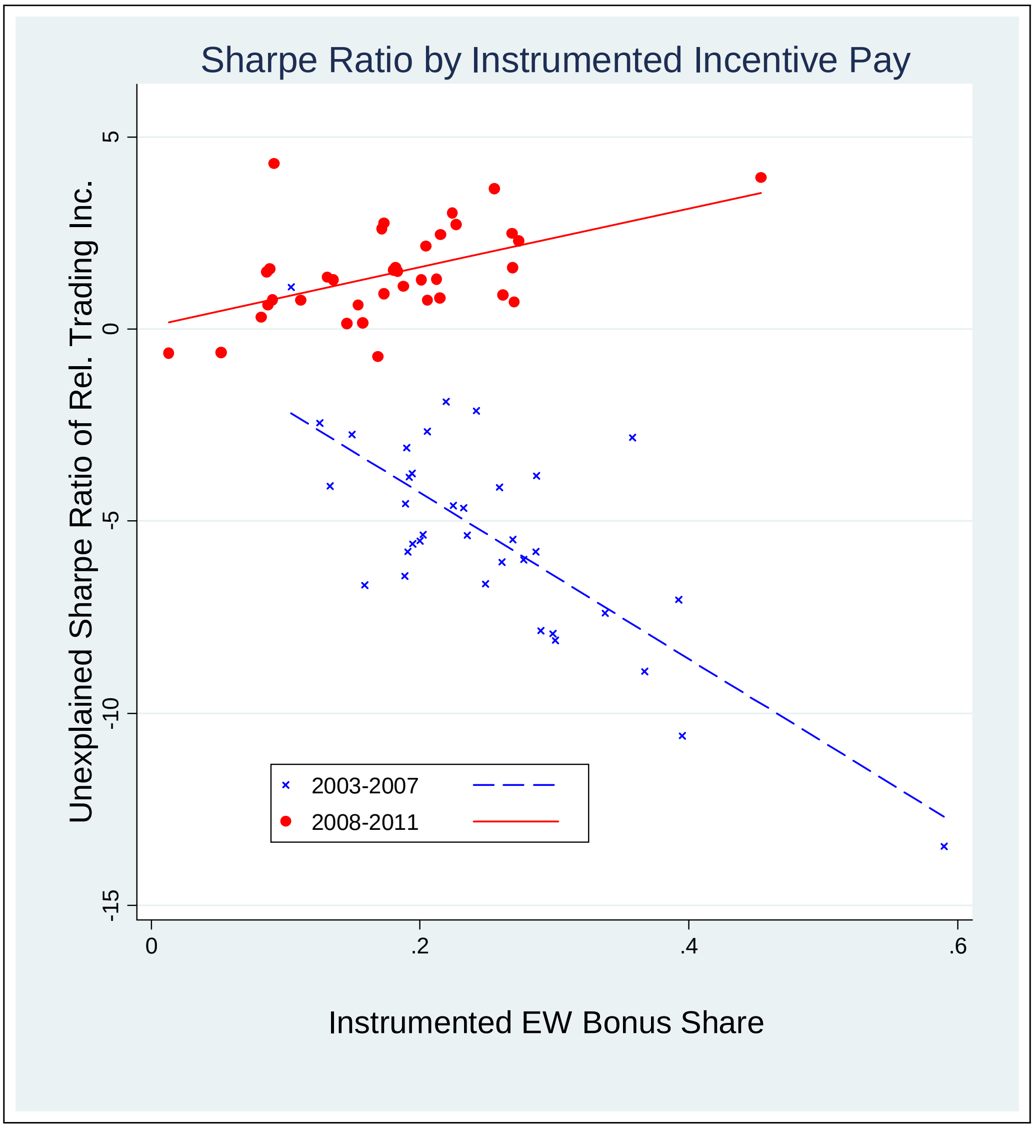

Figure 5: The component of the Sharpe ratios that is unexplained by the control variables is plotted against the instrumented *EW Bonus Share* of each bank, as estimated by the IV regression in Table 9. The slope of the blue (dashed) and red (unbroken) line equal the correlation between instrumented bonus share and the unexplained component of the Sharpe ratio in the pre-crisis and crisis period, respectively.

Table 1: Summary Statistics for Employee Level Incentives

Reported are summary statistics on employee characteristics and their individual compensation in a given year. The variables are subject to the following cleaning procedures: First, 681,455 observations from service divisions and cross-divisional functions are dropped. Second, 67,960 observations of employees not eligible for a bonus are dropped. Finally, we discard 4,708 observations with base salaries below €24,000. We winsorize the 10 largest and 10 smallest observations of the variables *Age*, *Tenure*, *Base*, and *Bonus*. *Bonus Share* is defined as the ratio of *Bonus* over the sum of *Bonus* and *Base Salary*. *Age* and *Tenure* are recoded as categorical variables.

	Obs.	Mean	S.D.	Skew.	Min	Max
Employee Information						
Age	436,826	39.7	9.5	0.07	18	66
Age Missing	521,194	0.16	–	–	–	–
Tenure	494,675	13.7	10.0	0.72	0	47
Tenure Missing	521,194	0.05	–	–	–	–
Base Salary	516,486	61,862	26,372	2.00	24,000	418,000
Bonus	521,194	15,709	47,760	17.91	0	2,662,500
Total Salary	516,486	77,706	65,669	9.97	24,000	3,065,640
Bonus Share by Country						
Austria	31,673	0.05	0.07	3.25	0	0.76
Germany	372,151	0.12	0.11	2.25	0	0.95
Switzerland	112,662	0.18	0.15	1.16	0	0.95
Bonus Share by Bank Segment						
Investment Banking	12,343	0.23	0.20	0.92	0	0.94
Treasury/Capital Market	34,977	0.23	0.20	0.94	0	0.95
Asset Management	21,188	0.24	0.16	0.67	0	0.92
Corporate Banking	53,685	0.15	0.11	1.23	0	0.92
Private Banking	75,547	0.19	0.14	1.01	0	0.92
Retail Banking	318,746	0.08	0.07	1.78	0	0.85
Bonus Share by Hierarchy Level						
Hierarchy Level 1 (Lowest)	42,042	0.05	0.04	1.59	0	0.57
Hierarchy Level 2	123,028	0.06	0.05	1.74	0	0.79
Hierarchy Level 3	117,826	0.09	0.07	2.08	0	0.87
Hierarchy Level 4	130,913	0.14	0.11	1.58	0	0.90
Hierarchy Level 5	78,354	0.23	0.15	0.81	0	0.95
Hierarchy Level 6	23,377	0.33	0.18	0.35	0	0.95
Hierarchy Level 7 (Highest)	946	0.46	0.25	−0.16	0	0.94
All	516,486	0.13	0.12	1.94	0	0.95

Table 2: Incentive Pay and Trading Income Before and During the Crisis

We report separately for the pre-crisis period (2003-7) and the crisis period (2008-11) the individual employee-compensation for performance across capital market segments (Panel A) as well as the *Log Period-Average Relative Trading Income*, computed as the natural logarithm of the period-average of *Trading Income* in percent of *Interest Income*, the *Log Standard Deviation of Relative Trading Income,* and the *Sharpe Ratio of Trading Income* (Panel B). The symbols *,**, and *** represent significance levels of 10%, 5%, and 1% in two-sample t-tests. We use Wilcoxon rank-sum tests to check if variables are distributed the same before and during the crisis (H0) and report the p-values.

Panel A: Employee Compensation Capital Market Segments

	Obs.	Mean	S.D.	Skew.	Min	Max
Base Salary						
Pre-Crisis Period	26,046	82,896	32,427	1.62	24,100	418,000
Crisis Period	21,274	91,005	39,969	1.61	24,444	418,000
Difference		−8,109***				
Wilcoxon (*p-value*)		0.00				
Bonus						
Pre-Crisis Period	26,070	68,017	154,617	7.33	0	2,662,500
Crisis Period	21,276	34,056	73,279	7.27	0	2,164,453
Difference		33,961***				
Wilcoxon (*p-value*)		0.00				
Bonus Share						
Pre-Crisis Period	26,046	0.28	0.21	0.71	0	0.95
Crisis Period	21,274	0.17	0.17	1.22	0	0.95
Difference		0.11***				
Wilcoxon (*p-value*)		0.00				

Panel B: Trading Income

	Obs.	Mean	S.D.	Skew.	Min	Max
Log Period-Average Relative Trading Income						
Pre-Crisis Period	62	0.936	2.404	−0.282	−4.461	5.482
Crisis Period	56	0.997	2.392	−0.399	−4.826	4.956
Difference		−0.061				
Wilcoxon (*p-value*)		0.80				
Log SD of Relative Trading Income						
Pre-Crisis Period	40	0.137	1.700	0.062	−2.942	3.413
Crisis Period	40	0.836	1.763	−0.097	−2.501	4.478
Difference		−0.699**				
Wilcoxon (*p-value*)		0.10				
Sharpe Ratio of Trading Income						
Pre-Crisis Period	39	1.793	1.931	0.790	−1.213	7.092
Crisis Period	40	0.837	1.096	0.571	−1.793	4.297
Difference		0.956***				
Wilcoxon (*p-value*)		0.04				

Table 3: Summary Statistics at the Bank Level

Reported are bank characteristics. The variables *Assets*, *Trading Income*, *Gross Interest Income*, *Trading Income/Gross Interest Income*, *Gross Interest Income/Assets* and *Net Loans/Assets* are winsorized at the 1% level in each tail. The variables *Relative Trading Income*, *Gross Interest Income/Assets*, and *Net Loans/Assets* are given as percentages. *Employment Non-Capital Markets Segments* is the fraction of employees working in the non-capital market segments corporate banking, private banking, and retail banking. *Relative Trading Income* is defined as *Trading Income* as percentages of *Gross Interest Income*. *Log Relative Trading Income* is computed as *Ln*(*Relative Trading Income* +18.24) where the constant 18.24 is chosen to reduce the skewness of the variable to zero. The standard deviation of *Relative Trading* Income is computed only if the variable has at least three observations. The constant 0.05 reduces the skewness of Log of *SD of Relative Trading Income*, defined as *Ln*(*SD of Relative Trading Income* +0.05), to zero. *Sharpe Ratio of Trading Income* is computed as the ratio of *Relative Trading Income* and *SD of Relative Trading Income*. *EW Base Salary* and *HW Base Salary* are standardized by 100,000.

	Pre-Crisis Period 2003-7			Full Period 2003-11		
	Obs.	Mean	S.D.	Obs.	Mean	S.D.
Bank Characteristics						
Assets	186	167,288	341,35	365	165,186	337,91
Log Assets	186	10.61	1.85	365	10.52	1.90
Trading Income	186	276.30	1,266.53	365	256.14	1,280.28
Gross Interest Income	186	5,729.75	9,305.73	365	5,273.60	8,828.06
Relative Trading Income (%)	186	6.33	12.00	365	8.59	20.96
Gross Interest Income/Assets (%)	186	4.16	1.72	365	3.73	1.77
Net Loans/Assets (%)	186	41.09	22.84	365	40.25	23.46
Employment Non-Capital Markets Segm.	37	0.68	0.26	87	0.72	0.25
Performance Characteristics						
Log Relative Trading Income	186	3.11	0.40	365	3.13	0.54
Log of SD of Relative Trading Income	40	0.14	1.70	80	0.49	1.76
Sharpe Ratio of Trading Income	39	1.79	1.93	79	1.31	1.63
Pay in Capital Market Segments						
EW Bonus Share	41	0.27	0.14	96	0.23	0.13
EW Base Salary	41	0.86	0.18	96	0.92	0.23
HW Bonus Share	41	0.31	0.16	96	0.26	0.15
HW Base Salary	41	0.98	0.23	96	1.02	0.26
Pay in Non-Capital Market Segm.						
EW Bonus Share	37	0.16	0.07	87	0.14	0.08
EW Base Salary	37	0.72	0.17	87	0.77	0.20
HW Bonus Share	37	0.18	0.08	87	0.17	0.10
HW Base Salary	37	0.80	0.19	87	0.85	0.24

Table 4: Incentive Pay Structure at the Employee Level

The employee-level bonus share is regressed on a set of fixed effects for bank segment, hierarchy, age, tenure, and year, as well as on the *Log Base Salary* and *Log Base Salary Squared*. Standard errors are clustered by bank and are reported in parentheses. The symbols *,**, and *** represent significance levels of 10%, 5%, and 1% respectively.

Dep. Variable:	All Bank Segments				Capital Market Segments	
Bonus Share	2004-2007	2008-2011	2004-2007	2008-2011	2004-2007	2008-2011
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	14.907***	10.075***			−0.840	−5.701*
	(2.189)	(1.394)			(4.215)	(3.162)
Log Base Salary	−2.923***	−1.962***			−0.146	0.858
	(0.404)	(0.251)			(0.771)	(0.554)
Log Base Salary Squared	0.144***	0.096***			0.020	−0.031
	(0.019)	(0.011)			(0.035)	(0.024)
Retail Banking			−0.079***	−0.097***		
			(0.001)	(0.013)		
Corporate Banking			−0.076***	−0.088***		
			(0.001)	(0.013)		
Private Banking			−0.032	−0.058***		
			(0.024)	(0.022)		
Investment Banking			−0.003	−0.043**	−0.020***	−0.004
			(0.015)	(0.018)	(0.008)	(0.011)
Treasury/Capital Market			0.034**	−0.050***		
			(0.014)	(0.018)		
Hierarchy Level 2			0.006	−0.007*	0.008	−0.017
			(0.007)	(0.004)	(0.019)	(0.025)
Hierarchy Level 3			0.030***	0.013***	0.017	−0.018
			(0.007)	(0.004)	(0.023)	(0.028)
Hierarchy Level 4			0.084***	0.050***	0.025	−0.010
			(0.013)	(0.008)	(0.026)	(0.028)
Hierarchy Level 5			0.176***	0.112***	0.067**	0.003
			(0.017)	(0.015)	(0.030)	(0.033)
Hierarchy Level 6			0.286***	0.188***	0.097**	0.049
			(0.021)	(0.016)	(0.038)	(0.042)
Hierarchy Level 7 (Highest)			0.457***	0.256***	0.142***	0.111**
			(0.040)	(0.040)	(0.053)	(0.050)
Other Dummies						
Age Group	No	No	Yes	Yes	Yes	Yes
Tenure Group	No	No	Yes	Yes	Yes	Yes
Year	No	No	Yes	Yes	Yes	Yes
Obs	305,918	210,568	305,918	210,568	26,046	21,274
R^2	0.472	0.370	0.520	0.415	0.442	0.257

Table 5: Partial Correlations

The lower-left triangle of the matrix reports partial correlations between bank variables measured as four-year averages for the pre-crisis period (2003-7) and the crisis period (2008-11). The partial correlations between two variables are calculated based on the sample mean of each subperiod. The upper-right triangle of the matrix reports the number of observations used to calculate the correlations. The variables characterize the (i) bank incentive culture, (ii) bank governance, (iii) labor market characteristics of the employees in the capital market segment, and (iv) bank risk management. We distinguish the equally weighted (EW) Bonus Share in the bank's capital market segment (Capital Mkt.) from that in the non-capital market segments (Non-Cap. Mkt.). STD Bonus Share refers to the standard deviation of the Bonus Share within either the capital market segments or the non-capital market segments of the bank. The bank governance variables characterize the quality of the supervisory and executive board as described in Hau and Thum (2009). The labor market characteristics comprise the average age and the average job tenure in the capital market segment of a bank. The role of risk management is captured by the average compensation of risk managers (RMs) and their average hierarchy level. Correlations significant at the 5% level are printed in bold.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Bank Incentive Culture														
1	EW Bonus Share Capital Mkt.		183	209	178	79	37	37	37	37	183	172	208	181	181
2	EW Bonus Share Non-Cap. Mkt.	**0.59**		177	242	80	34	36	36	36	183	149	175	200	200
3	STD Bonus Share Capital Mkt.	**0.53**	**0.33**		173	79	37	37	37	37	177	162	199	172	172
4	STD Bonus Share Non-Cap. Mkt.	**0.60**	**0.65**	**0.42**		80	34	36	36	36	178	146	170	195	195
	Bank Governance														
5	State Bank Dummy	**−0.34**	**−0.25**	−0.22	−0.15		46	48	47	48	71	69	77	85	85
6	Financial Experience Sup. Board	−0.21	0.06	0.06	0.20	−0.15		46	45	46	34	36	36	37	37
7	Foreign Experience Sup. Board	0.19	0.20	0.25	−0.14	**−0.35**	0.23		47	48	34	36	36	39	39
8	Capital Markets Exp. Exec. Board	−0.18	0.06	−0.05	−0.05	0.10	−0.06	−0.03		47	34	36	36	39	39
9	Political Affiliations Exec. Board	0.20	0.10	−0.07	0.24	0.08	**−0.55**	−0.23	−0.18		34	36	36	39	39
10	Employment other Segments	**−0.18**	**−0.27**	**−0.17**	−0.07	−0.10	−0.21	0.12	−0.15	−0.04		149	175	159	159
	Labor Market Characteristics														
11	Average Age in Capital Mkt.	**−0.40**	−0.09	−0.11	−0.07	0.20	0.20	−0.20	−0.29	0.08	0.12		171	152	152
12	Average Job Tenure in Cap. Mkt.	**−0.28**	**−0.37**	**−0.20**	**−0.27**	**0.36**	−0.13	0.04	0.00	0.05	**0.39**	**0.48**		171	171
	Bank Risk Management														
13	Average Compensation of RMs	**0.50**	**0.56**	**0.30**	**0.38**	**−0.25**	−0.05	0.11	0.19	0.06	**−0.31**	**−0.27**	**−0.33**		250
14	Av. Hierarchy Level of RMs	**0.16**	**0.25**	0.11	0.10	−0.07	−0.03	0.28	0.28	−0.15	**−0.31**	−0.10	**−0.15**	**0.54**	

Table 6: Trading Income and Incentive Pay

In Panel A, we regress the *Log Relative Trading Income* defined as the Log of the ratio of *Trading Income* to *Gross Interest Income* on a bank's *Equally Weighted (EW) Bonus Share* and *Equally Weighted (EW) Base Salary* calculated for all employees in the segments *Treasury/Capital Market* and *Investment Banking.* In Panel B, we regress the same dependent variable on the *Hierarchy-Weighted (HW) Bonus Share* and the *Hierarchy-Weighted (HW) Base Salary* calculated for the same capital market segments. The controls are: *Log Assets* = natural logarithm of bank assets; *Net Loans/Assets* = net loans over bank assets and year fixed effects. Ordinary least squares (OLS) regressions are used in columns (1) and (4). In columns (2) and (5) we weight each bank by the square root of the number of employee-observations used to compute the bank average bonus share (WOLS). Column (3) reports the results of random effects (RE) panel regressions. All specifications include a constant. Robust standard errors clustered at the bank level are reported in parentheses. The symbols *,**, and *** represent significance levels of 10%, 5%, and 1% respectively.

Panel A: Trading Income and the Equally Weighted Bonus Share

Dep. Variable:	Pre-Crisis Period 2003-7			Full Period 2003-11	
Log Relative Trading Income	OLS	WOLS	RE	OLS	WOLS
	(1)	(2)	(3)	(4)	(5)
EW Bonus Share	2.028***	1.910***	2.011***	0.701	1.249***
	(0.545)	(0.659)	(0.561)	(0.421)	(0.449)
EW Base Salary	−1.501***	−1.366***	−1.522***	0.146	−0.223
	(0.463)	(0.582)	(0.477)	(0.320)	(0.325)
Log Assets	−0.103***	−0.081**	−0.113***	−0.090***	−0.075***
	(0.025)	(0.032)	(0.028)	(0.019)	(0.024)
Net Loans/Assets	−0.001	−0.001	−0.001	−0.002**	−0.002**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Year FE	Yes	Yes	Yes	Yes	Yes
Obs	186	186	186	365	365
R^2	0.330	0.237	0.329	0.266	0.264

Panel B: Trading Income and the Hierarchy-Weighted Bonus Share

Dep. Variable:	Pre-Crisis Period 2003-7			Full Period 2003-11	
Log Relative Trading Income	OLS	WOLS	RE	OLS	WOLS
	(1)	(2)	(3)	(4)	(5)
HW Bonus Share	1.853***	1.811***	1.839***	0.800**	1.275***
	(0.469)	(0.567)	(0.479)	(0.382)	(0.412)
HW Base Salary	−1.216***	−1.017**	−1.247***	−0.023	−0.309
	(0.344)	(0.409)	(0.353)	(0.283)	(0.259)
Log Assets	−0.102***	−0.075**	−0.113***	−0.091***	−0.075***
	(0.027)	(0.035)	(0.030)	(0.019)	(0.024)
Net Loans/Assets	−0.001	−0.002	−0.001	−0.002	−0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Year FE	Yes	Yes	Yes	Yes	Yes
Obs	186	186	186	365	365
R^2	0.342	0.246	0.340	0.265	0.273

Table 7: Trading Income Volatility and Incentive Pay

In Panel A, we regress the *Log Standard Deviation (SD) of the Relative Trading Income* defined as the Log of the standard deviation of the ratio of *Trading Income* to *Gross Interest Income* on a bank's *Equally Weighted (EW) Bonus Share* and *Equally Weighted (EW) Base Salary* calculated for all employees in the segments *Treasury/Capital Market* and *Investment Banking*. In Panel B, we regress the same dependent variable on the *Hierarchy-Weighted (HW) Bonus Share* and the *Hierarchy-Weighted (HW) Base Salary* calculated for the same capital market segments. The controls are: *Log Assets* = natural logarithm of bank assets; *Net Loans/Assets* = net loans over bank assets; *Crisis Dummy* = 1 for years 2008 to 2011. Ordinary least squares (OLS) regressions are used in columns (1) and (3). In columns (2) and (4) we weight each bank by the square root of the number of employee-observations used to compute the bank average bonus share (WOLS). All specifications include a constant. Robust standard errors clustered at the bank level are reported in parentheses. The symbols *,**, and *** represent significance levels of 10%, 5%, and 1% respectively.

Panel A: Volatility of Trading Income and the Equally Weighted Bonus Share

Dep. Variable:	Pre-Crisis Period 2003-7		Full Period 2003-11	
Log SD of Relative Trading Income	OLS	WOLS	OLS	WOLS
	(1)	(2)	(3)	(4)
EW Bonus Share	12.235***	10.066***	4.837**	5.153***
	(2.785)	(3.041)	(2.062)	(1.786)
EW Base Salary	−8.054***	−5.070*	−0.136	0.509
	(2.461)	(2.956)	(1.712)	(1.601)
Log Assets	−0.216	−0.047	0.119	0.199*
	(0.135)	(0.140)	(0.116)	(0.111)
Net Loans/Assets	−0.006	−0.020*	−0.017**	−0.023***
	(0.010)	(0.011)	(0.008)	(0.008)
Crisis Dummy			1.079***	1.276***
			(0.372)	(0.350)
Obs	40	40	80	80
R^2	0.337	0.299	0.210	0.334

Panel B: Volatility of Trading Income and the Hierarchy-Weighted Bonus Share

Dep. Variable:	Pre-Crisis Period 2003-7		Full Period 2003-11	
Log SD of Relative Trading Income	OLS	WOLS	OLS	WOLS
	(1)	(2)	(3)	(4)
HW Bonus Share	10.303***	9.032***	4.913***	5.033***
	(2.406)	(2.522)	(1.775)	(1.497)
HW Base Salary	−5.618***	−3.434	−0.420	0.183
	(1.988)	(2.171)	(1.419)	(1.259)
Log Assets	−0.181	−0.009	0.130	0.208**
	(0.145)	(0.140)	(0.114)	(0.102)
Net Loans/Assets	−0.007	−0.021*	−0.016**	−0.022**
	(0.010)	(0.011)	(0.008)	(0.008)
Crisis Dummy			1.195***	1.406***
			(0.365)	(0.333)
Obs	40	40	80	80
R^2	0.317	0.329	0.226	0.353

Table 8: Trading Income and Instrumented Incentive Pay

We estimate a two-stage regression with *Log Relative Trading Income* as the dependent variable and in which the *Equally Weighted (EW) Bonus Share* is instrumented in a first stage regression (Panel A) by the equally weighted bonus share in *Retail Banking*, *Private Banking* and *Corporate Banking* of the same bank (= *EW Bonus Share other Segm.*), and the share of the total number of employees in these segments relative to total employment (= *Employment Other Segm.*). Panel B reports the second-stage regression and Panel C replaces the instrument *EW Bonus Share Other Segm.* with an alternative instrument, *Filtered EW Bonus Share Other Segm.* The latter is purged of any intertemporal correlation between trading income as the dependent variable and the *EW Bonus Share Other Segm.* We use the same control variables as before: *Log Assets* = natural logarithm of bank assets; *Net Loans/Assets* = net loans over bank assets; and year fixed effects. Two-stage least squares (2SLS) regressions are used in columns (1) and (3). In columns (2) and (4) we weight each bank by the square root of the number of employee-observations used to compute the bank average bonus share (W2SLS). All specifications include a constant. Robust standard errors clustered at the bank level are reported in parentheses. The symbols *,**, and *** represent significance levels of 10%, 5%, and 1% respectively. The last rows of Panel B and C report the p-values for the null hypothesis that all instruments are valid.

Panel A: First Stage Regression for EW Bonus Share				
Dep. Variable:	Pre-Crisis Period 2003-7		Full Period 2003-11	
EW Bonus Share	2SLS	W2SLS	2SLS	W2SLS
	(1)	(2)	(3)	(4)
EW Bonus Share Other Segm.	0.760***	0.824***	0.776***	0.897***
	(0.122)	(0.167)	(0.099)	(0.105)
Employment Other Segm.	0.128***	0.149***	0.126***	0.136***
	(0.038)	(0.047)	(0.027)	(0.033)
EW Base Salary	0.436***	0.389***	0.313***	0.286***
	(0.068)	(0.099)	(0.043)	(0.054)
Log Assets	0.017**	0.016***	0.011***	0.012***
	(0.006)	(0.005)	(0.004)	(0.004)
Net Loans/Assets	−0.001	−0.000	−0.000	−0.000
	(0.001)	(0.001)	(0.000)	(0.000)
Year FE	Yes	Yes	Yes	Yes
Obs	169	169	332	332
R^2	0.783	0.699	0.711	0.697
$F-Test$ (H_0 : all coeff. = 0)	52.56	19.08	30.71	32.68
$F-Test$ (H_0 : IV coeff. = 0), *weak ID*	19.57	12.25	36.60	37.13
SY weak ID test critical values				
(10%/15%/20% *maximal size*)				19.93/11.59/8.75

Table 8 continued

Panel B: Second Stage with Instruments for EW Bonus Share				
Dep. Variable	Pre-Crisis Period 2003-7		Full Period 2003-11	
Log Relative Trading Income	2SLS	W2SLS	2SLS	W2SLS
	(1)	(2)	(3)	(4)
EW Bonus Share (instrumented)	3.180***	3.865***	2.000**	2.781***
	(1.191)	(1.357)	(0.880)	(0.816)
EW Base Salary	−1.921**	−2.227**	−0.245	−0.736
	(0.891)	(1.094)	(0.565)	(0.508)
Log Assets	−0.118***	−0.116***	−0.098***	−0.093***
	(0.033)	(0.041)	(0.019)	(0.025)
Net Loans/Assets	0.002	0.001	0.000	0.000
	(0.002)	(0.003)	(0.001)	(0.002)
Year FE	Yes	Yes	Yes	Yes
Obs	169	169	332	332
R^2	0.269	0.135	0.265	0.255
Overident. Test (p-value)	0.233	0.162	0.538	0.136

Panel C: Second Stage with Filtered Instruments for EW Bonus Share				
Dep. Variable	Pre-Crisis Period 2003-7		Full Period 2003-11	
Log Relative Trading Income	2SLS	W2SLS	2SLS	W2SLS
	(1)	(2)	(3)	(4)
EW Bonus Share (instrumented)	2.807**	3.830**	1.639	2.843***
	(1.235)	(0.149)	(1.143)	(1.062)
EW Base Salary	−1.682*	−2.186*	−0.094	−0.771
	(0.927)	(1.154)	(0.631)	(0.594)
Log Assets	−0.115***	−0.115***	−0.097***	−0.094***
	(0.033)	(0.042)	(0.020)	(0.025)
Net Loans/Assets	0.002	0.001	−0.000	0.000
	(0.001)	(0.003)	(0.001)	(0.002)
Year FE	Yes	Yes	Yes	Yes
Obs	164	164	324	324
R^2	0.295	0.149	0.280	0.257
Overident. Test (p-value)	0.139	0.127	0.360	0.0994

Table 9: Trading Income Volatility and Instrumented Incentive Pay

We estimate a two-stage regression with the *Log Standard Deviation (SD) of Relative Trading Income* as the dependent variable and in which the *Equally Weighted (EW) Bonus Share* is instrumented in a first-stage regression (Panel A) by the equally weighted bonus share in *Retail Banking*, *Private Banking* and *Corporate Banking* of the same bank (= *EW Bonus Share Other Segm.*), and the share of total number of employees in these segments relative to total employment (= *Employment Other Segm.*). Panel B reports the second-stage regression and Panel C replaces the instrument *EW Bonus Share Other Segm.* with an alternative instrument, *Filtered EW Bonus Share other Segm.* The latter is purged of any intertemporal correlation between trading income as the dependent variable and the *EW Bonus Share Other Segm.* We use the same control variables as before: *Log Assets* = natural logarithm of bank assets; *Net Loans/Assets* = net loans over bank assets; *Crisis Dummy* = 1 for years 2008 to 2011. Two-stage least squares (2SLS) regressions are used in columns (1) and (3). In columns (2) and (4) we weight each bank by the square root of the number of employee-observations used to compute the bank average bonus share (W2SLS). All specifications include a constant. Robust standard errors clustered at the bank level are reported in parentheses. The symbols *,**, and *** represent significance levels of 10%, 5%, and 1% respectively. The last rows of Panel B and C report the p-values for the null hypothesis that all instruments are valid.

Panel A: First Stage Regression for EW Bonus Share

Dep. Variable:	Pre-Crisis Period 2003-7		Full Period 2003-11	
EW Bonus Share	2SLS	W2SLS	2SLS	W2SLS
	(1)	(2)	(3)	(4)
EW Bonus Share Other Segm.	0.735***	0.795***	0.706***	0.881***
	(0.124)	(0.165)	(0.110)	(0.120)
Employment Other Segm.	0.133***	0.149***	0.125***	0.136***
	(0.039)	(0.046)	(0.029)	(0.035)
EW Base Salary	0.435***	0.388***	0.377***	0.307***
	(0.071)	(0.101)	(0.058)	(0.067)
Log Assets	0.017**	0.016***	0.008*	0.010**
	(0.007)	(0.005)	(0.004)	(0.004)
Net Loans/Assets	−0.001	−0.000	−0.000	0.000
	(0.001)	(0.001)	(0.000)	(0.001)
Crisis Dummy			−0.063***	−0.080***
			(0.014)	(0.018)
Obs	37	37	74	74
R^2	0.778	0.698	0.699	0.684
$F-Test$ (H_0 : all coeff. = 0)	67.41	30.33	38.97	42.45
$F-Test$ (H_0 : IV coeff. = 0), *weak ID*	17.62	11.68	24.63	28.09
SY weak ID test critical values				
(10%/15%/20% *maximal size*)				19.93/11.59/8.75

Table 9 continued

Panel B: Second Stage with Instruments for EW Bonus Share

Dep. Variable:	Pre-Crisis Period 2003-7		Full Period 2003-11	
Log SD of Relative Trading Income	2SLS	W2SLS	2SLS	W2SLS
	(1)	(2)	(3)	(4)
EW Bonus Share (instrumented)	16.871***	14.705***	10.001**	8.302**
	(4.789)	(5.351)	(4.810)	(3.728)
EW Base Salary	−10.591***	−7.360	−2.931	−1.552
	(3.786)	(4.520)	(3.228)	(2.415)
Log Assets	−0.283**	−0.126	0.083	0.129
	(0.141)	(0.156)	(0.110)	(0.101)
Net Loans/Assets	−0.001	−0.016	−0.014	−0.020**
	(0.014)	(0.015)	(0.009)	(0.009)
Crisis Dummy			1.726***	1.850***
			(0.541)	(0.554)
Obs	37	37	74	74
R	0.307	0.263	0.197	0.344
Overident. Test (p-value)	0.417	0.979	0.444	0.4402

Panel C: Second Stage with Filtered Instruments for EW Bonus Share

Dep. Variable:	Pre-Crisis Period 2003-7		Full Period 2003-11	
Log SD of Relative Trading Income	2SLS	W2SLS	2SLS	W2SLS
	(1)	(2)	(3)	(4)
EW Bonus Share (instrumented)	14.127**	12.238**	10.050*	7.690
	(5.609)	(5.879)	(5.991)	(4.761)
EW Base Salary	−8.913**	−6.068	−2.980	−1.311
	(4.051)	(4.423)	(3.721)	(2.816)
Log Assets	−0.245	−0.085	0.086	0.134
	(0.151)	(0.167)	(0.112)	(0.1005)
Net Loans/Assets	−0.002	−0.017	−0.014	−0.021**
	(0.014)	(0.015)	(0.009)	(0.009)
Crisis Dummy			1.709***	1.745**
			(0.625)	(0.705)
Obs	36	36	73	73
R^2	0.317	0.265	0.183	0.332
Overident. Test (p-value)	0.295	0.799	0.426	0.394

Table 10: Sharpe Ratio of Trading Income and Optimal Pay Incentives

We estimate a two-stage regression with the *Sharpe Ratio of Trading Income* as the dependent variable and in which the *Equally Weighted (EW) Bonus Share* (column (1)) as well as its interaction with the crisis dummy (column (2)) are instrumented in first-stage regressions by the equally weighted bonus share in *Retail Banking*, *Private Banking* and *Corporate Banking* of the same bank (= *EW Bonus Share Other Segm.*) and its interaction with the crisis dummy. Column (3) reports the second-stage regression and column (4) the OLS regression for comparison. We use the same control variables as before: *Log Assets* = natural logarithm of bank assets; *Net Loans/Assets* = net loans over bank assets; *Crisis Dummy* = 1 for years 2008 to 2011. All specifications include a constant. Robust standard errors clustered at the bank level are reported in parentheses. The symbols *,**, and *** represent significance levels of 10%, 5%, and 1% respectively.

	1st Stage		2nd Stage	
Dep. Variable:	*EW Bonus Share*	*EW Bonus Share × Crisis Dummy*	*Sharpe Ratio Trading Income*	*Sharpe Ratio Trading Income*
	2SLS	2SLS	2SLS	OLS
	(1)	(2)	(3)	(4)
EW Bonus Share Other Segm.	0.441***	0.015		
	(0.153)	(0.031)		
EW Bonus Share Other Segm. × Crisis Dummy	0.149	0.511**		
	(0.222)	(0.203)		
EW Bonus Share			−21.404*	−2.797
			(12.818)	(4.129)
EW Bonus Share × Crisis Dummy			29.472**	5.253
			(14.815)	(4.111)
EW Base Salary	0.532***	0.023	13.239*	0.946
	(0.070)	(0.021)	(7.641)	(2.861)
EW Base Salary × Crisis Dummy	−0.221**	0.326***	−17.474*	−2.151
	(0.109)	(0.085)	(8.958)	(2.880)
Log Assets	0.009*	0.001	−0.154	−0.263***
	(0.005)	(0.003)	(0.120)	(0.064)
Net Loans/Assets	0.000	0.000	−0.013	−0.011
	(0.000)	(0.000)	(0.012)	(0.008)
Crisis Dummy (= CD)	0.100	−0.170***	7.065*	−0.258
	(0.081)	(0.055)	(4.234)	(1.915)
Obs	73	73	73	79
R^2	0.646	0.822	−0.097	0.2151
$F-Test$ (H_0 : all coeff. = 0)	44.48	37.38	4.64	5.06
$F-Test$ (H_0 : IV coeff. = 0)	5.65	3.20		
$Kleibergen-Paap\ rk\ Wald\ F-stat.$		4.48		
SY weak ID test critical values (10%/15%/20% maximal size)		7.03/4.58/3.95		