Asymmetric Fund Manager Compensation and
Equilibrium Asset Pricing: Theory and Evidence from China

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Abstract

This paper studies the link between asymmetric compensation in the financial industry and equilibrium asset pricing. It shows that a severe, but not a slight, asymmetry in compensation leads to a negative Sharpe ratio, a reversed risk-return relationship, and non-diversification. Further, a careful examination reveals that in one scenario, a positive time-series and a negative cross-sectional risk-return relationship may coexist in the same market. We also find that under our assumption of riskfree rate adjusted performance fees, a manager with asymmetric compensation holds the market portfolio rather than shifting towards riskier stocks as long as the asymmetry in compensation is not severe enough to create a negative Sharpe ratio of the market portfolio. Because of pronounced asymmetric compensation in China, Chinese stock markets offer a natural laboratory for testing implications of the agency asset pricing model. Using data from China as well as the United States, we find significant and robust empirical support by employing either traditional Fama-MacBeth procedure or modifications with improved power. One of the most striking results is a negative risk-return relationship in China, which is significant both statistically and economically. Further evidence include the dominating role of total risk over beta in explaining returns, much lower E/P ratios than interest rates, and an event study based on a crackdown by the government on speculative investment by agents with *de facto* asymmetric compensation.

1 Introduction

Agency issues in the management of financial assets have significant implications for equilibrium pricing, as investigated in contributions by Allen (2001), Allen and Gale (2000a, 2000b), Allen and Gorton (1993), Arora and Ou-Yang (2000), Brennan (1993), and Cuoco and Kaniel (2001). For example, if fund managers face a small underperformance penalty but a large reward for positive performance, overpricing of assets may occur. Previous authors have argued that this scenario is relevant for North American markets, where asymmetric rewards could be due to limited liability, or because some contracts, in particular those of hedge fund managers, explicitly call for sharing of profits but not losses.

For institutional reasons, asymmetric fund manager compensation is likely to be much more important in China than North America. The majority of investment in Chinese markets comes from state-owned sources that include banks, security dealers, and the accounts of industrial corporations (Hu and Yu, 1999). Managers of state-owned enterprises face an implicit soft budget constraint that severely dampens the impact of poor investment outcomes.[1] The importance of the soft budget for financial markets is highlighted by an official crackdown in 1997 on stock investment of government capital by managers of state-owned enterprises.[2] Chinese markets therefore provide an ideal natural experiment to test the implications of agency-based asset-pricing theories.

Our contribution in this paper is to develop an agency asset pricing model that is appropriate for the setting in China, and to test its equilibrium implications. The intuition of the model is that when a fund manager benefits from gains more than he is punished for losses, the desired portfolio risk increases and affects expected returns in equilibrium. This provides three important testable implications. First, when agency problems are severe because of a high asymmetry in compensation, higher risks lead to lower expected returns,

[1] Lin and Tan (1999) state, "In a socialist economy, when a state-owned enterprise incurs losses, the government often provides it with additional funding, cuts its taxes, and offers other compensations. Coincidentally, the managers of an SOE (State-Owned Enterprise) also expect to receive financial assistance from the State. Such a phenomenon is called the soft budget constraint (SBC)." For more references on the soft budget constraint problem, see the excellent literature review by Maskin (1999). Blayney (1999) discusses issues that increase the severity of SBC, such as the misappropriation of state assets by SOE managers and the lack of monitoring by the Chinese government.

[2] The announcement of crackdown in Shanghai Securities News (1997) by regulation agencies in China points to "a sustained flow of state-owned capital to stock markets" that "boosts stock speculations and puts state-owned assets at high risk".

and the equilibrium risk-return relationship can become inverted. Second, the appropriate measure of risk is total volatility rather than covariance with the market. This is because the marginal investor in equilibrium seeks risk and thus holds a nondiversified portfolio. Finally, the degree of overpricing in the market is related to the degree of asymmetry in compensation. We test all three of these implications with a comprehensive data set of Chinese equity returns and find strong support for the agency-based model.

Our simple one-period model permits two groups of fund managers. The first group have asymmetric compensation (convex performance fees), and the second group have symmetric compensation (fulcrum performance fees), receiving the same amount of bonus per unit of profit as the penalty per unit of loss. The representative managers of these two groups are a and s respectively. Our model does not include individual investors, the role of which is subsumed by that of managers with symmetric compensation. Each fund manager is risk averse with an identical concave utility function,[3] and maximizes expected utility from consuming end-of-period compensation. At time zero, fund assets are allocated to a combination of risky and riskfree assets. No short sales are permitted, as is the real situation in China. Asset prices are derived in a partial equilibrium with fixed supply of risky assets and exogenous riskfree rate.

Relative to Manager s, Manager a underrates the downside risk because of the lack of penalty for poor performance, and hence have larger appetites for risk. The smaller the penalty relative to bonus, the larger Manager a's demand for risky assets at a given price level. In equilibrium, the larger demand by managers with asymmetric compensation leads to a higher price level of risky assets. When the penalty is sufficiently small, equilibrium stock prices are higher than present values of stocks' expected payoffs. In such a market, Manager s does not invest in the stock market because of the negative Sharpe ratio, and the no short sales constraint is binding. Welfare comparisons show that Manager a may actually be harmed in equilibrium by having a very small downside penalty. This is due to the very high stock prices resulting from a severe asymmetry in compensation.

A rise in the risk of Manager a's holdings increases both the risk and the expected value of his compensation, *ceteris paribus*. Although manager a dislikes the first effect (risk effect),

[3] Kachelmeier and Shehata (1992) carry out carefully designed experiments with real monetary incentives, and conclude that no difference exists between the risk aversion of Chinese and North American people.

the second effect (value effect) is desirable. When the first outweighs the second, manager a chooses to diversify, and a positive risk-return relationship holds. By contrast, when the value effect dominates the risk effect, Manager a chooses not to diversify, and the risk-return relationship may become negative.

In one scenario, an increase in risk raises manager a's utility, but lowers his holdings of risky assets. In equilibrium, this may generate a negative cross-sectional and a positive time-series risk-return relationship. This also implies that a time-series regression is not as strict a test as a cross-sectional one in investigating the agency asset pricing theory.

When the Sharpe ratio of the market portfolio is negative, manager a does not diversify, and the cross-sectional risk-return relationship is negative. Conversely, if the Sharpe ratio is positive, the situation is the other way around. Further, both manager a and s hold the market portfolio, though manager a does invest more in risky assets than manager s.

We test the cross-sectional risk-return relationship in China using the traditional Fama-MacBeth (1973) procedure, the Ferson and Harvey (1999) refinement, and an additional modified estimator with improved power. We find a persistently negative risk-return relationship that is both statistically and economically significant. The results are insensitive to whether risk is measured by beta or total volatility. When both beta and total volatility are included in the regression, beta is driven out and total risk dominates. This indicates that the marginal investor is nondiversified, which is again consistent with the agency theory. Finally, we use an event study to investigate overpricing in Chinese stock markets and its relation with asymmetric compensation. On May 22, 1997, regulators announced heightened punishments for speculative stock investment by managers of state-owned enterprises. In the absence of our agency theory, such an announcement should lead to a positive market reaction by improving the information content of stock prices and/or reducing the "lemons" problem from asymmetric information. However, as predicted by our model, we find a significant negative impact on stock prices around the event date. This supports the hypothesis that agency considerations can have a dramatic impact on asset prices.

The pioneering studies by Allen (2001), Allen and Gale (2000a, 2000b), and Allen and Gorton (1993) link equilibrium price bubbles with the agency problem from limited liability. Among this set, Allen and Gale (2000a, 2000b) are the closest to ours, but they assume a risk-neutral world with a single asset, and hence do not analyze either portfolio choices or the interaction between an agent's personal risk aversion and the risk-shifting agency problem.

Brennan (1993) and Cuoco and Kaniel (2001) study the implications of performance fees for asset prices in equilibrium. Cuoco and Kaniel (2001) extend Brennan's (1993) static one-period model with symmetric (fulcrum) performance fees to a continuous setting with either symmetric or *asymmetric* performance fees. Different from our model, Cuoco and Kaniel (2001) use market index rather than riskfree rate as the benchmark for performances,[4] and assume no penalty for under-performance in asymmetric compensation contracts. They focus on the pricing differences between index and non-index stocks, not *aggregate* overpricing of the market portfolio or the risk-return relationship at the market level. It can nonetheless be inferred that the market portfolio cannot have a negative Sharpe ratio in their model. Moreover, our simple model enables us to investigate the impact of asymmetric compensation on equilibrium asset pricing with functional analysis, while Cuoco and Kaniel (2001) must use numerical analysis. Arora and Ou-Yang (2000) endogenize both compensation contracts and asset prices, but the asymmetric compensation in China does not belong to one of the optimal compensation contracts derived in their study.

With given asset prices, many researchers have studied the agency problem arising from performance fees or limited liability. Important contributions include Admati and Pfleiderer (1997), Brander and Lewis (1986), Carpenter (2000), Heinkel and Stoughton (1994), Ou-Yang (2000), Starks (1987), and others. Ou-Yang (2002) endogenizes asset prices, but focuses on the moral hazard in a firm rather than in the financial industry.

Brennan (1993) empirically investigates the impact of symmetric performance fees on the equilibrium structure of asset pricing. Brown, Harlow, and Starks (1996), Elton, Gruber, and Blake (2003), and Chen and Pennacchi (2002) take asset prices as given and investigate implications of performance fees for other issues such as fund performances and fund's choice of risk. Our work is unique in empirically testing the equilibrium pricing implications of *asymmetric* compensation.

Previous empirical work on Chinese stock markets includes Lee, Chen, and Rui (2001)

[4] See Shirley and Xu (2000) and Xu (2000) for evidence on the structure of performance contracts in China.

who use a GARCH-M specification to investigate the relation between market index returns and volatilities. This is a time-series analysis of the risk-return relationship based on conditional CAPM. They seek evidence of a positive risk-return relationship, and reject this hypothesis. Careful inspection of their results, however, shows a significantly negative risk-return relationship in Shanghai *A-Shares*,[5] consistent with our theory. Our empirical work adds to this evidence by using traditional Fama-MacBeth method as well as modifications with improved power to show a strong and persistent cross-sectional negative relation between risk and return in Chinese *A-Shares*.

There is a rich literature on the pricing differences between Chinese A-Shares and B-Shares, such as Diao (2002), Fernald and Rogers (2002), Gordon and Li (2001), and Su (1999). All of these show that A-Share prices are many times higher than B-Share prices. Considering that asymmetric compensation is much milder among international investors in Chinese B-Share markets than Chinese investors in A-Share markets, our agency asset pricing model may contribute to a better understanding of such pricing differences from a new angle.

Shirley and Xu (2000) and Xu (2000) investigate compensation contracts of SOE managers in China, and find that in general the performance contracts for SOE managers lead to negative or insignificant performance improvement. This is consistent with our argument, for the lack of penalty for losses may lead managers to undertake projects with negative present values.

The rest of this essay proceeds as follows. Section 2 develops and characterizes the model: Agency Capital Asset Pricing Model, then extends it to multiple assets. Section 3 conducts numerical analysis. After the empirical tests in Section 4, Section 5 concludes.

2 Agency Asset Pricing Model

In the traditional CAPM, which assumes a perfect market with no agency problems in the financial industry, asset prices depend only on risk. By contrast, this paper takes into

[5]In China, shares open to Chinese investors only are called *A-Shares*, and shares open to foreign investors only are called *B-Shares*. Such ownership restrictions have changed recently, but not in our sample period.

specific account the agency problem resulting from asymmetric fund manager compensation. This makes the investment decision of a fund manager different from one pursuing the best interests of fund owners. Consequently, an asset's price depends not only on its risk, but also on fund managers' compensation.

For parsimony, we first assume a single risky asset in addition to a riskless bond in the market, and then extend the model to multiple risky assets at end of this section. The riskfree rate is given, and the end-of-period payoff of the risky asset is $\tilde{\pi}$, following a normal distribution $N(\mu, \sigma)$. Without loss of generality, total claims on the risky asset are normalized to a single share that is infinitely divisible, and the riskfree rate is normalized to zero.

Our static one-period model permits two types of fund managers: managers with asymmetric and symmetric compensation. The mass of the each group of managers is denoted by ω and $1-\omega$ respectively, where $\omega \in (0,1)$. We call the representative manager with asymmetric (symmetric, respectively) compensation Manager a (s, respectively). For $i \in \{a, s\}$, the size of Fund i is W_i. Manager i's compensation (w_i) includes a fixed salary δ_i,[6] plus a bonus of \$$b$ per Fund i's \$1 profit, and minus a penalty of \$$p$ per Fund i's \$1 loss, where profits and losses are riskfree rate adjusted performances. We call b the *bonus rate*, and p the *penalty rate*. The equality $b = p$ always holds for Manager s, and we assume $b \geq p$ for Manager a unless otherwise specified. To gauge the severity of the asymmetry in manager a's compensation, we define *compensation ratio* as $c = p/b$. In our model, the role of Manager s is similar to an individual investor who directly invests in the stock market with his own wealth, and so without loss of generality, we have only the two types of fund managers in our model. We also leave out a fund manager's personal investment in the stock market, for a fund manager in our model does not make any such investment anyway. No short sales are permitted.

At the beginning of the period, Manager i allocates fund i's assets to the risky asset and the riskless bond, with an objective to maximize his personal utility from consuming end-of-period compensation. All managers are risk averse with identical CARA utility $-\exp(-\gamma\tilde{w}_i)$, where γ is a positive constant and $\tilde{w}_i$ is the terminal compensation. For ease of notation, we define $x^+ = \max\{x, 0\}$, and $x^- = \max\{-x, 0\}$. Facing given market price (P) of the risky

[6] Manager i's reserve utility is assumed to be satisfied by δ_i alone.

asset, Manager i's ($i \in \{a, s\}$) investment problem is

$$\max_{D_i \geq 0} E\{-\exp(-\gamma \tilde{w}_i)\} \tag{1}$$

s.t.

$$\begin{aligned} \tilde{w}_i &= \delta_i + D_i \tilde{\pi}_i \\ W_i &= D_i P + C_i \end{aligned}$$

where $\tilde{\pi}_a = b(\tilde{\pi} - P)^+ - pD_i(\tilde{\pi} - P)^-$, $\tilde{\pi}_s = b\tilde{\pi}$, C_i is the amount of investment in cash, and D_i is the amount of shares in Fund i's holdings. The first constraint is the compensation contract, and the second one is the budget constraint.

For Manager s, (1) forms a standard mean-variance maximization problem: $\text{MAX}_{D_s \geq 0}\ \{(\mu - P)D_s - 0.5b\gamma\sigma^2 D_s^2\}$. Taking first order conditions, yields

$$D_s = \frac{(\mu - P)^+}{b\gamma\sigma^2}. \tag{2}$$

For Manager a, we first derive Lemma 1:

Lemma 1 *Manager a's utility maximization problem is equivalent to*

$$\max_{D_a \geq 0} -M(-S + b\gamma D_a \sigma) - M(S - p\gamma D_a \sigma), \tag{3}$$

where $S = (\mu - P)/\sigma$, $M(x) = \big(1 - \Phi(x)\big)/\phi(x)$, and $\phi(x)$ and $\Phi(x)$ are the density and distribution functions of a standard normal variable. $M(x)$ is strictly decreasing in x.

Here S is *Sharpe ratio*, and $M(x)$ is the well-known *Mill's ratio*. The first part in equation (3) is a proxy for manager a's expected utility from future bonus, and the second part represents manager a's expected suffering from future penalty. The reverse of Sharpe ratio ($-S$) is the standardized kink (benchmark point) of the risky asset's terminal payoff above which manager a receives bonus, and $-S + b\gamma D_a \sigma$ (or $-S + p\gamma D_a \sigma$, respectively) is the risk-adjusted kink for future bonus (penalty, respectively).[7] Since market price is taken as given

[7]Equation (3) is improper for examining the relationship between manager a's expected utility and the standardized kink, for a multiplicative part is droped out during the transformation from (1) to (3). This dropped component is a function of S.

by managers, S is treated as a constant in managers' utility optimization. Therefore, it is straightforward that an increase in D_a leads to higher expected utility from future bonus as well as more expected suffering from future penalty, noting that $M(x)$ is strictly decreasing in x. Manager a chooses his optimal level of investment to achieve his maximum expected utility.

Denoting $m(x)$ as the derivative function of $M(x)$, we get the first order condition of Manager a's optimization:

$$m(S - p\gamma D_a \sigma)p = m(-S + b\gamma D_a \sigma)b. \tag{4}$$

In (4), $m(S - p\gamma D_a\sigma)$ and $m(-S + b\gamma D_a\sigma)$ stand for risk-adjusted marginal loss and profit respectively. Using constant equivalent terms, equation (4) requires that a larger b than p must be met with a proportionally smaller marginal profit than marginal loss, such that the marginal bonus from holding riskier asset equals the marginal penalty.

2.1 Equilibrium and Its Properties

Putting together equations (2-4) and the market clearing condition $1 = (1-\omega)D_s + \omega D_a$, yields

Proposition 1 *In equilibrium, the implicit pricing function is*

$$m\left(S + \frac{1-\omega}{\omega}cS^+ - \frac{p\gamma\sigma}{\omega}\right)p = m\left(-S - \frac{1-\omega}{\omega}S^+ + \frac{b\gamma\sigma}{\omega}\right)b. \tag{5}$$

When the Sharpe ratio is negative, the no-short-sales constraint is binding, and the market clearing condition reduces to $1 = \omega D_a$. This is why the second items inside brackets of equation (5) exist only if the Sharpe ratio is positive. The transcendental equation (5) has no closed form solution. We can, however, study major issues of concern by characterizing this function.

First, we study how the asymmetry in compensation affects the market price in equilibrium. We define *compensation ratio* as $c = p/b$ and use it to gauge the severity of asymmetry.

The lower the value of c, the more asymmetric manager s's incentive compensation. By inspecting the implicit derivative function of P with respect to c, we derive the relationship between market price and compensation ratio. Without loss of generality, we hold b as a constant and derive the following:

Property 1 *For $c \in (0, 1]$, $\partial P/\partial c < 0$. Further, $P \to \mu - b\gamma\sigma^2$ as $c \to 1$, and $P \to \infty$ as $c \to 0$.*

Proposition 1 shows that the lower the compensation ratio, the higher the market price. A very small compensation ratio leads to a market price that is much higher than its intrinsic value since $P \to +\infty$ as $c \to 0$. In such a situation, the Sharpe ratio is much smaller than zero.

In China, stock markets are widely considered to be a "policy market", partly due to the fact that Chinese stock markets often fluctuate abruptly and turbulently as the government changes its policy. One reason for this phenomenon is the government's power to change the intensity of its monitoring on investments by SOE managers and government officials, and hence these agents' *de facto* compensation ratio. For example, when the government loosens punishment on stock investments by these agents, c goes down, and so P rises. In this scenario, rising bubbles can form in Chinese stock markets.

Next, we examine the relationship between the level of risk (standard deviation of the risky asset's terminal payoff) and the required rate of return in equilibrium.

Property 2 *The risk-return relationship in equilibrium is negative if and only if the Sharpe ratio is smaller than $-\gamma\sigma\theta/\omega$, where θ is a weighted average of b and p.*[8]

Proposition 2 indicates that a slightly lower penalty rate than bonus rate does not necessarily lead to a negative risk-return relationship. The intuition is as follows. Managers a's investment decision for fund a is equivalent to a decision of investing his personal wealth in an asset a: $\tilde{\pi}_a = b(\tilde{\pi} - P)^+ - p(\tilde{\pi} - P)^-$. With price fixed, an increase in the variance of $\tilde{\pi}$ inflates both the expected value of and the variance of $\tilde{\pi}_a$.[9] When the compensation

[8]For definition of θ, see proof of Property 2 in Appendix B.

[9]Mathematically, there can be a situation when the increase in σ does not increase $E\{\tilde{\pi}_a\}$. However, such a situation is not admissible in this model, for it requires the expectation of $\tilde{\pi}_a$ to be negative in the first

ratio is close to one, the second effect dominates the first, and manager a makes risk averse investment decisions. By contrast, if the compensation ratio is close to zero, the first effect dominates the second, and manager a makes risk-seeking investment decisions. Therefore, the risk-return relationship depends on the severity of the asymmetry in compensation.

We have also found a linear relationship between price and expected off: $\partial P/\partial\mu = 1$. Therefore, the overpricing of the risky asset comes only from the misevaluation of its risk component, not its fundamental value. This has an implication for the comparison between *A-Share* and *B-Share* market reactions to events in China: when there is news about a shock to a firm's cash flow, abnormal returns in *A-Share* market should have a smaller magnitude than in *B-Share* market. However, if the news affects the firm's risk and/or agents' aggregate compensation ratio, it may cause a larger change in *A-Share* than in *B-Share* returns. This is consistent with evidence in literature.

2.2 Extension to Multiple Assets

In the following, we replace the assumption of a single risky asset with two risky assets, and examine managers' portfolio choices and risk-return relationship in equilibrium. The terminal payoffs of the two risky assets are $\tilde{\pi}_1$ and $\tilde{\pi}_2$ respectively. For $j \in \{1, 2\}$, $\tilde{\pi}_j = \tilde{\pi}_m + \tilde{\varepsilon}_j$, where $\tilde{\pi}_m \sim N(\mu, \sigma_m^2)$ and $\tilde{\varepsilon}_j \sim N(0, \sigma_j^2)$. The random variables $\tilde{\varepsilon}_1$, $\tilde{\varepsilon}_2$, and $\tilde{\pi}_m$ are independent of each other. Other assumptions remain the same.

For $i \in \{a, s\}$, manager i takes market prices (P_1 and P_2 for asset I and II respectively) as given and invests in bonds and risky assets on behalf of fund i. The objective is to maximize his personal utility from compensation: $\text{MAX}_{D_i \geq 0,\ 0 \leq \alpha_i \leq 1}\ \text{E}\left\{-\exp(-\gamma\tilde{w}_i)\right\}$, where α_i is the percentage of asset I in manager i's stock portfolio, and D_i is the amount of his holdings of such a portfolio. Manager i's optimization is subject to the budget constraint $W_i = D_{i,p}P + C_i$ and his compensation contract $\tilde{w}_i = \delta_i + D_i\tilde{\pi}_i$, where $\tilde{\pi}_s = b\tilde{\pi}_p$, $\tilde{\pi}_a = b(\tilde{\pi}_p - P_p)^+ - p(\tilde{\pi}_p - P_p)^-$, $\tilde{\pi}_p = \alpha_i\tilde{\pi}_1 + (1-\alpha_i)\tilde{\pi}_2$, and $P_p = \alpha_i P_1 + (1-\alpha_i)P_2$. The Sharpe ratio of manager i's portfolio is $S_p = (\mu - P_p)/\sigma_p$, where $\sigma_p^2 = \sigma_m^2 + \alpha_i^2\sigma_1^2 + (1-\alpha_i)^2\sigma_2^2$. Putting together the market clearing condition and manager s and a's utility optimization, we derive the following property:

place, which cannot exist in equilibrium: Manager a is a risk averse individual as well, and so does not hold a risky asset with a negative mean for himself.

Property 3 *When the Sharpe ratio of the market portfolio is positive, both manager a and s choose to hold the market portfolio, and the cross-sectional risk-return relationship is positive. When the Sharpe ratio is negative, however, manager a chooses not to diversify, and the cross-sectional risk-return relationship is negative.*

This property shows that the cross-sectional risk-return relationship strictly depends on whether the compensation ratio is so low that the equilibrium price of the market portfolio exceeds its expected payoff. Contrary to the intuition that manager a should tilt his portfolio toward the riskier asset, Property 3 discovers that manager a holds the market portfolio when the Sharpe ratio of the market portfolio is positive. We have also found that in equilibrium, it is impossible to have a positive Sharpe ratio for one asset and a negative Sharpe ratio for the other. This claim may not hold if the two risky assets are negatively correlated, noting that we have implicitly assumed a non-negative correlation between risky assets in this model.

The pricing functions are given by a system of equations when the Sharpe ratio is negative: i) two separate first order conditions (one for each risky asset) from manager a's utility optimization ii) the equality between the maximum utility achieved from holding either asset iii) the market clearing condition. When the Sharpe ratio is positive, all managers invest in the market portfolio, and the price of the market portfolio is obtained by employing the pricing function (5) for the case of a single asset. Next, the relative prices between risky assets are derived following the same method as in a standard CAPM.

In property 2, we find that the market price of the single risky asset *may* decrease with respect to risk in equilibrium even if the Sharpe ratio is negative. This may appear to be a contradictory to property 3, which states that Manager a always chooses not to diversify as long as the Sharpe ratio is negative. The explanation for this lies in the equilibrium effect of a change in risk. This has important for implications for empirical analysis, indicating the potential coexistence of a positive time-series and a negative cross-sectional risk-return relationship in the same market. In next section, we give an illustration of this phenomenon with a numerical analysis.

3 Numerical Illustration

3.1 Single Risky Asset

Using numerical analysis, this subsection illustrates properties of our model with a single risky asset. The parameters are set as follows: $\gamma = 0.5$, $\mu = 10$, and $\omega = 0.5$. Then, we fix the bonus rate at 0.05, and allow the compensation ratio to vary between 1 and 0.02. The value of σ fall in $[0.05\mu, 0.30\mu]$. This means a standard deviation from 5% to 30% of expected payoff, close to what it should be in the real world. We solve for the market price in equilibrium for each combination of the two pricing factors (compensation ratio and risk), and investigate their relationship. Next, we calculate each manager's utility and holdings of the risky asset in equilibrium, and examine how managers' welfare and market shares vary according to different market conditions. Last, we reduce the fraction of managers with asymmetric compensation from 50% ($\omega = .5$) to 20% ($\omega = .2$), and inspect how market prices reacts to such a shift. For ease of comparison, the unit of P and σ in all figures is standardized to μ throughout this analysis and the numerical example in next section.

Figure 1 is a 3-D view of the agency asset pricing model. It shows that the market price increases with the compensation ratio, and price-risk relationship depends on compensation ratio. When compensation is low, price decreases with risk, indicating a positive risk-return relationship. As compensation ratio decreases, however, price-risk curve bends upward and eventually becomes upward sloping.

Figure 2 provides cross-sectional views of Figure 1. Figure 2(a) shows that P is decreasing in c. The value of σ affects only the slope of the price-compensation ratio curve, but not the sign of it. In Figure 2(b), we find that when $c = 1$, the market price decreases with σ, as in a standard CAPM. This is not surprising since $c = 1$ means symmetric compensation for all managers. When c is slightly less than 1, the price-risk relationship remains negative, as shown by the curve at $c = 0.9$. On the other hand, P is strictly increasing in σ at $c = 0.02 \ll 1$, where the Sharpe ratio is negative. This demonstrates that a slight asymmetry in compensation may not lead to a negative risk-return relationship, but a sever asymmetry does. The price-risk curve at $c = 0.6$ shows that P is higher than the present value of the risky asset's expected payoff. This suggests that even a moderate asymmetry in compensation may have dramatic impact on asset pricing. Further, market price decreases with risk after reaching its maximum value at $\sigma = 260$, demonstrating a scenario where the price-risk relationship is negative even when the Sharpe ratio is smaller than zero. We will discuss more on this in next subsection.

With $\delta_s = \delta_a = 1$, Figures 3(a) and 3(b) shows that manager a's utility increases with compensation ratio at first, and then decreases after c reaches a certain kink. This suggests that a very low compensation ratio also harms managers with asymmetric compensation. Figures 3(c) and 3(d) illustrate manager a and manager s's holdings of the risky asset in equilibrium. Both managers have the same demand at $c = 1$, but manager s's market share decreases with c and vanishes once the asset's price is higher than its expected payoff.

The proportion of managers with asymmetric compensation also affects the level of market price in equilibrium. Figure 4(a) shows that the market price falls upon a reduction of ω from 0.5 to 0.2, and the cross-sectional views evidence that the market price falls more for a riskier stock. Together with an assumption that the composition of managers do change over time, this may help explain the formation of bubbles.

3.2 Multiple Risky Assets

This subsection uses a numerical example to illustrate a scenario where the aggregate market price decreases with the aggregate market risk, while manager a still exhibits risk-seeking behavior by choosing not to diversify. Throughout this example, we set $c = 0.6$, which insures the rise of the scenario described above. We replace the single asset in last subsection with two risky assets with identical distribution ($\sigma_1 = \sigma_2$),[10] and set $\sigma_m^2/ = \sigma_1^2 = 99/2$. In such a setting, the standard deviation of a risky asset ($\sqrt{\sigma_m^2 + \sigma_1^2}$) is half a percent higher than that of the market portfolio (σ). To be consistent with last subsection, we set $\mu = 5$ so that the sum of the two risky assets' expected payoffs is still 10. All other parameters are set as in last subsection.

The analysis in this example includes two stages. First, we force managers to hold the

[10] In this situation, the two risky assets must have the same market price, and such a simplistic assumption helps us focus on manager a's portfolio choice without involving the complexity of an explicit analysis of the cross-sectional risk-return relationship.

market portfolio and inspect the relationship between σ and P. This reduces to the case of a single asset, and we obtain a non-linear price-risk relationship, as shown in the top diagram of Figure 5. Market price is clearly higher than one for all σ, indicating a negative Sharpe ratio and non-investment by manager s. Therefore, we only need to consider manager a. Second, manager a takes the market price in the top diagram as given, and choose $\alpha \in [0, 1]$ to maximize his utility. As shown in the second diagram, we find that manager a always holds one asset only, even for $\sigma \in [0.26, 0.35]$ where P decreases with σ.

The results above confirm the properties inferred from functional analysis in Section 2. Next, we show why manager a chooses not to diversify even when P decreases with σ. The answer lies in the equilibrium effect. The third diagram displays manager a's optimal demand for risky assets when forced to hold the market portfolio ($D^*_{a,\ \alpha_a=.5}$) vs. when allowed a free choice ($D^*_{a,\ \alpha^*_a \in[0,1]}$). In the range of $\sigma \in [0.05, 0.26)$, $D^*_{a,\ \alpha_a=.5} < D^*_{a,\ \alpha^*_a \in[0,1]}$ means that an increase in the risk of manager a's portfolio leads to an increase in his demand. In equilibrium, such a increase in demand drives up the market price. This is why P increases with σ if $\sigma < 0.26$. By contrast, $D^*_{a,\ \alpha_a=.5} > D^*_{a,\ \alpha^*_a \in[0,1]}$ if $\sigma > 0.26$. This explains why the price-risk curve in the top diagram slopes down in the range $\sigma \in [0.26, 0.35]$.

A close examination of the third diagram reveals that $D^*_{a,\ \alpha_a=.5} - D^*_{a,\ \alpha^*_a \in[0,1]}$ is much smaller than half a percent of $D^*_{a,\ \alpha_a=.5}$ in the interval $\sigma \in [0.26, 0.35]$. Noting that the standard deviation of manager a's portfolio increases half a percent as he moves from $\alpha_a = .5$ to $\alpha^*_a \in [0, 1]$, this manifests a larger amount of total risk in manager a's holdings even though he holds less shares of risky assets. Therefore, manager a is still risk-seeking, but his appetite for risk does not grow as fast as the risk of his portfolio, leading to a lower demand for risky assets and a negative aggregate price-risk relationship in equilibrium.

The bottom diagram compares the shift in manager a's maximum utility when moving from $\alpha_a = .5$ to $\alpha^*_a \in [0, 1]$. It confirms that manager a does benefit from holding a riskier portfolio – a single risky asset. This also indicates that a riskier asset is more desirable even if $\sigma > 0.26$, and hence a negative cross-sectional risk-return relationship should persist.

4 Empirical Tests

4.1 Data

Our data come from a number of sources: the Shanghai Stock Exchange, the Shenzhen Stock Exchange, Shenyin Wanguo Securities Company, Shanghai Jiao Tong University, Wan De Consulting, and Datastream. In addition, we also use CRSP and COMPUSTAT databases to retrieve U.S. data, such as the SP500 returns used in a comparison study. Our sample period for Chinese data is from Jan 1, 1993 to Dec 31, 2000. We exclude the period before 1993 because of two reasons: the limit on daily price movement before May 1992 and the small sample size before 1992. By contrast, stock prices from 1993 to 2000 face few binding hurdles in daily movements, and stock price movement resembles much more of a random walk than a straightforward upward trend. Moreover, both Chinese *A*- and *B-Share* markets have been expanding very quickly since early 1993. By the end of 2000, there were 559 *A-Share* firms listed in the Shanghai Stock Exchange, and another 500 *A-Share* firms listed in the Shenzhen Stock Exchange.

Following a logic similar to the one adopted by CRSP in calculating returns for U.S. stocks, we use the transaction and distribution data collected from China to construct the Chinese database of returns in our study. For reported results, our guideline is to use the data from Datastream unless Datastream data are missing or proven to be inaccurate. This keeps our empirical tests as comparable with other samples of work as possible. To check the robustness of our tests, we repeat our tests using filtered data, for the existing literature has shown that empirical results are often sensitive to the exclusion of outliers. For each firm-year, we first calculate the deviation of daily returns relative to market index returns, and then standardize such index-adjusted excess returns with the standard deviation in each firm-year. These are called *Standardized Abnormal Returns (SARs)*. We exclude the top and bottom 1% of i) the entire sample ii) each firm series of SARs, then repeat the tests. Further, we repeat tests with data from different sources.

Table 1 compares the E/P ratios with the interest rates on one-year fixed term bank deposits.[11] Table 1 shows that the interest rate is much higher than the E/P ratio most of

[11] In China, treasury bills were not a feasible investment choice for the public until recently, and the official

the time. This may be explained by two alternative hypotheses: either the high growth rate of Chinese firms or the existence of agency problems from asymmetric compensation.[12] If we accept the first hypothesis, the risk-return relationship should remain positive, as predicted by the traditional CAPM or its variants. On the contrary, if agency problems do exist, a negative risk-return relationship may prevail. In the rest of this section, we first test the risk-return relationship, then conduct an event study on the existence and impact of asymmetric compensation.

4.2 Tests of Risk and Return

Methodology The well-known Fama-MacBeth (1973) procedure is a two stage regression. First, they estimate sample firms' betas and other factors using "rolling" historical data. Second, they conduct a cross-sectional regression of returns on these estimated factors period by period. Fama-MacBeth (1973) calculate the arithmetic average of factor coefficient estimators and use a t-statistic to determine whether each factor coefficient is significantly different zero. A drawback of the Fama-MacBeth (1973) procedure is the loss of statistical power. An arithmetic average of factor coefficient estimators gives each cross-sectional regression an equal weight, but the accuracy of factor coefficient estimators tend to vary over time, owing to different sample size and/or noises. Ferson and Harvey (1999) propose a pooled regression in the second stage rather than the period-by-period cross-sectional regression in Fama-MacBeth (1973). Such a pooled regression addresses the differences in the accuracy of coefficient estimates over different time periods, but Ferson and Harvey (1999) make an implicit assumption of no time effects, upon which we do not agree. We argue that pooled returns should have significant time effects, which leads to serious distortion in coefficient estimators in a pooled regression. One argument in support of time effects comes from the fact that time-series shocks to macroeconomic variables do affect market-wide stock returns. Fama-MacBeth (1973) have implicitly incorporated time effects with the intercept term in their cross-sectional regression at each time period.

interest rates are the effective riskfree rates to Chinese residents.

[12]Contrary to the small firms listed in NASDAQ which may give investors plenty of room for growth imagination, the firms listed in the Shanghai Stock Exchange (SHSE) are mainly large cap stocks that have been in operation for many years before going public. Moreover, unlike the high tech industry in NASDAQ, most Chinese firms listed in the SHSE are mature and relatively stable companies. Anyhow, here we just give two alternative explanations, and leave the choice to empirical tests.

To account for both the heteroskedasticity of coefficient estimates and the time effects of stock returns, we propose panel analysis with fixed time effects. Appendix A discusses this further. In the following, we test the risk-return relationship in China following different procedures, then repeat the same tests with U.S. data as a comparison.

Results We see in Table 2 that each of the three risk measures has a significant negative coefficient when used separately in the regression. This indicates that the higher the risk, the lower the return. Moreover, the measure of total risk dominates two other risk measures for residual risk and market risk.[13] This is exactly the prediction of our model, where managers with asymmetric compensation do not diversify when the market sharpe ratio is negative, caring about a firm's total risk only.

Table 2 shows beyond-doubt fixed time effects based on the F-test statistics. This supports our argument for the existence of time effects. Second, the significance level of each risk measure coefficient is much stronger in this table than the counterpart in Table 3, which indicates the improved efficiency of our empirical procedure than Fama-MacBeth (1973).

In Table 2, we also see that the loading for the measure of market risk, β, is over 1% for the entire sample of listed Chinese firms. This indicates that an aggregate Chinese investor is willing to sacrifice more than 1% of return in a typical month to hold a stock with exactly the same level of risk as the market index.

Some people may be concerned that if the market return is negative in the sample period, it may contribute to the negative risk return relationship. Our answer lies in the following two arguments. First, the market indices have risen around 100% during our sample period, and such an argument of conditional market movement can only strengthen our results. Second, we have used fixed time effects in our model, which absolves the impact of market-level return variations over time.

To check the robustness of our tests, we have repeated our tests in a variety of ways, including different subsamples (the Shanghai Stock Exchange v.s. the Shenzhen Stock Exchange), different return intervals (monthly v.s. weekly observations), different rolling pe-

[13] We exclude the model with all three risk measures being independent variables, for the total risk of each firm is in fact the sum of its market risk and idiosyncratic risk, and hence a multi-linearity problem may show up if putting all of them in one regression.

riods (3 years, 2 years, and 5 years), different stock indices (value-weighted v.s. equal weighted), different updating periods of factor estimators (once a year v.s. every time period), different grouping (individual firms v.s. sorted portfolios), different data filtering procedures, and different data sources. The results are persistently similar.[14]

Table 3 shows coefficient estimators from the Fama-Macbeth (1973) procedure. The results are significant and consistent with our agency asset pricing model, but far from so strong as in table 2. Though not reported here, we have also run pooled regressions following Ferson and Harvey (1999), and the results are similar, with significance levels falling between Table 3 and Table 2.

4.3 An Event Study: Crackdown on AMC

In May 1997, the government announced a crackdown on illegal stock trading by managers and officials in state-owned sectors. Here we quote part of the announcement by the government:

> *"Some SOEs and listed companies invest in stock markets with bank loans; ... and some invest in stock markets with capital allocated for corporate development and expansion. This not only boosts stock speculations, but also exposes state-owned capital to excessive risk. Such speculative trading by SOEs and listed firms must be prohibited so as to maintain orders in stock markets."*

Since SOE managers and government officials are *de facto* agents with asymmetric compensation, this event offers a good opportunity for an event study. Some people may doubt the enforcement of the crackdown. We argue that, while acknowledging the limit of the government's enforcing ability, such a crackdown should at least have some marginal effect, and hence remain a solid event for investigating the impact of a change in the severity of asymmetric compensation on asset prices.

Table 4 shows the results. Using the base window as benchmark, Panel A shows that the abnormal returns in the event window are significantly negative. This provides empirical

[14] See Diao (2002) for details.

support for the significant market impact of agents with asymmetric compensation, against the null hypothesis that no agents exist, or that the market reaction should be positive because of a reduction in the "lemons" problem from asymmetric information. Meanwhile, the pre-event window period also exhibits significant negative returns, indicating leakage of information on the crackdown before the government made the public announcement on May 22, 1997. Further, a cross-sectional regression serves as a stronger test against the null hypothesis that no agency problem from asymmetric compensation exists in the market. According to traditional CAPM, it should be beta rather than total risk that explains the cross-sectional differences in abnormal returns of listed firms. The results in Panel B, however, show that total risk is not only a significant factor, but also dominates the role of beta. This lends further support to the agency theory.

5 Conclusion

Asymmetric compensation, together with the no short-sale constraint, leads to severe overpricing and non-diversification in China. A negative risk-return relationship also arises from a sufficiently low penalty for underperformance. It is also shown that an excessively low penalty rate is not beneficial for managers with asymmetric compensation, for the competition among managers forces themselves to pay high prices for risky assets.

A careful examination of the risk-return relationship in a model with a single risky asset vs. one with multiple assets leads to a surprise inference: a positive time-series and a negative cross-sectional risk-return relationship may coexist in the same market. We also find that under our assumption of profit/loss based incentive fees, a manager with asymmetric compensation holds the market portfolio rather than shifting towards riskier stocks as long as the Sharpe ratio of the market portfolio remains positive.

Our tests find a significant and robust negative cross-sectional risk-return relationship in China, which is in sharp contrast with the traditional CAPM, but consistent with our model. The dominance of total risks over idiosyncratic risks and betas support another implication of our model: non-diversification. In addition, the event study provides supporting evidence for the existence of agents with *de facto* asymmetric compensation in Chinese stock markets.

Appendices

A Empirical Procedure

The use of panel data with time effects is not new: see Hsiao (1986) and Greene (1999) for full references. Below we show why this method has an advantage over the procedures in Fama-MacBeth (1973) and Ferson and Harvey (1999). We first write the panel data regression with fixed time effects in the following matrix form:

$$Y = D\alpha + X\beta + \varepsilon \tag{6}$$

where $y = [y_1', y_2', ..., y_T']'$, $\alpha = [\alpha_1, \alpha_2, ..., \alpha_T]'$, $X = [x_1', x_2', ..., x_T']'$, $\varepsilon = [\varepsilon_1', \varepsilon_2', ..., \varepsilon_T']'$, and $D = [e_1, e_2, ..., e_T]$. Here $e_t = [0_1', ..., 0_{t-1}', 1_t', 0_{t+1}', ..., 0_T']'$, and the variance-covariance matrix of the error term, ε, is Ω. After a M_D transformation, where $M_D = I - D(D'D)^{-1}D'$, (6) becomes

$$M_dY = M_dX\beta + M_d\varepsilon \tag{7}$$

The intuition for the transformation is as follows. First, by definition $M_D = diag[M_1, M_2, ..., M_t, ..., M_T]$, where $M_t = I_t - \frac{1}{size_t}1_t1_t'$ for $t \in 1, 2, ..., T$. Meanwhile, for a vector Z_t, $M_tZ_t = Z_t - \bar{z}_ti$, where $\bar{z}_t$ is the mean of Z_t. Therefore, the panel data regression with fixed time effects is equivalent to a simple pooled regression with dependent and independent variables being first transformed to cross-sectional mean-deviations.

Fama-MacBeth (1973) run the following regression for each time period t

$$Y_t = \alpha_t + X_t\beta + \varepsilon_t, \tag{8}$$

then conduct a t-test to determine whether the simple time-series average of the β_t estimators is different from 0. A M_t transformation of (8) gives

$$M_tY_t = M_tX_t\beta_t + M_t\varepsilon_t \tag{9}$$

It is straightforward that the estimator of β_t in (9), b_t, is in fact the same as the estimator in (8). From (7), we get the GLS estimator of β

$$b = [X'M_d'\Omega^{-1}M_dX]^{-1}[X'M_d'\Omega^{-1}M_dY] \tag{10}$$

Assuming that there is no time-series correlation in the residuals ε, we can rewrite (10) as

$$b = \Sigma \ \ [\Sigma \ X_t' M_t' \Omega_t^{-1} M_t X_t]^{-1} \cdot [X_t' M_t' \Omega_t^{-1} M_t X_t] \cdot b_t \tag{11}$$

where $b_t = [X_t' M_t' \Omega_t^{-1} M_t X_t]^{-1} [X_t' M_t' \Omega_t^{-1} M_t Y_t]$ is the GLS estimator of β_t in (9). Since $Est\, VAR\{b_t\} = [X_t' M_t' \Omega_t^{-1} M_t X_t]^{-1}$, b is a weighted average of $b_t, t = 1, ..., T$, and the weight for each period t is a multiple of the inverse variance-covariance matrix of the estimated b_t. Therefore, similar to Ferson and Harvey (1999), we conclude that the GLS estimator b in panel data regression with fixed time effects has improved efficiency over the simple arithmetic average of b_t in Fama-Macbeth (1973).

Ferson and Harvey (1999) use the following pooled regression $Y = \alpha_0 + X\beta + \varepsilon$, where $y = [y_1', y_2', ..., y_T']',$, $X = [x_1', x_2', ..., x_T']',$, $\varepsilon = [\varepsilon_1', \varepsilon_2', ..., \varepsilon_T']'$, $E(\varepsilon\varepsilon') = \Omega$, and α_0 is a constant. The GLS estimator b in Ferson and Harvey (1999) is

$$b = [X' M_{one}' \Omega^{-1} M_{one} X]^{-1} [X' M_{one}' \Omega^{-1} M_{one} Y] \tag{12}$$

where $M_{one} = I - \vec{1}(\vec{1}'\vec{1})^{-1}\vec{1}', \vec{1} = [1_1, 1_2, ..., 1_{m1}, ..., 1_{mt}, ..., 1_{mT}]'$. By implicitly assuming no time effects, Ferson and Harvey (1999) show that their pooled regression has improved efficiency over Fama-MacBeth (1973). However, with time effects being considered, the estimator in (12) is obviously not as accurate or efficient as the estimator in (10) and (11).

B Proofs

Notation For ease of notation, we define the following functions and symbols:
$\boldsymbol{\Phi(x)} = \int_{-\infty}^{x} e^{-z^2/2}/\sqrt{2\pi}\,\mathrm{d}z$, $\boldsymbol{\phi(x)} = e^{-x^2/2}/\sqrt{2\pi}$, $\boldsymbol{h(x)} = \phi(x)/\big(1 - \Phi(x)\big)$,
$\boldsymbol{M(x)} = 1/h(x)$, $\boldsymbol{\Psi(x)} = xM(x)$, $\boldsymbol{\psi(x)} = \partial\Psi(x)/\partial x$, $\boldsymbol{c} = p/b$, $\boldsymbol{S} = (\mu - P)/\sigma$,
$\boldsymbol{l_+} = (1 - c + c/\omega)S - p\gamma\sigma/\omega$, $\boldsymbol{g_+} = -(S + b\gamma\sigma)/\omega$, $\boldsymbol{l_-} = S - p\gamma\sigma/\omega$, and $\boldsymbol{g_-} = -S + b\gamma\sigma/\omega$.

Statement 1 *Well-known in Reliability Theory, the hazard rate function $h(x)$ has the following properties: $h'(x) > 0, h''(x) > 0, h(x) \to x$ as $x \to \infty$, and $h(x) \to 0$ as $x \to -\infty$.*

Statement 2 $\Psi(x) < 1$, *and* $\psi(x) > 0$.

Proof: Since $M(x) = 1/h(x)$, we get $\partial M(x)/\partial x = -h'(x)/h^2(x) < 0$. Noting that $\phi'(x) = -x\phi(x)$ and $\Phi'(x) = \phi(x)$, we have

$$0 > \frac{\partial M(x)}{\partial x} = -1 + \frac{x\,[1-\Phi(x)]}{\phi(x)} = -1 + x\ M(x) = -1 + \Psi(x) \tag{13}$$

Therefore, $\Psi(x) < 1$. Next we show $\frac{\partial \Psi(x)}{\partial x} > 0$. From $h'(x) > 0$ and $h(x) \to x$ *as* $x \to \infty$, we can infer that $h'(x) \to 1$ *as* $x \to \infty$. Since $h''(x) > 0$ and $h'(x) > 0$, we have $0 < h'(x) < 1$ $\forall x < \infty$, and so $1 > \Psi(x) > h'(x)\Psi(x)$. Therefore, $\partial\Psi(x)/\partial x = (1 - h'(x)\Psi(x))\,/h(x) > 0$. ■

Proof of Lemma 1 It is straightforward to show that for a random variable $\tilde{z} \sim N(\mu_z, \sigma_z^2)$, we have $E_{\tilde{z}\geq 0}\{e^{\tilde{z}}\} = e^{\mu_z+\sigma_z^2/2}\ \Phi(\mu_z/\sigma_z + \sigma_z)$, and $E_{\tilde{z}\leq 0}\{e^{\tilde{z}}\} = e^{\mu_z+\sigma_z^2/2}\ \Phi(-\mu_z/\sigma_z - \sigma_z)$. Since $E\{U_a(\tilde{w}_a\} = -e^{-a\delta_a}[E_{\tilde{y}\geq 0}\ \ e^{-\gamma bD_a\tilde{y}} + E_{\tilde{y}\leq 0}\ \ e^{-\gamma pD_a\tilde{y}}]$, where $\tilde{y} = \tilde{\pi} - P$ follows a normal distribution $N(\mu - P, \sigma^2)$, by substitution we get

$$E\left\{U_a(\tilde{w}_a)\right\} = -e^{-a\delta_a}\ \left[e^{\mu_1+\sigma_1^2/2}\ \Phi\Big(-\frac{\mu_1}{\sigma_1} - \sigma_1\Big) + e^{\mu_2+\sigma_2^2/2}\ \Phi\Big(\frac{\mu_2}{\sigma_2} + \sigma_2\Big)\right], \tag{14}$$

where $\mu_1 = -\gamma bD_a(\mu - P)$, $\sigma_1 = \gamma bD_a\sigma$, $\mu_2 = -\gamma pD_a(\mu - P)$, and $\sigma_2 = \gamma pD_a\sigma$. For $i \in \{1,2\}$, we have $e^{\mu_i+\sigma_i^2/2} = \big(e^{-S^2/2}/\sqrt{2\pi}\big)/\big(e^{-(S-\sigma_i)^2/2}/\sqrt{2\pi}\big)$, and so the right hand side of equation (14) is $-e^{-a\delta_a}\,\phi(S)\,\big[(M(l_-) + M(g_-)\big]$, where S, $M(\cdot)$, l_-, and g_- are as defined in *Notation*. Since $e^{-a\delta_a}\phi(S)$ is positive and independent of D_a, so " $\mathrm{MAX}_{D_a\geq 0}\ \ E\left\{U_a(\tilde{w_k})\right\}$" is equivalent to " $\mathrm{MAX}_{D_a\geq 0}\ \ -M(l_-) - M(g_-)$". ■

Proof of Proposition 1 If the Sharpe ratio is negative at time zero, Manager s does not invest in the risky asset, and the market clearing condition reduces to $D_a = 1/\omega$. Substituting $1 = \omega D_a$ into (4), we have

$$m\Big(S - \frac{p\gamma\sigma}{\omega}\Big)\,p = m\bigg(-S + \frac{b\gamma\sigma}{\omega}\bigg)\,b, \qquad S \leq 0. \tag{15}$$

If the Sharpe ratio is positive, however, the market clearing condition is $1 = \omega D_a + (1-\omega)D_s$. Substituting (2) and the market clearing condition into (4), then rearranging, we get

$$m\left(S + \frac{1-\omega}{\omega}cS - \frac{p\gamma\sigma}{\omega}\right)p = m\left(-S - \frac{1-\omega}{\omega}S + \frac{b\gamma\sigma}{\omega}\right)b, \qquad S > 0. \tag{16}$$

Combining equation (16) and equation (15), we have [15]

$$m\left(S + \frac{1-\omega}{\omega}cS^{+} - \frac{p\gamma\sigma}{\omega}\right)p = m\left(-S - \frac{1-\omega}{\omega}S^{+} + \frac{b\gamma\sigma}{\omega}\right)b. \qquad \blacksquare$$

Proof of Property 1 For $p \in (0, b]$, we have

$$\frac{\partial P}{\partial c} = -\frac{\sigma}{Rc}\ \frac{-m(g_{S-}) + c^2\left(S - S/\omega + b\gamma\sigma\right)\psi(l_+)}{c\left(1 - c + c/\omega\right)\psi(l_+) + \omega^{-1}\psi(g_+)} < 0$$

when $S > 0$, and when $S \leq 0$,

$$\frac{\partial P}{\partial c} = -\frac{\sigma}{Rc}\ \frac{-m(g_-) + b\gamma\sigma c^{-2}\omega^{-1}\ \psi(l_-)}{c\ \psi(l_-) +\ \psi(g_-)} < 0.$$

Further, from the implicit pricing function, we have
$P \to \mu - b\gamma\sigma^2$ as $c \to 1$, and $P \to \infty$ as $c \to 0$. $\blacksquare$

Proof of Property 2 Because $\partial P/\partial\sigma = (-S - \gamma\sigma\eta/\omega)/R$ for $S > 0$, and $\partial P/\partial\sigma = (-S - \gamma\sigma\theta/\omega)/R$ for $S \leq 0$, we infer that $\partial P/\partial\sigma < 0$ if and only if $-S - \gamma\sigma\theta/\omega < 0$. Here

$$\eta = \frac{b^2\ \psi(g_+) + p^2\ \psi(l_+)}{b\omega^{-1}\ \psi(g_+) + p(1 - c + c/\omega)\ \psi(l_+)}$$

and $\theta = \left[\, b^2\psi(g_-) + p^2\psi(l_-) \,\right] / \left[\, b\psi(g_-) + p\psi(l_-) \,\right]$, where $\psi(x) = \partial\Psi(x)/\partial x$. It is straightforward that $p < \theta < b$ and $p/(1 + -c + c/\omega) < \eta < b\omega$. $\blacksquare$

[15] If we relax the assumption that $p \leq b$ in the analysis above, the same results still hold as long as $D_a > 0$. However, if $D_a = 0$ because of a much larger p than b, the model shall collapse to one with symmetric compensation only, and equation (5) should be replaced with $P = (\mu - b\gamma\sigma^2/(1-\omega))/R$.

Proof of Property 3 Here we only show that for $\sigma_1 = \sigma_2 = \sigma_0$, manager a chooses to diversify if and only if the Sharpe ratio is positive.[16] Under such a setup, asset I and asset II must have the same price in equilibrium. Otherwise, all managers will purchase more of the asset with a lower price, and consequently increase its price. Therefore, we denote prices of asset I and II (P_1 and P_2) at time zero with the same symbol: P. Defining $l_p = S_p - p\gamma D_a\sigma_p$ and $g_p = -S_p + b\gamma D_a\sigma_p$, we rewrite Manager a's utility maximization problem as " $\mathrm{MAX}_{D_a\geq 0,\ 0\leq\alpha_k\leq 1}$ $\{\ \phi(S_p)[-M(l_p) - M(g_p)]\ \}$". Take the first order condition with respect to D_a, and get $m(g_p)b = m(l_p)p$. Taking first order condition of the utility maximization function with respect to α_a, we get

$$\frac{\partial\Pi}{\partial\alpha_a} = \phi\left(S_p\right)\gamma D_a\left\{\left(S_p\right)'_\alpha\left[p\ M(l_p) + b\ M(g_p)\right]\sigma_p + \left(\sigma_p\right)'_{\alpha_a}\left[p\ m(l_p) - b\ m(g_p)\right]\right\} = 0, \tag{17}$$

where $\Pi = \phi(S_p)(-M(l_p) - M(g_p))$, $(S_p)'_\alpha = \partial S_p/\partial\alpha_a = (P-\mu)(2\alpha_k - 1)\sigma_0^2/\sigma_p^3$, and $(\sigma_p)'_{\alpha_a} = \partial\sigma_p/\partial\alpha_a = (2\alpha_k - 1)\sigma_0^2/\sigma_p$. Since $m(g_p)b = m(l_p)p$, equation (17) simplifies to $\phi(S_p)(S_p)'_\alpha\gamma D_a\sigma_p[pM(l_p) + bM(g_p)] = 0$. Noting that $\phi(S_p) > 0$ and $\gamma D_a\sigma_p[pM(l_p) + bM(g_p)] > 0$, we get $(S_p)'_\alpha = 0$, and hence $\alpha_a = 1/2$ when $S_p = (\mu - P)/\sigma_p \neq 0$.

To check whether $\alpha_a = 1/2$ maximizes or minimizes Manager a's utility, we examine the sign of $\partial\Pi/\partial\alpha_a$ in equation (17) for $\alpha_a \in [0,1]$. When $S_p > 0$, $\partial\Pi/\partial\alpha_a < 0$ for $\alpha_a \in (1/2, 1]$, and $\partial\Pi/\partial\alpha_a > 0$ for $\alpha_a \in [0, 1/2)$. In such a situation, $\alpha_a = 1/2$ maximizes Manager a's personal utility. This means that Manager a chooses a well diversified portfolio when the Sharpe ratio is positive. However, when $S_p < 0$, $\partial\Pi/\partial\alpha_a > 0$ for $\alpha_a \in (1/2, 1]$, and $\partial\Pi/\partial\alpha_a < 0$ for $\alpha_a \in [0, 1/2)$. In this case, the constraint $0 \leq \alpha_k \leq 1$ is binding, and Manager a chooses either $\alpha_a = 0$ or $\alpha_a = 1$. This means that Manager a chooses not to diversify when the Sharpe ratio is negative. ■

[16] The complete proof of the rest of the property is cubersome and available upon request.

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Figure 1: Agency Asset Pricing Model — The Case of One Asset

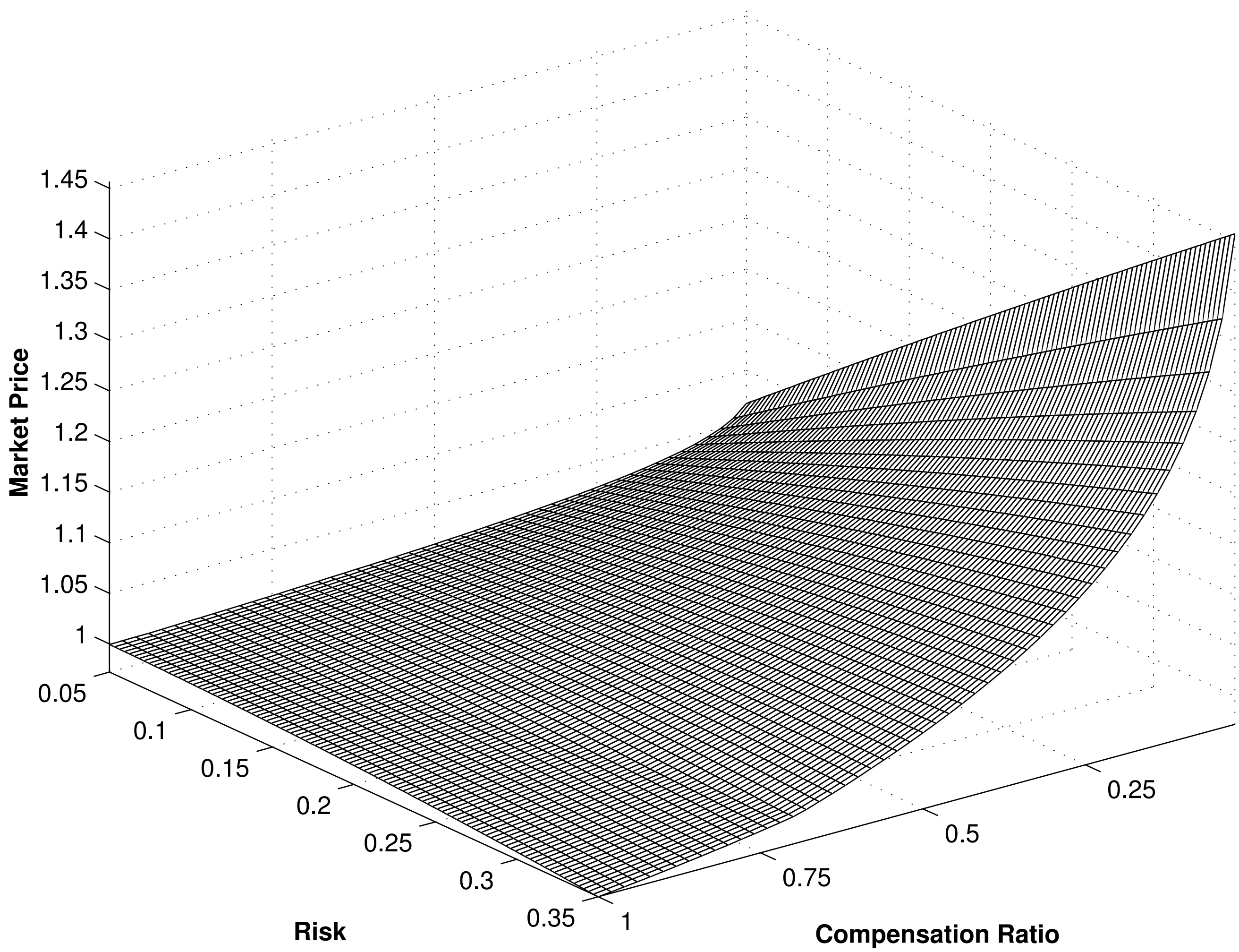
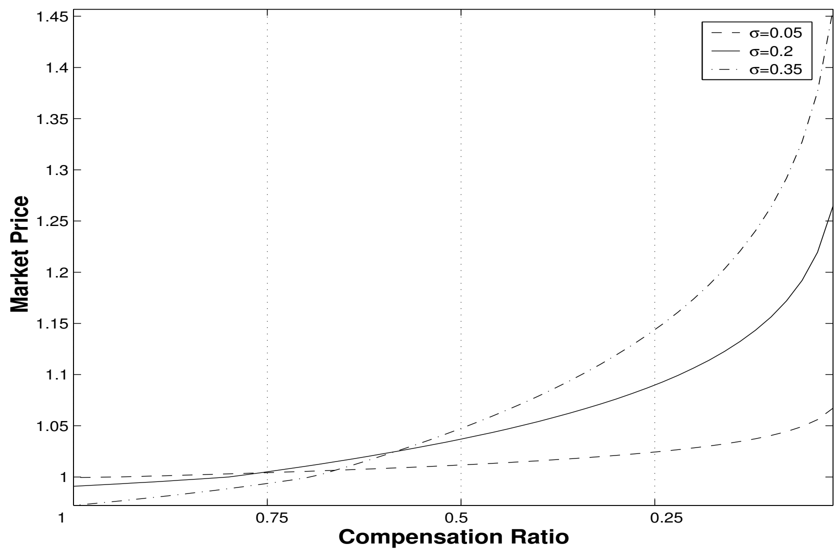
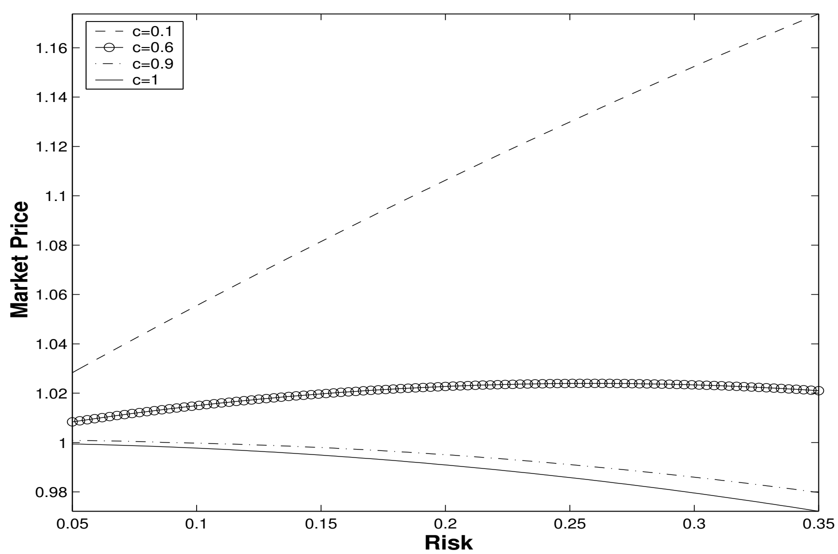


Figure 2: Cross-Sectional Views of Agency Asset Pricing Model



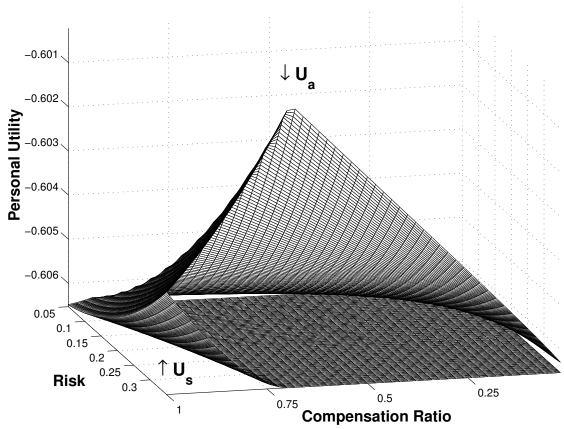
(a) Price-Compensation Ratio Curves



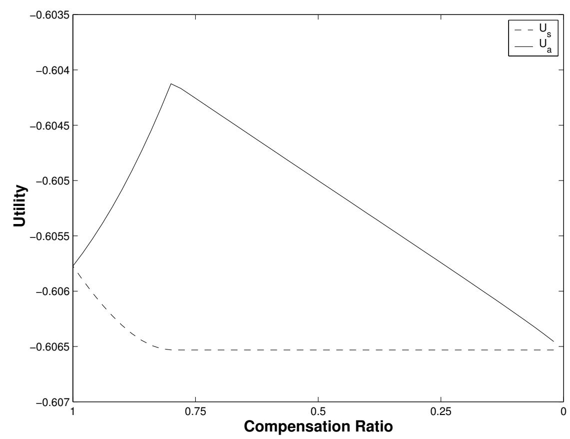
(b) Price-Risk Curves

Figure 3: Utility and Demand

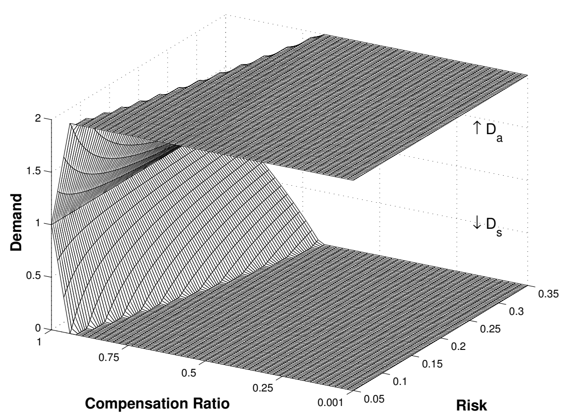
Figure 3(b) and 3(d) are, respectively, cross-sectional views of Figure 3(a) and 3(c) at $\sigma = 0.2$.



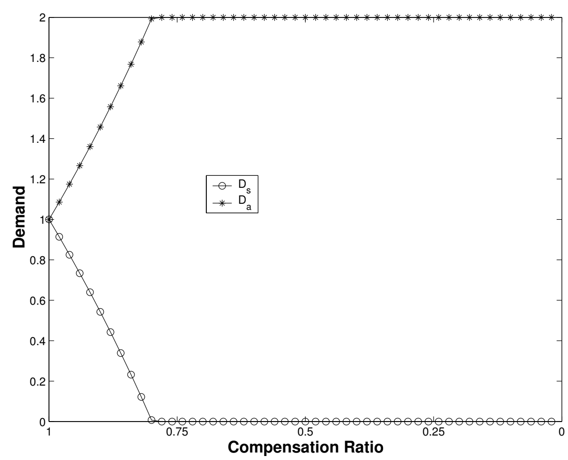
(a) Utility



(b) A Cross-Sectional View



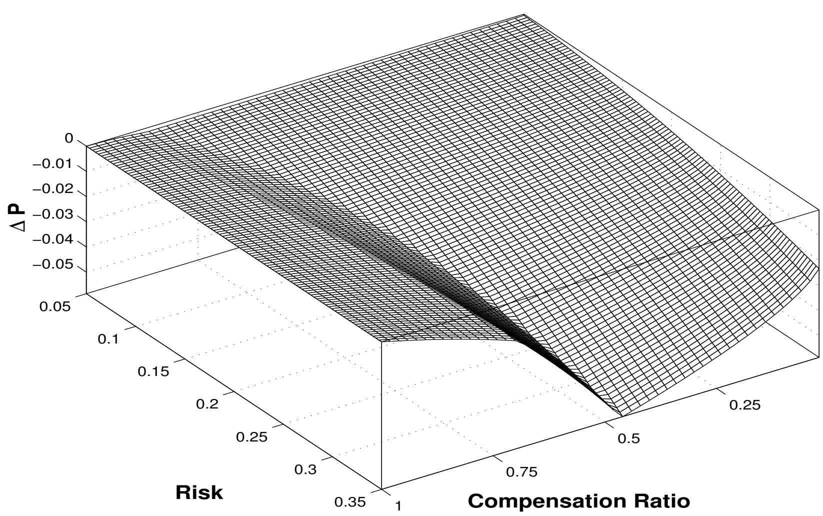
(c) Demand



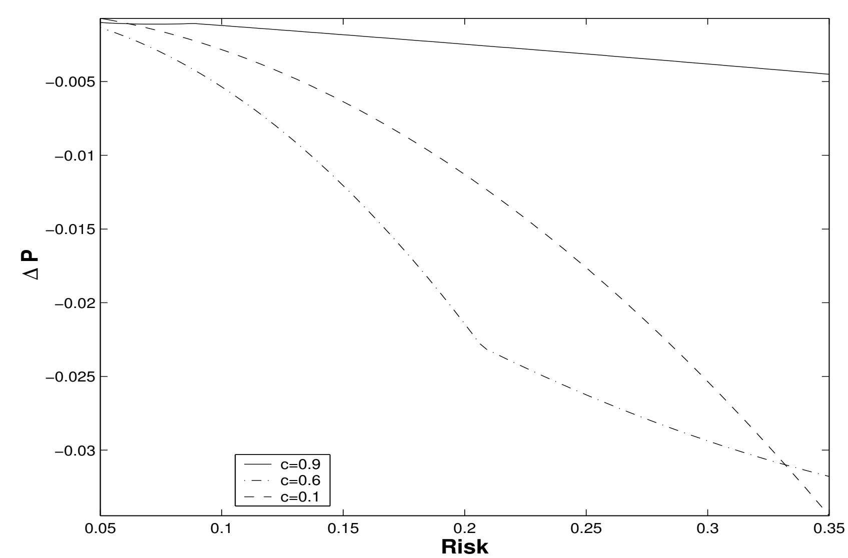
(d) A Cross-Sectional View

Figure 4: Market Price and Fraction of Managers With Asymmetric Compensation

This figure shows the change in market price as the fraction of managers with asymmetric compensation drops from 50% to 20%. Figure 4(b) is a cross-sectional view of Figure 4(a) at $\sigma = 200$.



(a) Price Difference and the Number of AMC Managers



(b) A Cross-Sectional View

Figure 5: Portfolio Choice

This figure presents a numerical analysis of Manager a's portfolio choice, and the purpose is to illustrate why manager a may choose not to diversify even when the market price decreases with the risk of the market portfolio. The top diagram provides the market price when fixing α_a at 0.5. The second diagram shows manager a's optimal choice of α_a in his utility optimization, with price fixed at the top diagram. The third diagram compares manager a's demand at $\alpha_a = 0.5$ vs. $\alpha_a^* \in [0, 1]$. The bottom diagram shows the gain in utility when manager a moves from $\alpha_a = 0.5$ to $\alpha_a^* \in [0, 1]$.

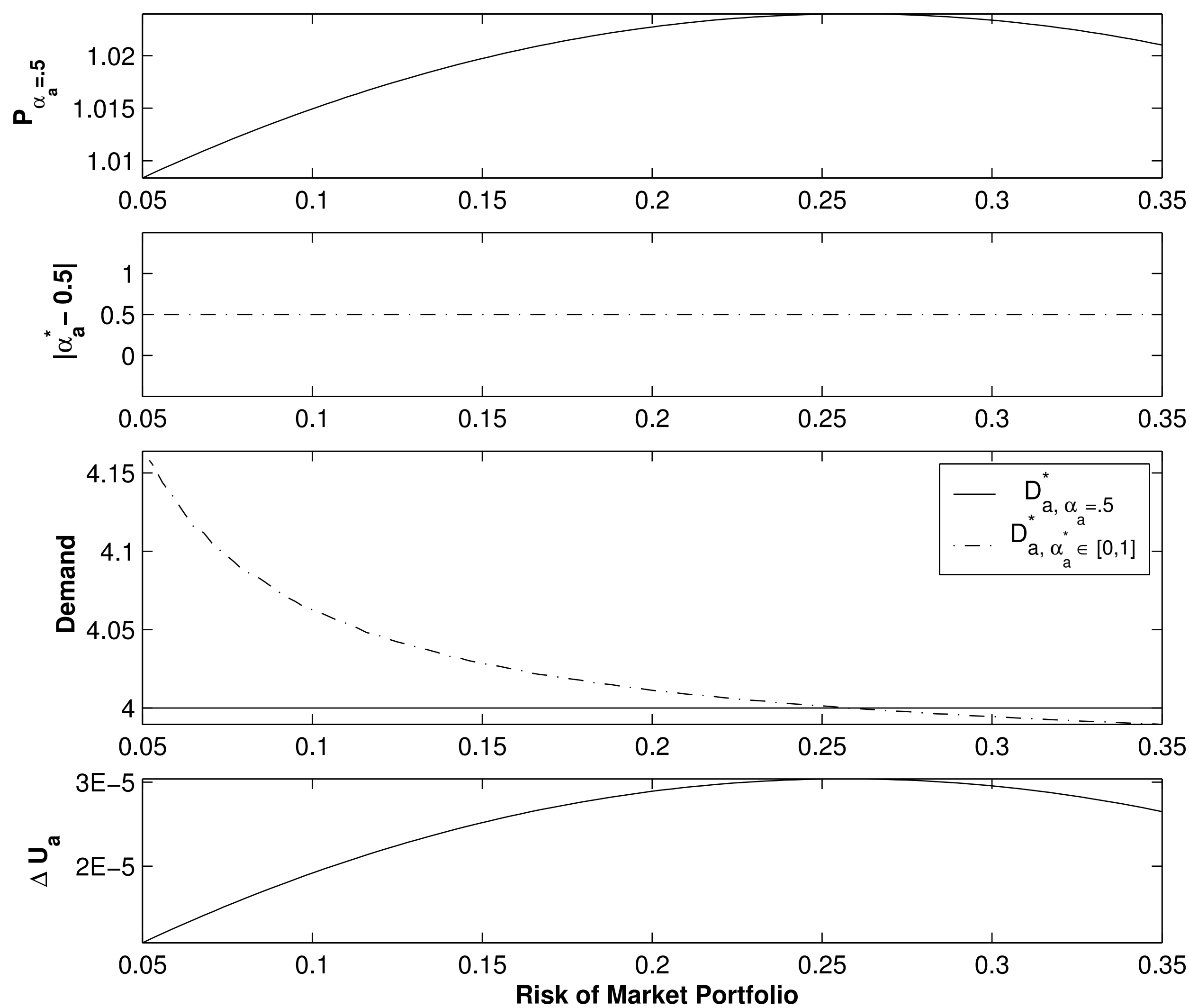


Table 1: A Comparison Between E/P Ratios and Interest Rates in China

This tables compares the mean and median of E/P ratios in Chinese stock markets with the corresponding 1-year interest rates of bank deposits. The time period is from January 1, 1993 to December 31, 2000. Firms with negative earnings are also included in the data sample. The rates are matched year to year, and the one-year interest rate is a compounded rate of different subperiods if there are changes in the official interest rates over a certain year.

Year	1993	1994	1995	1996	1997	1998	1999	2000
Rf	9.42%	10.98%	10.98%	9.19%	7.13%	5.03%	2.92%	2.26%
Mean	3.51%	5.68%	4.87%	2.52%	3.25%	3.39%	1.80%	2.14%
Median	3.40%	5.14%	4.28%	2.98%	2.78%	3.95%	2.11%	1.38%

Table 2: Panel Data Analysis with Fixed Time Effects

Panel A shows the results from panel data regression with fixed time effects in China. All listed Chinese firms are included, and the sample time period is from January 1, 1993 to December 31, 2000. In each model, the monthly log excess returns of Chinese firms are regressed on a subset of the three risk measures. The F-statistics in the last column of the table are the results of F-tests in each regression against the null hypothesis of no fixed time effects. Panel B presents the results from a comparison study with U.S. SP500 firms in the same sample period.

Panel A: China

	Total Risk	Residual Risk	Beta	*F Value (time effects)*
Model 1	-0.1319			*243.91******
(t-value)	*-9.59******			
Model 2		-0.1341		*241.17******
		*-5.33******		
Model 3			-0.0174	*241.40******
			*-6.49******	
Model 4		-0.1050	-0.0151	*240.82******
		*-4.09******	*-5.51******	
Model 5	-0.1287		-0.0010	*242.68******
	*-7.07******		*-0.27*	
Model 6	-0.1392	0.0216		*242.88******
	*-8******	*0.68*		

Panel B: U.S.

	Total Risk	Residual Risk	Beta	*F Value (time effects)*
Model 1	-0.0166			*103.35******
(t-value)	*-1.05*			
Model 2		-0.0215		*103.31******
		-1.25		
Model 3			0.0007	*103.62******
			0.62	
Model 4		-0.0303	0.0014	*103.18******
		*-1.63***	*1.21*	
Model 5	-0.0319		0.0019	*103.13******
	*-1.68***		*1.45*	
Model 6	0.0350	-0.0581		*103.31******
	0.58	*-0.89*		

* significant at 0.1 level, ** 0.05, *** 0.01, **** 0.0001.

Table 3: Fama-MacBeth Regression

Panel A presents the results from the traditional Fama-MacBeth Procedure in China. All listed Chinese firms are included, and the sample time period is from January 1, 1993 to December 31, 2000. In each model, the monthly log excess returns of Chinese firms are regressed on a subset of the three risk measures. Panel B presents the results from a comparison study with U.S. SP500 firms in the same sample period.

Panel A: China

	Total Risk	Residual Risk	Beta
Model 1	-0.1228		
(t-value)	*-2.64****		
Model 2		-0.1433	
		*-2.00***	
Model 3			-0.0300
			*-2.24***
Model 4		-0.1512	-0.0306
		*-2.29***	*-2.40***
Model 5	-0.0971		-0.0079
	*-2.11***		*-0.74*
Model 6	-0.1437	-0.0046	
	*-2.40***	*-0.05*	

Panel B: U.S.

	Total Risk	Residual Risk	Beta
Model 1	0.0007		
(t-value)	*0.01*		
Model 2		-0.0137	
		-0.14	
Model 3			0.0020
			0.36
Model 4		-0.0290	0.0026
		-0.34	*0.65*
Model 5	-0.0234		0.0027
	-0.26		*0.74*
Model 6	0.2349	-0.2515	
	1.24	*-1.58*	

* significant at 0.1 level, ** 0.05, *** 0.01, **** 0.0001.

Table 4: Event Study of the Crack-Down on AMC in May 1997

This tables presents the market reaction to the crackdown on various forms of asymmetric compensation on May 22, 1997. The test is based on daily returns, and the four window periods are as follows: base window (-221,-22), pre-event window (-21, -2), event window (-1,0), post-event window (1,20). There are 343 firms with daily returns for all four window periods, and all of them are included. The mean returns in base window is used as benchmark in calculating abnormal returns for all window periods. The beta and total risk are also estimated with returns in the base window. In Panel A, The pre-event window is the buffer zone to account for potential release of information before the date of announcement. T-test is against equal means, and the choice of pooled t-test or Satterthwaite t-test is based on the result of F-test against the null hypothesis of equal variances at a significance level of 10%. In Panel B, we first sort firms into beta deciles and total risk deciles, then form portfolios based on both beta and total risk. There are 100 possible combinations in total, and we obtain 69 portfolios in real data. Using these formed portfolios, we regress abnornal return on different combinations of beta and total risk.

Panel A: Market Reaction

	Base Window	**Pre-Event Window**	**Event Window**	**Post-Event Window**
Mean Return	0.33%	-0.09%	-6.80%	0.06%
(std err)	*(-0.0002)*	*(-0.0006)*	*(-0.0015)*	*(-0.0004)*
Mean AR		-0.42%	-7.09%	-0.26%
***(t-Value,* method)**		*(-6.66****,* pooled)	*(-44.58****,* Satterthwaite)	*(-5.62****,* pooled)

Panel B: Cross-Sectional Reaction

	Model I	**Model II**	**Model III**
Total Risk	-0.86009		-0.7282
(t-value)	*(-4.1****)*		*(-2.97***)*
Beta		-0.0243	-0.0098
(t-value)		*(-2.85***)*	*(-1.04)*

* significant at 0.1 level, ** 0.05, *** 0.01, **** 0.0001.