Institutionalization, Delegation, and Asset Prices

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Abstract

We investigate the effects of institutionalization on fund manager compensation and asset prices. Institutionalization raises the performance-sensitive part of the equilibrium contract, making institutional investors effectively more risk averse. In consequence, institutionalization has two opposing effects on market outcomes. The direct effect is to bring in more informed institutional investors, and the indirect effect is to make each institutional investor trade less aggressively on information. Institutionalization can non-monotonically affect the cost of capital and return volatility. Releasing public information has similar effects as institutionalization. Our theory helps to understand a wide range of financial phenomena and suggests new testable predictions.

Keywords: Institutionalization, delegation, information acquisition, agency problem, asset prices, public information

JEL Classifications: G12, G14

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1. Introduction

One salient trend in most modern financial markets is institutionalization.\(^1\) For instance, French (2008) documents that the U.S. financial market has become dominated by institutional investors from 1980 to 2007, in which institutional investors accounted for more than 80% ownership of equities in 2007, compared to 50% in 1980.\(^2\) Financial institutions such as mutual funds and hedge funds do not trade their own money. Instead, they collect money from households and hire professional money managers to operate; therefore, there exist agency and delegation issues in portfolio management. How does delegation affect the ultimate risk attitude and trading behavior of financial institutions? How does the asset management industry design contracts to incentivize fund managers to exert effort in an institutionalized market? What are the implications of institutionalization for manager compensation and asset prices? In this paper, we address these questions by analyzing a financial market model with delegated portfolio management and endogenous information acquisition.

We develop a model with three types of players: financial institutions (funds), managers, and retail investors. The financial market has two assets, one risk-free asset and one risky asset. Each fund hires a portfolio manager to operate the fund and trade the assets. Retail investors trade assets on their own. We parameterize institutionalization as an increase in the number of funds (and a decrease in the number of retail investors). In our model, managers are able to produce superior information about the risky asset’s payoff, which captures the fact that in practice, on average,

\(^1\)In Campbell R. Harvey’s Hypertextual Finance Glossary, institutionalization refers to “(t)he gradual domination of financial markets by institutional investors, as opposed to individual investors. This process has occurred throughout the industrialized world.” (http://people.duke.edu/~charvey/Classes/wpg/bfglosi.htm)

\(^2\)More evidence about the U.S market can be found in Allen (2001), Gompers and Metrick (1998), Jones and Lipson (2004), Chordia, Roll, and Subrahmanyam (2011) and others. In addition, institutional investors have also dominated markets around the world. For example, according to TheCityUK, in 2013, about $87 trillion assets (comparable to the global GDP) are managed by financial institutions globally.
financial institutions are more informed than individual investors. However, funds cannot observe managers’ information acquisition decisions and portfolio choices, so that moral hazard arises (i.e., managers shirk from studying the market and enjoy quiet life). Each fund, therefore, designs an incentive contract to ensure that its hired manager exerts effort to acquire information and trade on information in equilibrium.

We follow the literature and assume that the contract is linear in trading profits (e.g., Admati and Pfleiderer, 1997; Kyle, Ou-Yang, and Wei, 2011). The intercept term in the linear contract provides a fixed salary. The slope term in the contract corresponds to a proportional management fee that provides incentives and thus, we refer to it as the “incentive part” of the contract. As Admati and Pfleiderer (1997) show, a linear contract alone cannot induce a manager to exert effort because the manager can scale up or down the portfolio choice and undo the incentive of the linear contract. To get around this irrelevance result, some types of market frictions have to be introduced so that managers cannot undo the incentive freely.\(^3\) In our setup, the frictions are transaction costs. These costs can refer to monetary costs (e.g., inventory cost or commission fee) or to non-monetary costs (e.g., attention cost).

One key observation from our analysis is that portfolio delegation makes the effective risk aversion of an institution equal to a product of the risk aversion \(\gamma\) of its manager, which is intrinsic to the manager’s preference, and the incentive part \(b\) of the contract, which is endogenously determined in equilibrium. The endogenous \(b\) changes the trading behavior of institutions and drives asset price patterns. When more institutional investors are present in the market, the price becomes more informative (recall that in equilibrium, institutions design contracts to motivate their managers to acquire information). One might be tempted to conjecture that this will induce institutions to reduce the incentive part \(b\) of the contract, since more

\(^3\) Kyle, Ou-Yang, and Wei (2011) rely on strategic trading to recover the incentive-effort result. In their setting, market impact mitigates the manager’s incentive to undo changes in the linear contract.
informative price reduces information asymmetry (which implicitly improves the contractibility of information acquisition effort). Interestingly, we find the opposite, that is, institutionalization strengthens the equilibrium incentive.

What the conjecture misses is that fund managers not only produce private information but also trade on the produced information. Huang (2016) analyzes a model of in-house analysts who only produce information and then pass on information to funds for trading purposes, and he indeed shows that a more informative price system lowers the incentive part of the contract with analysts. By contrast, in our setting, a more informative price system reduces the uncertainty faced by an uninformed investor and strengthens the incentive of a portfolio manager to deviate from acting as an informed investor. As a result, funds have to give up a higher fraction of trading profits to the managers to keep them acquiring and trading on information. That is, institutionalization raises the incentive part $b$ of the contract with portfolio managers.

This incentive result implies that institutionalization has two opposing effects on market outcomes. The first effect is that institutionalization directly brings in more informed traders into the market who face less uncertainty in trading the risky asset and whose trading directly injects information into the asset price. The second effect is that institutionalization raises the effective risk aversion $\gamma b$ of each institutional investor, since the hired manager has more skin in the game (due to the increased incentive variable $b$). This causes each institution to trade less aggressively on the produced information. The overall effect on market outcomes is determined by the relative strength of these two effects.

We investigate three market variables that are often discussed in the literature (e.g., Vives, 2008; Easley, O’Hara, and Yang, 2016; Goldstein and Yang, 2017): price informativeness, the cost of capital, and return volatility. The first variable is a measure for market quality, while the last two variables concern the asset price behavior. We show that institutionalization always improves price informativeness, which means that the direct effect always dominates the indirect effect associated with the contract
incentive $b$. This is intuitive, because the increase in $b$ is driven by the increase in price informativeness in the first place. On the other hand, we find that the other two asset price variables can exhibit a non-monotonic pattern with institutionalization. For instance, the cost of capital, defined as the expected difference between the cash flow generated by the risky asset and its price, can first decrease and then increase with institutionalization. This means that the indirect (direct) effect dominates when the number of funds is large (small). Intuitively, the indirect effect works through changing funds’ risk aversion $\gamma b$; when there are many funds active in the market and when each of them becomes more risk averse (due to the increased $b$), their aggregate trading can scale back a lot, making the indirect effect particularly strong.

Our insight on institutionalization also helps to understand the role of disclosing public information in financial markets, a classical topic studied the literature (see Verrecchia (2001), Kanodia (2006), Kanodia and Sapra (2016), and Goldstein and Yang (2017) for survey articles). Intuitively, the driving force underlying institutionalization’s working is that institutionalization bolsters a portfolio manager’s incentive to deviate from acting as an informed investor, by lowering the uncertainty faced by the manager if she stays uninformed. Disclosure of public information has a similar effect on reducing uncertainty by directly providing free information to all investors. We formalize this intuition by extending the model with a public signal. Indeed, we find that similar to institutionalization, public disclosure increases the equilibrium contract incentive $b$ and raises the effective risk aversion of institutions. As a result, disclosure of public information can non-monotonically affect the cost of capital and return volatility. One new result in this extended setting is that releasing public information negatively affects how the price aggregates private information.

Our theory further generates empirical predictions. Some of these predictions are useful for understanding a variety of existing empirical findings, and others offer new opportunities to test the model. For instance, our theory provides a force through which fund competition drives up management fees, which helps to explain
the empirical puzzle that fund fees decline only slowly or even increase over time, despite sharply rising competition in the asset management industry (e.g., French, 2008; Khorana, Servaes, and Tufano, 2008; Sun, 2014). Our result that institutionalization improves price informativeness is also consistent with some recent time-series and cross-sectional evidence (e.g., Bai, Philippon, and Savov, 2016; Kacperczyk and Nosal, 2018). The two competing effects of institutionalization on asset prices help to explain the documented empirical findings on return volatility and institutional ownership (e.g., Brandt, Brav, Graham, and Kumar, 2007). The non-monotonic relation between disclosure and the cost of capital helps to reconcile the mixed empirical findings in the disclosure literature (see Beyer, Cohen, Lys, and Walther (2010)). Our model also offers new predictions, such as the U-shaped association between institutionalization and the cost of capital.

1.1. Related Literature

Our paper builds on the literature of delegated portfolio management. This literature is voluminous, and so here we only discuss a few studies that are mostly closely related to our paper.

Kyle, Ou-Yang, and Wei (2011) develop a setting with a single fund. The fund’s trading has price impacts, and this breaks down the “irrelevance result” highlighted by Stoughton (1993) and Admati and Pfleiderer (1997), so that a linear contract induces the manager to exert more effort for information acquisition in a strategic trading setting. Our study differs from and complements Kyle, Ou-Yang, and Wei (2011) in three important ways. First, their model is not suitable for studying institutionalization, since there is only one institution in their setting. Second and more importantly, the channels are quite different in two papers. The channel in Kyle, Ou-Yang, and Wei (2011) works through information acquisition of the informed institution and

\footnote{See Stracca (2006) and Bhattacharya, Dasgupta, Guembel, and Prat (2008) for survey articles on the delegation literature.}
adding delegation only amplifies this information-acquisition channel. In our setting, the channel works through changing the contract incentive $b$, which in turn is driven by uninformed investors free riding on price information. This free-riding problem is absent in Kyle, Ou-Yang, and Wei (2011), since again, there is only one informed trader in their setting. Third, the focus is different: we explore implications for the cost of capital, return volatility, and public information, while their primary focus is on price informativeness and the existence of equilibrium.

Breugem and Buss (2018) study the joint portfolio and information choice problem of institutional investors. In their setup, some institutional investors care about their performance relative to a benchmark, and such a career concern can make institutional investors more risk averse in the case of power utility (but not in the case of exponential utility, or constant absolute risk aversion (CARA) utility). Our model complements their study by providing a different channel that is related to moral hazard rather than benchmarking concerns. Our channel works in the case of CARA utility. These two channels can have different implications for price informativeness and asset prices. For instance, Breugem and Buss (2018) predict that the presence of benchmarking institutions monotonically decreases price informativeness and increases return volatility. By contrast, our model predicts that institutionalization increases price informativeness and can affect return volatility non-monotonically.

Huang (2016) considers a buy-side analyst setting in which the agent only acquires information but does not trade. This leads to different contract implications from ours. Sockin and Xiaolan (2017) link the incentive equilibrium with moral hazard to financial market equilibrium, but their focus is on the link between model-implied measure and several widely-adopted empirical statistics of managerial ability.

García and Vanden (2009) study the formation of fund industry and show that a sufficiently competitive mutual fund sector yields more informative prices and a lower equity risk premium. Kaniel and Kondor (2013) examine the implications of increased delegated capital for trading strategies and equilibrium prices by introducing delega-
tion into a standard Lucas exchange economy. Gârleanu and Pedersen (2018) build a model that combines search and traditional noisy rational expectations equilibrium, to connect the efficiency of asset prices with the efficiency of the asset management market. Our study provides a new channel through which the development of asset management industry affects asset prices, i.e., through changing the equilibrium contract and hence the effective risk aversion of institutional investors.

2. A Model of Financial Institutionalization

The economy lasts for two periods, $t = 0$ and $1$. The timeline of the economy is described by Figure 1. On date $1$, a financial market operates; financial institutions and retail investors trade financial assets. We can interpret financial institutions as mutual funds, hedge funds, pension funds, or investment banks. To ease expositions, we simply refer to institutions as funds and use these two words interchangeably. We normalize the total mass of institutional and retail investors as $1$. We use $\lambda \in (0, 1)$ to denote the mass of funds, and the remaining mass $1 - \lambda$ is reserved for retail investors. Parameter $\lambda$ controls the degree of financial institutionalization in our setting. We will follow Basak and Pavlova (2013) and conduct comparative statics analysis with respect to parameter $\lambda$ to examine the implications of institutionalization. On date $0$, each fund hires a portfolio manager who is capable of developing costly information that is useful for the later trading in the financial market. Effort undertaken to acquire and trade on information is unobservable, which leads to a moral hazard problem. In consequence, funds need to design incentive contracts to motivate their

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5Since the key difference between retail and institutional investors in our setting is delegation, a higher value of $\lambda$ also corresponds to more delegated capital. One can consider the following thought experiment to interpret an increase in $\lambda$: Initially, the market is populated entirely with retail investors who trade on their own (i.e., $\lambda = 0$). Later on, a mass $\lambda$ of retail investors decide to delegate their money to fund managers, which leads to a decrease in the size of retail money by the same mass $\lambda$ and an increase in the size of delegated capital by mass $\lambda$. Following Basak and Pavlova (2013), we treat the shift from retail to delegated money as exogenous. Kaniel and Kondor (2013) have explicitly modeled how retail investors choose between trading on their own and delegating to funds.
hired managers to work at acquiring information. Our setting seeks to capture the realistic feature that institutions are more informed than retail investors by hiring capable portfolio managers.

2.1. Financial Market and Retail Investors

Two assets, a risky asset and a risk-free asset, are traded in the date-1 financial market. The risk-free asset pays a constant return, which is normalized at 0 for simplicity. The risky asset has a positive constant supply $Q > 0$, and its price $\tilde{p}$ is endogenously determined in equilibrium. The risky asset can be interpreted as an index or a single stock. It pays a liquidation value $\tilde{f}$ at the end of period 1,

$$\tilde{f} \equiv \tilde{v} + \tilde{\varepsilon},$$

where $\tilde{v} \sim \mathcal{N}(0, \tau_v^{-1})$ and $\tilde{\varepsilon} \sim \mathcal{N}(0, \tau_\varepsilon^{-1})$ with $\tau_v, \tau_\varepsilon \in (0, \infty)$, and $\tilde{v}$ and $\tilde{\varepsilon}$ are mutually independent. As standard in the literature, we assume that there is noisy demand for the risky asset, denoted by $\tilde{\xi} \sim \mathcal{N}(0, \tau_\xi^{-1})$ with $\tau_\xi \in (0, \infty)$, where $\tilde{\xi}$ is independent of $(\tilde{v}, \tilde{\varepsilon})$. The noisy demand provides the randomness necessary to make our rational expectations equilibrium partially revealing. It can be viewed as random float of the
risky asset from the point of view of rational investors.\textsuperscript{6}

Financial institutions (with mass \( \lambda \)) and retail investors (with mass \( 1 - \lambda \)) trade assets to maximize their conditional expected utilities. Trading is costly for both types of investors in the economy. We introduce transaction cost to avoid the irrelevance result studied by Admati and Pfleiderer (1997) (More details can be found in Section 3). We assume that the transaction cost of investor \( i \) is quadratic in the investor’s demand \( D_i \) as follows:

\[
\frac{1}{2} T \times D_i^2,
\]

where \( T \) is a positive constant. The quadratic form of transaction cost is common in the literature and is a reduced form to model transaction frictions (e.g., Garleanu and Pedersen, 2013; Davila and Parlatore, 2018). In economic terms, transaction cost in our setting can be interpreted as commission fee, inventory cost, or operation cost.

In reality, institutions are more informed than retail investors. To capture this feature, we seek an equilibrium in which retail investors are uninformed and institutions hire professional managers to produce private information. So, we assume that retail investors do not receive any private information when trading, although they can actively extract information from the asset price \( \tilde{p} \), as standard in the REE literature. Retail investors are risk averse and have constant absolute risk aversion (CARA) utility functions over their final wealth \( \tilde{W}_R \) at the end of period 1: \( -e^{-\gamma \tilde{W}_R} \), where \( \gamma \) is the risk aversion parameter. Let \( D_R \) denote a retail investor’s demand for the risky asset. Given transaction cost function (2), we have

\[
\tilde{W}_R = D_R(\tilde{f} - \tilde{p}) - \frac{1}{2} T D_R^2,
\]

where we have normalized the investor’s initial wealth at 0, which is without loss of generality under CARA preference.

\textsuperscript{6}Alternatively, the noisy demand can come from the trading of “sentiment traders” who trade on noise as though it were information (e.g., Mendel and Shleifer, 2012; Peress, 2014; Banerjee and Green, 2015; Rahi and Zigrand, 2018). These traders are irrational individuals since they have wrong beliefs. The retail investors analyzed in our setting represent rational individuals who have correct beliefs and actively infer information from the price.
2.2. Financial Institutions and Agency Problems

Financial institutions have to hire portfolio managers to acquire information and trade. Managers have skills to acquire private information about the asset payoff \( \tilde{f} \), and trade assets based on this private information. We assume that the pool of managers is sufficiently large so that each fund can hire one manager on date 0. Then, a hired manager can pay cost \( c > 0 \) to observe element \( \tilde{v} \) in the asset payoff \( \tilde{f} \) in (1) before trading in the date-1 financial market. Cost \( c \) can represent a manager’s time spent in conducting fundamental research, money spent in firm visits, or forgone private benefits from shirking. We focus on the realistic scenario in which those hired managers are incentivized to acquire information \( \tilde{v} \) in equilibrium, so that institutional investors are more informed than retail investors.\(^7\)

Because funds could not observe whether fund managers exert effort to acquire information, a principal-agency problem arises. To solve the agency problem, each fund (the principal) designs an incentive contract to motivate its hired manager (the agent) to undertake effort. We now describe the incentive contracts and trading behavior of institutional investors.

Let us consider fund \( i \in [0, \lambda] \). The fund’s manager invests \( D_i \) shares of risky assets, which incurs transaction cost \( \frac{1}{2}T D_i^2 \) and generates the following trading profits:

\[
\tilde{W}_i = D_i (\tilde{f} - \tilde{p}) - \frac{1}{2}T D_i^2.
\]  
(4)

We consider linear contracts under which the manager’s compensation \( S(\tilde{W}_i) \) linearly depends on the fund’s trading profits as follows:

\[
S(\tilde{W}_i) = a_i + b_i \tilde{W}_i,
\]  
(5)

where \( a_i \) and \( b_i \) are two endogenous constants. In particular, the slope \( b_i \) of the linear contract determines the sensitivity of manager compensation to fund profits, which is expected to provide incentive for the manager to work hard. As discussed in the

\(^7\)In principle, it is also possible that funds may hire portfolio managers only for risk-sharing purpose without information acquisition. In our setting, this alternative scenario is not supported in equilibrium when fund managers’ information acquisition cost is not very high (The detailed conditions are available upon request).
Introduction, we can interpret $b_i$ as the proportional management fee and refer to it as the incentive part of the contract. The linear incentive contract is widely used in the industry (c.f., Massa and Patgiri, 2009), and receives a lot of attention from the principal-agent literature (e.g. Admati and Pfleiderer, 1997; Stoughton, 1993; Bolton, Scheinkman, and Xiong, 2006; Kyle, Ou-Yang, and Wei, 2011). As standard in this literature, we restrict $b_i \in [0, 1]$ to make the problem economically meaningful.

Managers derive expected utility over final wealth according to CARA utility functions with a common risk aversion coefficient $\gamma$. All managers have the same reservation wage $W$, which can be interpreted as the best alternative opportunity that managers can achieve. Recall that acquiring information costs $c$. Thus, for fund $i$’s manager with compensation $S(W_i)$, her final wealth at the end of period 1 is

$$S(W_i) - c \cdot I_{\{\text{effort}\}};$$

where $I_{\{\text{effort}\}}$ is an indicator function defined as

$$I_{\{\text{effort}\}} \equiv \begin{cases} 1, & \text{if fund } i \text{'s manager exerts effort to acquire information,} \\ 0, & \text{otherwise.} \end{cases}$$

As we mentioned before, we seek an equilibrium in which the incentive contract (5) solves the moral hazard problem. That is, in equilibrium, fund $i$ designs an optimal contract to motivate its manager to exert effort to acquire information $\tilde{v}$. Thus, in the date-1 financial market, fund $i$’s manager has information set $\{\tilde{v}\}$ and the manager chooses the optimal demand for the risky asset as follows:

$$D_i^* = \arg \max_{D_i} E \left[ -e^{-\gamma[S(W_i) - c]} \bigg| \tilde{v} \right].$$

On date 0, when solving the principal’s optimal contract, we need to consider two additional constraints: the incentive compatibility constraint (IC) and the participation constraint (PC). The IC states that the manager’s expected utility with information acquisition (observing $\tilde{v}$) exceeds the expected utility without information acquisition, the manager’s information set is $\{\tilde{v}, \hat{p}\}$. Nonetheless, the information contained in $\hat{p}$ is redundant because $\hat{p}$ is just a noisy version of $\tilde{v}$, as in Grossman and Stiglitz (1980). This will not be the case when managers acquire diverse signals. We have also considered a variation with diverse signals and found that the results are robust, although the analysis is more complicated.
tion acquisition (observing $\tilde{p}$), that is,

$$E \left[ \max_{D_i} E \left( -e^{-\gamma[S(\tilde{W}_i)-c] | \tilde{v}} \right) \right] \geq E \left[ \max_{D_i} E \left( -e^{-\gamma S(\tilde{W}_i) | \tilde{p}} \right) \right].$$

(9)

Given reservation wage $\tilde{W}$ (e.g., from outside options), a manager accepts fund $i$’s contract (5) if her expected utility from accepting the contract exceeds her reservation utility from consuming the reservation wage $\tilde{W}$, leading to the PC as follows:

$$E \left[ \max_{D_i} E \left( -e^{-\gamma[S(\tilde{W}_i)-c] | \tilde{v}} \right) \right] \geq E \left( -e^{-\gamma \tilde{W}} \right).$$

(10)

After paying its manager compensation $S(\tilde{W}_i)$, fund $i$ is left with payoff

$$\tilde{W}_i - S(\tilde{W}_i).$$

(11)

We follow the literature (e.g., Kyle, Ou-Yang, and Wei, 2011) and assume that funds as a principal are risk neutral. As Stoughton (1993) justifies, this assumption is realistic because most pension and mutual funds are composed of many investors.\(^9\)

On date 0, fund $i$ chooses contract parameters $a_i$ and $b_i$ to maximize\(^{10}\)

$$E \left[ \tilde{W}_i - S(\tilde{W}_i) \right],$$

(12)

where $\tilde{W}_i$ and $S(\tilde{W}_i)$ are given by equations (4) and (5), respectively. The principal’s optimal contract is chosen subject to three constraints imposed by the agent: the optimal portfolio investment (8), the incentive compatibility constraint (9), and the participation constraint (10). Since there are infinitely many funds and managers in the economy, we consider a competitive incentive equilibrium, in which when choosing its contract parameters $a_i$ and $b_i$, each fund $i$ takes as given other funds’ contracting problems and other managers’ trading strategies.

\(^{9}\)Formally, one can view a fund as a Wilson (1968) syndicate formed by a collection of risk-averse individual principals. The syndicate risk tolerance is equal to the sum of the individual risk tolerance. As such, in the limit as the number of individuals gets large, the syndicate risk aversion goes to zero.

\(^{10}\)To establish our channel most transparently, we do not consider the feature that fund managers may care about their performance relative to a certain index (benchmarking), which has been extensively analyzed in the literature (e.g., Leippold and Rohner, 2012; Basak and Pavlova, 2013; Breugem and Buss, 2018).
2.3. Equilibrium Concept

The overall equilibrium in our model is composed of two subequilibria. On date 1, the financial market forms a noisy rational expectations equilibrium (noisy-REE). On date 0, each fund chooses an optimal contract \((a^*_i, b^*_i)\) to motivate its hired manager to acquire information. We consider symmetric equilibria at the incentive stage; that is, \(a^*_i = a^*_j = a^*\) and \(b^*_i = b^*_j = b^*\) for \(i \neq j\).

**Definition 1.** A symmetric equilibrium consists of an optimal date-0 contract, \((a^*, b^*)\); a date-1 price function, \(p(\bar{v}, \tilde{\xi}) : \mathbb{R}^2 \to \mathbb{R}\); a date-1 demand function of informed managers, \(D_I(\bar{v}) : \mathbb{R} \to \mathbb{R}\); and a date-1 demand function of retail investors, \(D_R(\bar{p}) : \mathbb{R} \to \mathbb{R}\), such that:

1. (Incentive equilibrium) On date 0, given that other funds choose \((a^*, b^*)\), contract \((a^*, b^*)\) maximizes fund i’s expected payoff (12) subject to optimal portfolio investment (8), the incentive compatibility constraint (9), and the participation constraint (10).

2. (Financial market equilibrium) On date 1, informed managers and retail investors submit their optimal portfolio choices \(D_I(\bar{v})\) and \(D_R(\bar{p})\) to respectively maximize their expected utilities conditional on their respective information sets. The equilibrium price \(p(\bar{v}, \tilde{\xi})\) clears the market almost surely:

\[
\lambda D_I(\bar{v}) + (1 - \lambda) D_R(\bar{p}) + \tilde{\xi} = Q. \tag{13}
\]

3. Equilibrium Characterization

We solve the equilibrium backward. We first compute the noisy-REE in the date-1 financial market under any given incentive contract \((a, b)\). We then go back to date 0 to compute the equilibrium incentive contract \((a^*, b^*)\).
3.1. Financial Market Equilibrium

In the date-1 financial market, retail investors and institutions trade assets against noisy trading. Retail investors are uninformed investors, and institutions are informed investors, because the equilibrium contract motivates portfolio managers to acquire information $\tilde{v}$. Thus, the trading from portfolio managers injects information $\tilde{v}$ into the asset price $\tilde{p}$. In addition, the price $\tilde{p}$ is affected by noisy trading $\tilde{\xi}$. As standard in the noisy-REE literature, we consider the following linear price function:

$$\tilde{p} = a_0 + a_v \tilde{v} + a_\xi \tilde{\xi},$$

where the $a$-coefficients are endogenous.

The demand function $D_I(\tilde{v})$ of a typical portfolio manager is determined by (8). After some algebra, we can compute

$$D_I(\tilde{v}) = \frac{E(\tilde{f}|\tilde{v}) - \tilde{p}}{\gamma b Var(\tilde{f}|\tilde{v}) + T},$$

(15)

In a standard CARA-normal setting without transaction cost and delegation problem, an informed CARA investor’s demand would be

$$D_{PT}(\tilde{v}) = \frac{E(\tilde{f}|\tilde{v}) - \tilde{p}}{\gamma Var(\tilde{f}|\tilde{v})},$$

(16)

where the subscript “PT” refers to “proprietary trading.”

We see that $D_I(\tilde{v})$ and $D_{PT}(\tilde{v})$ differ in the expressions of their denominators. First, the introduction of transaction cost $T$ causes the investor to trade less aggressively. As we will see shortly in the next subsection, transaction cost is necessary for the linear contract to be effective in motivating the manager to acquire information. Second, from expression (15), the effective risk aversion of a financial institution is the product of the manager’s risk aversion $\gamma$ and the incentive part $b$ of the contract. That is,

$$\text{Effective Risk Aversion of Institutions} = \gamma \times b.$$  (17)

So, a change in the equilibrium contract $b$ will change the effective risk aversion $\gamma b$ of institutions, which in turn will affect market outcomes.

Each retail investor observes $\tilde{p}$ and chooses demand $D_R$ to maximize $E(-e^{-\gamma \tilde{W}_R}|\tilde{p})$
with $\tilde{W}_R$ given by (3). Similar to a portfolio manager’s optimization problem, we can derive a typical retail investor’s optimal demand as follows:

$$D_R(\tilde{p}) = \frac{E(\tilde{f}|\tilde{p}) - \tilde{p}}{\gamma \text{Var}(\tilde{f}|\tilde{p}) + T}. \tag{18}$$

Retail investors make inference from the asset price $\tilde{p}$. According to price function (14), the price $\tilde{p}$ is equivalent to the following signal in predicting the asset payoff $\tilde{f}$:

$$\tilde{s}_p \equiv \frac{\tilde{p} - a_0}{a_v} = \tilde{v} + \frac{a_\varepsilon}{a_v} \xi. \tag{19}$$

The precision of this signal is a measure of price informativeness, denoted by $\tau_p$:

$$\tau_p \equiv \frac{1}{\text{Var}\left(\frac{a_\varepsilon}{a_v} \xi\right)} = \left(\frac{a_v}{a_\varepsilon}\right)^2 \tau_\xi. \tag{20}$$

We use Bayes’ rule to compute the expressions of $D_I(\tilde{v})$ and $D_R(\tilde{p})$ in (15) and (18), respectively. We then insert these expressions into the market-clearing condition (13) to derive price as a function of $\tilde{v}$ and $\tilde{\xi}$. Comparing this implied price function with the conjectured price function (14), we can solve the $a$-coefficients.

**Proposition 1.** (Financial Market Equilibrium) There exists a unique linear noisy rational expectations equilibrium in the date-1 financial market, with price function given by equation (14), where the expressions of $a_0$, $a_v$, and $a_\varepsilon$ are given by equations (A1)–(A3) in the Appendix. In equilibrium, price informativeness is

$$\tau_p = \frac{(\lambda \tau_\varepsilon)^2 \tau_\xi}{(\gamma b + T \tau_\xi)^2}. \tag{21}$$

**Corollary 1.** (Price Informativeness) Given the mass $\lambda$ of financial institutions, price informativeness $\tau_p$ decreases with the contract incentive $b$. Given $b$, price informativeness $\tau_p$ increases with the mass $\lambda$ of financial institutions.

Corollary 1 is intuitive. In our setup, financial institutions are informed investors, and as discussed above, the effective risk aversion of institutions is given by $\gamma b$. Thus, other things being equal, the more are there financial institutions ($\lambda$ is higher), their overall trading brings more information into the price and so the price is more informative ($\tau_p$ is higher). When the contract provides more incentives to managers ($b$ is higher), managers have more skin in the game and so trade more cautiously.
on information, making the price less informative ($\tau_p$ is lower). Note that we here conduct a partial equilibrium analysis in the sense that we vary $\lambda$ and $b$ independently. In an overall equilibrium, the incentive contract is also endogenous and thus, a change in $\lambda$ also changes the value of $b$. We now turn to the analysis on endogenizing $b$ via the date-0 incentive equilibrium.

3.2. Incentive Equilibrium

On date 0, funds design optimal contracts to motivate their portfolio managers to acquire information and trade on this information. Formally, fund $i$ chooses $(a_i, b_i)$ to maximize its expected payoff (12) subject to optimal portfolio investment (8), the incentive compatibility constraint (9), and the participation constraint (10). When making this optimal choice, each fund takes as given the other funds' choice $(a^*, b^*)$ and the financial market equilibrium. The idea of computing such an incentive equilibrium is to use the IC (9) to determine the slope $b$ of the linear contract and to use the PC (10) to determine the intercept $a$ of the contract. Our main focus is on the determination of $b$ since it determines the manager’s incentive to acquire and trade on private information.

To check the IC (9), we need to figure out the expected utility of a portfolio manager who acquires information and that of a manager who does not acquire information. We follow Grossman and Stiglitz (1980) to compute these expected utilities, and then show that the IC for fund $i$’s manager is equivalent to the following condition:

$$\frac{\gamma b_i \tau_e}{(\gamma b_i + T \tau_e) (\tau_v + \tau_p)} \geq e^{2\gamma c} - 1,$$

(22)

where $\tau_p$, given by (21), is taken to be exogenous from the perspective of an individual fund and its manager. Apparently, the left-hand-side of the IC (22) is increasing in $b_i$. We can show that for any individual fund $i$, its expected utility is decreasing in $b_i$ and thus, each fund will optimally set $b_i$ at a value such that the IC (22) holds with equality. In a symmetric equilibrium, $b_i = b^*$ for any $i \in [0, \lambda]$. So, replacing $b_i$
with \( b^* \) and inserting the expression of \( \tau_p \) into the left-hand-side of (22) and setting (22) with equality, we obtain the following condition that determines the equilibrium incentive \( b^* \):

\[
\frac{\gamma b^* \tau_v}{(\gamma b^* + T \tau_v)} = e^{2\gamma c} - 1.
\]

(23)

**Proposition 2.** (Incentive Equilibrium) Suppose

\[
\frac{\tau_v}{\tau_v} > e^{2\gamma c} - 1,
\]

(24)

and

\[
2 (\gamma + T \tau_v) [\tau_v - \tau_v (e^{2\gamma c} - 1)] > T \tau_v^2 + \tau_v \sqrt{4\lambda^2 \tau_v (e^{2\gamma c} - 1) [\tau_v - \tau_v (e^{2\gamma c} - 1)] + T^2 \tau_v^2}.
\]

(25)

Then, there exists a unique date-0 contract \((a^*, b^*)\) in a symmetric equilibrium in which all institutions hire managers to acquire information, where

\[
b^* = \left[ \frac{\tau_v - \tau_v - \tau_v (e^{2\gamma c} - 1)}{2 \gamma [\tau_v - \tau_v (e^{2\gamma c} - 1)]} \right] \in (0, 1),
\]

(26)

and

\[
a^* = c + \bar{W} - \bar{A},
\]

(27)

where the expression of \( A \) is given by equation (A23) in the Appendix.

Conditions (24) and (25) are rather technical. Condition (24), which intuitively says that the information-acquisition cost is relatively small, ensures that the optimal incentive \( b^* \) exists and is positive. Under condition (25), the value of \( b^* \) is smaller than 1, which guarantees the empirical relevance of the incentive contract.

Admati and Pfleiderer (1997) and Stoughton (1993) show that a linear contract is irrelevant to the manager’s effort to acquire information in a competitive market without transaction cost. This is because the manager can scale up or down her portfolio choice to undo the linear contract. In contrast, trading is costly in our setup and so the manager can no longer freely scale up or down her portfolio. This makes
the linear contract effective in motivating the manager to acquire information. This intuition can be formally examined in (22). Consider any individual fund \(i\). The left-hand-side of condition (22) measures the manager’s benefit of acquiring information while the right-hand-side measures the cost. If \(T = 0\), then the left-hand-side of condition (22) is independent of \(b_i\), meaning that the fund cannot use \(b_i\) to influence the manager’s information-acquisition behavior. In contrast, if \(T > 0\), then the left-hand-side of condition (22) is increasing in \(b_i\) and thus, the manager’s information-acquisition incentive is indeed affected by contract slope \(b_i\).

4. Implications for Incentive and Asset Prices

We use \(\lambda\) to parameterize institutionalization: a higher value of \(\lambda\) corresponds to a higher degree of institutionalization. In this section, we follow Basak and Pavlova (2013) and conduct comparative statics analysis with respect to \(\lambda\) to examine the implications of institutionalization for manager compensation and asset prices. To make transparent the role of delegation, we benchmark our analysis against an economy without an agency problem.

4.1. Benchmark Economy without Agency Problems

Our benchmark economy follows the analysis of the “first best” case in Stoughton (1993). In this case, managers’ information acquisition and trading behavior are observable and contractible. In designing contracts, a fund does not need to consider its manager’s incentive compatibility constraint. It will consider the manager’s participation constraint, make sure that its manager acquires information (since effort is observable and contractible), and then trade by itself on the developed information to maximize the principal’s utility. Now, fund \(i\)’s problem becomes:

\[
\max_{(a_i, b_i)} E \left[ \tilde{W}_i - S(\tilde{W}_i) \right]
\]
subject to the definitions $\hat{W}_i$ and $S(\hat{W}_i)$ in (4) and (5), the participation constraint (10), as well as the optimal portfolio rule $D^*_i$ set by the principal, which is given by

$$D^*_i = \arg \max_{D_i} E \left[ \hat{W}_i - S(\hat{W}_i) \big| \hat{v} \right].$$

We can show that the expected utility of fund $i$ decreases with $b_i$. Thus, fund $i$ will optimally set $b_i$ at 0. Intuitively, since a fund can perfectly observe its manager’s effort, the fund does not need to provide variable compensation to motivate the manager and therefore a fixed compensation is in the fund’s best interest. We use superscript “$B$” to denote the equilibrium variables in this benchmark economy, and so we have $b^B = 0$. After pinning down the slope $b^B$ of the linear contract, we then use the participation constraint (10) to figure out the intercept $a^B$ of the contract.

In the financial market, there exists a unique linear noisy-REE with price function given by (14). Based on the price function, price informativeness $\tau^B_p$ is still defined by equation (20). Since institutions are informed investors and trade on private information, increasing the mass $\lambda$ of institutions increases price informativeness $\tau^B_p$ in the benchmark economy.

Buying the asset and holding it for one period deliver a return of $\tilde{f} - \tilde{p}^B$. The first two moments of asset returns are:

$$E(\tilde{f} - \tilde{p}^B) = |a_0|,$$

$$\sigma(\tilde{f} - \tilde{p}^B) = \sqrt{\text{Var}(\tilde{f} - \tilde{p}^B)} = \sqrt{\frac{(1-a_v)^2}{\tau_v} + \frac{a^2_v}{\tau_\zeta} + \frac{1}{\tau_\xi}},$$

where the expressions of the moments follow directly from the price function. The first moment is often referred to as a firm’s “cost of capital” in the finance and accounting literature (e.g., Easley and O’Hara, 2004; Hughes, Liu, and Liu, 2007; Lambert, Leuz, and Verrecchia, 2007). We can show that both the cost of capital $E(\tilde{f} - \tilde{p}^B)$ and return volatility $\sigma(\tilde{f} - \tilde{p}^B)$ monotonically decrease with the mass $\lambda$ of financial institutions in the benchmark economy. These results are summarized in the following proposition.

**Proposition 3.** (Benchmark Economy) *In the benchmark economy without an agency*
problem, we have:

1. On date 1, there exists a unique linear rational expectations equilibrium with
   price function given by equation (14), where the expressions of $a_0$, $a_v$, and $a_\xi$
   are given by equations (A4)–(A6) in the Appendix. On date 0, funds choose a
   linear contract with a fixed compensation, that is, $b^B = 0$.

2. Institutionalization improves price informativeness and reduces the cost of capital and return volatility. That is,
   \[ \frac{\partial B_p}{\partial \lambda} > 0, \quad \frac{\partial E(\hat{f} - \hat{p}_B)}{\partial \lambda} < 0, \quad \text{and} \quad \frac{\partial \sigma(\hat{f} - \hat{p}_B)}{\partial \lambda} < 0. \]

4.2. Implications of Institutionalization with Agency Problems

We now turn to examine our baseline model with a moral hazard problem. The key
observation is that institutionalization affects the incentive part $b^*$ of the contract,
which therefore changes the effective risk aversion $\gamma b^*$ of financial institutions. This
gives rise to an additional effect on market outcomes, which can change the results
in the benchmark economy described above.

In the presence of moral hazard, the incentive part $b^*$ is determined by the incentive compatibility condition (23). In equilibrium, the contract motivates mangers to acquire information, and the incentive part $b^*$ is set at a value such that managers just have no incentives to deviate. The payoff for managers to deviate from acquiring information is to stay uninformed and save effort. An uninformed manager still actively makes inference from the asset price; formally, she extracts signal $\hat{s}_p$ with precision $\tau_p$ from the price. By Corollary 1, other things being equal, an increase in the mass $\lambda$ of financial institutions increases price informativeness $\tau_p$, and so if a manager stays uninformed, she would learn more information from a more institutionalized market. This implies a stronger incentive for those hired managers to deviate. To restore the managers’ incentive to acquire information, institutions optimally increase the profit share $b^*$ enjoyed by managers. Hence, $b^*$ increases with $\lambda$ in our setting.
As for price informativeness, two counteracting effects of institutionalization arise. The first effect is a positive direct effect: according to Corollary 1, for a given $b$, increasing $\lambda$ improves informativeness $\tau_p$. There is a second negative indirect effect: an increase in $\lambda$ also raises the incentive part $b^*$ of the equilibrium contract, which in turn increases the effective risk aversion $\gamma b^*$ of institutional investors (see equation (17)) and causes them to trade less aggressively on their information. This second effect tends to dampen the first effect. Nonetheless, we can show that overall, the positive effect dominates, so that institutionalization generally improves price informativeness. This result is consistent with the recent empirical evidence that price informativeness for firms in S&P500 has increased since 1960, which overlaps with the trend of institutionalization (e.g., Bai, Philippon, and Savov, 2016) and that price informativeness and institutional ownership are positively correlated in the cross section (e.g., Boehmer and Kelley, 2009; Kacperczyk and Nosal, 2018).

There are also two effects of institutionalization on the cost of capital and return volatility. The direct effect is similar to Part 2 of Proposition 3: for a given $b$, an increase in $\lambda$ brings more information into the price and lowers the risk faced by traders, which therefore reduces the cost of capital and return volatility. Again, there is a second indirect effect: increasing $\lambda$ raises $b^*$, which causes institutional investors to become more risk averse. This second effect tends to increase the cost of capital and return volatility. Unlike the price-informativeness result, the indirect effect sometimes dominates the direct effect, so that the overall effect of institutionalization is to increase the cost of capital and return volatility. In the following proposition, we provide a sufficient condition under which return moments are U-shaped in institutionalization.

**Proposition 4.** (Implications of Institutionalization) *In the economy with an agency problem, we have:*

1. Institutionalization increases the incentive part $b^*$ of the equilibrium contract. That is, $\frac{\partial b^*}{\partial \lambda} > 0$. 

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This figure plots the implications of institutionalization for contracts \( b \), price informativeness \( \tau_p \), and asset prices \( E(f - \tilde{p}) \) and \( \sigma(f - \tilde{p}) \), in economies without agency problems (Panel A) and with agency problems (Panel B). Parameter values are: \( \tau_v = 5, \tau_c = 1, \tau_\xi = 5, c = 0.02, T = 0.2, \gamma = 2, \) and \( Q = 0.1 \).

2. Institutionalization improves price informativeness \( \tau^*_p \). That is, \( \frac{\partial \tau^*_p}{\partial \lambda} > 0 \).

3. When the market is primarily dominated by retail investors, institutionalization lowers the cost of capital and return volatility. That is, for sufficiently small \( \lambda \), \( \frac{\partial E(f - \tilde{p}^*)}{\partial \lambda} < 0 \) and \( \frac{\partial \sigma(f - \tilde{p}^*)}{\partial \lambda} < 0 \). When the market is primarily dominated by institutional investors, institutionalization raises the cost of capital and return volatility for sufficiently high \( \tau_v \) and \( \frac{\tau_\xi}{\tau_v} \). That is, if \( \lambda \) is close to 1, then for sufficiently high \( \tau_v \) and \( \frac{\tau_\xi}{\tau_v} \), \( \frac{\partial E(f - \tilde{p}^*)}{\partial \lambda} > 0 \) and \( \frac{\partial \sigma(f - \tilde{p}^*)}{\partial \lambda} > 0 \).

Figure 2 graphically illustrates Propositions 3 and 4 under parameter configuration
of $\tau_v = 5, \tau_\xi = 1, \tau_\zeta = 5, c = 0.02, T = 0.2, \gamma = 2$, and $Q = 0.1$. Panel A plots economies without an agency problem, while Panel B plots economies with an agency problem. Consistent with Proposition 3, in Panel A, contract incentive $b^B$ equals 0 in equilibrium, price informativeness $\tau^B_p$ increases with $\lambda$, and the cost of capital $E(\tilde{f} - \tilde{p}^B)$ and return volatility $\sigma(\tilde{f} - \tilde{p}^B)$ decrease with $\lambda$. Also consistent with Proposition 4, in Panel B, both contract incentive $b^*$ and price informativeness increase with $\lambda$, while the cost of capital $E(\tilde{f} - \tilde{p}^*)$ and return volatility $\sigma(\tilde{f} - \tilde{p}^*)$ first decrease and then increase with $\lambda$.

5. An Extension with Public Information

In this section, we consider an extension to examine the implications of public disclosure. We find that a similar insight arises: releasing more precise public information increases the incentive part $b^*$ of the equilibrium contract, which effectively causes financial institutions to become more risk averse. As in Section 4, the endogenous change in $b^*$ (and hence institutions’ risk aversion) gives rise to an indirect effect of public information on various market variables. Relative to Section 4, what is new in this section is that the indirect effect on price informativeness can be dominant and as a result, the way in which public information affects private information aggregation in a market with delegation can be fundamentally different from that in a market without delegation.

5.1. Setup and Equilibrium

We introduce public information into the baseline model described in Section 2. Specifically, at the beginning of date 1 and before trading, all investors—financial
institutions and retail investors—observe a public signal\(^\text{11}\) as follows:

\[
\tilde{y} = \tilde{v} + \tilde{\eta}, \text{ with } \tilde{\eta} \sim N(0, \tau_\eta^{-1}) \text{ and } \tau_\eta \in (0, \infty),
\]

(30)

where \(\tilde{\eta}\) is independent of all other random variables. The public signal can be thought of as announcements made by listed companies about their future prospects or as economic statistics released by governments, central banks, or credit rating agencies. The precision \(\tau_\eta\) controls the quality of the public signal \(\tilde{y}\), and a higher value of \(\tau_\eta\) signifies that \(\tilde{y}\) is more informative about the asset payoff \(\tilde{f}\). This can be achieved with more frequent announcements or more accurate data. All of our other features remain unchanged from Section 2. In particular, the extended setting presented in this section nests the baseline model in Section 2 by setting \(\tau_\eta\) to be 0.

In the date-1 financial market, portfolio managers’ information set is augmented to \(\{\tilde{v}, \tilde{y}\}\). Since \(\tilde{y}\) is a noisy version of \(\tilde{v}\), public information \(\tilde{y}\) is redundant (also see footnote 11). Retail investors’ information set is augmented to \(\{\tilde{p}, \tilde{y}\}\) and both pieces of information are useful for retail trading. The asset price aggregates private information \(\tilde{v}\), public information \(\tilde{y}\), and noisy trading \(\tilde{\xi}\). We consider the following linear price function:

\[
\tilde{p} = a_0 + a_v \tilde{v} + a_y \tilde{y} + a_\xi \tilde{\xi},
\]

(31)

where the \(a\)-coefficients are endogenously determined in equilibrium. Conditional on the public signal \(\tilde{y}\), the price is equivalent to a signal as follows:

\[
\tilde{S}_p \equiv \frac{\tilde{p} - a_0 - a_y \tilde{y}}{a_v} = \tilde{v} + \frac{a_\xi}{a_v} \tilde{\xi},
\]

(32)

which has precision \(\tau_p\) in predicting \(\tilde{v}\), and is defined by equation (20).

As in Section 2, precision \(\tau_p\) can still be interpreted as a measure for price informativeness. It measures the additional information contained in the price relative to that in the disclosure. This measure is particularly relevant in the context of learning from prices (for instance, in the government intervention setting considered by Bond

\(^{11}\)For simplicity, we here assume that the public information is about the forecastable element \(\tilde{v}\) instead of about the total asset payoff \(\tilde{f}\). This implies that managers’ private information \(\tilde{v}\) is more precise than public disclosure \(\tilde{y}\) in forecasting payoff, so that they do not need to learn from \(\tilde{y}\). This assumption allows us to illustrate our price informativeness result in the most transparent way, by removing the direct effect of disclosure on \(\tau_p\) (see Part 2 of Proposition 6).
and Goldstein (2015), in which a government releases signal \( \tilde{y} \) to the general public and tries to learn information about \( \tilde{v} \) from the financial market; in the production settings explored by Kurlat and Veldkamp (2015), in which financial information spills over to the real economy via the firm’s investments; or in the credit rating setting analyzed by Goldstein and Yang (2018), in which a rating agency releases its rating \( \tilde{y} \) about a firm, and a creditor tries to learn the firm’s future prospects from its share prices).

Following similar steps as in Section 2, we can show that for a given contract \((a, b)\), there exists a unique linear noisy-REE with price function given by (31) in the date-1 financial market. We then go back to date 0 to determine the equilibrium contract parameters \((a^*, b^*)\). Still, in the equilibrium of interest, institutions design optimal contracts to motivate their hired managers to exert effort and acquire information. The equilibrium value of \( b^* \) is pinned down by the incentive compatibility constraint, which we can compute as follows:

\[
\frac{\gamma b^* \tau_\varepsilon}{(\gamma b^* + T \tau_\varepsilon) \left[ \tau_v + \tau_\eta + \frac{(\lambda \tau_\varepsilon)^2 \tau_\varepsilon}{(\gamma b^* + T \tau_\varepsilon)^2} \right]} = e^{2\gamma c} - 1.
\]

(33)

Comparing (33) with (23), we find that the introduction of a public signal modifies the IC as if the prior precision of \( \tilde{v} \) increases from \( \tau_v \) to \( \tau_v + \tau_\eta \). This is intuitive: conditional on public information \( \tilde{y} \), all investors gain extra precision \( \tau_\eta \). After we pin down \( b^* \), we can determine the value of \( a^* \) using the participation constraint.

**Proposition 5.** (Equilibrium with Public Information) *In the extended economy with public information, we have:*

1. **On date 1,** for any given \((a, b)\), there exists a unique linear noisy-REE with price function given by equation (31), where the expressions of \( a_0 \), \( a_v \), \( a_y \), and \( a_\xi \) are given by equations (A10)-(A13) in the Appendix.

2. **Suppose**

\[
\frac{\tau_\varepsilon}{\tau_v + \tau_\eta} > e^{2\gamma c} - 1
\]

(34)
and

\[ 2 (\gamma + T \tau_x) \left[ \tau_x - (\tau_v + \tau_\eta) \left( e^{2\gamma c} - 1 \right) \right] \]
\[ > T \tau_x^2 + \tau_x \sqrt{4\lambda^2 \tau_x \left( e^{2\gamma c} - 1 \right) \left[ \tau_x - (\tau_v + \tau_\eta) \left( e^{2\gamma c} - 1 \right) \right] + T^2 \tau_x^2}. \tag{35} \]

Then, there exists a unique date-0 contract \((a^*, b^*)\) in a symmetric equilibrium in which all institutions hire managers to acquire information, where

\[ b^* = \frac{+\tau_x \sqrt{4\lambda^2 \tau_x \left( e^{2\gamma c} - 1 \right) - 4\lambda^2 \tau_x \left( \tau_v + \tau_\eta \right) \left( e^{2\gamma c} - 1 \right)^2 + T^2 \tau_x^2}}{2 \gamma \left[ \tau_x - (\tau_v + \tau_\eta) \left( e^{2\gamma c} - 1 \right) \right]} \in (0, 1) \tag{36} \]

and

\[ a^* = c + \bar{W} - A, \tag{37} \]

where the expression of \(A\) is given by equation (A23) in the Appendix.

5.2. Implications of Public Information

We now examine the incentive and price implications of public information by conducting comparative statics analysis with respect to the precision \(\tau_\eta\) of public information \(\tilde{y}\). In this analysis, we fix the mass \(\lambda\) of financial institutions. Similar to Section 4, we benchmark our analysis against an economy without moral hazard, which is the economy described in Section 4.1 augmented with the public signal \(\tilde{y}\).

Introducing public information into the benchmark economy does not change the nature of equilibrium contract. It is still in the best interests of institutions to pay a fixed compensation to their respective managers, i.e., \(b^H = 0\), because funds can perfectly observe their managers’ effort and so need not to provide variable compensation to motivate information acquisition. In our setting, private information \(\tilde{v}\) is brought into the price via the trading of informed portfolio managers. Since public information \(\tilde{y}\) is a noisy version of \(\tilde{v}\), managers do not use \(\tilde{y}\) in their trading and as a result, public information does not affect how the asset price aggregates private information \(\tilde{v}\). Nonetheless, public information affects retail investors’ trading by re-
ducing the uncertainty faced by them. Being risk averse, retail investors trade more aggressively, which lowers the cost of capital \( E(f - \tilde{p}^B) \). Finally, retail trading injects public information into the price, bringing the price \( \tilde{p}^B \) closer to asset payoff \( \tilde{f} \) and hence reducing return volatility \( \sigma(f - \tilde{p}^B) \) in the benchmark economy without moral hazard problems.

Proposition 6. (Benchmark Economy with Public Information) In the benchmark economy without an agency problem but with public information, we have:

1. On date 1, there exists a unique linear noisy-REE with price function given by equation (31), where the expressions of \( a_0 \), \( a_v \), \( a_y \), and \( a_\zeta \) are given by equations (A24)-(A27) in the Appendix. On date 0, funds choose a linear contract with a fixed compensation, that is, \( b^B = 0 \).

2. Releasing more precise public information does not affect the price informativeness \( \tau^B_p \) about private information, and it reduces the cost of capital and return volatility. That is, \( \frac{\partial \tau^B_p}{\partial \tau_\eta} = 0 \), \( \frac{\partial E(\tilde{f} - \tilde{p}^B)}{\partial \tau_\eta} < 0 \), and \( \frac{\partial \sigma(\tilde{f} - \tilde{p}^B)}{\partial \tau_\eta} < 0 \).

In an economy with moral hazard, the incentive part \( b^* \) of the equilibrium contract takes a positive value that is determined by the incentive compatibility condition (33). In equilibrium, the contract motivates managers to undertake effort and \( b^* \) is set at a value such that managers just have no incentives to deviate. The payoff for managers to deviate is to stay uninformed and save effort. An uninformed manager can learn information directly from public information \( \tilde{y} \) (in addition to asset price \( \tilde{p} \)). Thus, an increase in the precision \( \tau_\eta \) of \( \tilde{y} \) directly strengthens managers’ incentive to deviate from undertaking effort, which is reflected in the denominator of the left-hand-side of equation (33). To keep managers to work hard, institutions have to give more incentives to motivate managers and as a result, \( b^* \) increases with public information precision \( \tau_\eta \).

The increased \( b^* \) implies that institutional investors are effectively more risk averse (see equation (17)) and hence, they trade more cautiously on their private information.
This figure plots the implications of public information precision for contracts ($b$), price informativeness ($\tau_p$), and asset prices ($E(\tilde{\bar{p}})$ and $\sigma(\tilde{\bar{p}})$), in economies without agency problems (Panel A) and with agency problems (Panel B). Parameter values are: $\nu = 5$, $\mu = 2$, $\xi = 5$, $c = 0.02$, $T = 0.2$, $\gamma = 2$, $\lambda = 0.1$, and $Q = 0.1$.

\(\tilde{v}\). In consequence, the asset price $\tilde{\bar{p}}$ aggregates less private information in equilibrium, i.e., $\tau_p^*$ decreases with $\tau_\eta$.

**Proposition 7.** (Implications of Public Information) *In the economy with an agency problem and public information, an increase in the precision $\tau_\eta$ of public information:

1. Increases the incentive part $b^*$ of the equilibrium contract. That is, $\frac{\partial b^*}{\partial \tau_\eta} > 0$.

2. Decreases the price informativeness $\tau_p^*$ about private information. That is, $\frac{\partial \tau_p^*}{\partial \tau_\eta} < 0$.

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Figure 3 graphically illustrates Propositions 6 and 7 under parameter configuration of \( \tau_v = 5, \tau_\xi = 2, \tau_\zeta = 5, c = 0.02, T = 0.2, \gamma = 2, \lambda = 0.1, \) and \( Q = 0.1. \) Panel A plots economies without an agency problem and Panel B plots economies with an agency problem. In Panel A, the equilibrium contract incentive \( b^B \) equals 0, price informativeness \( \tau_p^B \) does not depend on public information precision \( \tau_\eta, \) and the cost of capital \( E(\tilde{f} - \tilde{p}^B) \) and return volatility \( \sigma(\tilde{f} - \tilde{p}^B) \) decrease with \( \tau_\eta. \) This is consistent with Proposition 6. In Panel B, the contract incentive \( b^* \) increases with \( \tau_\eta \) and price informativeness \( \tau_p^* \) decreases with \( \tau_\eta, \) which is consistent with Proposition 7. In addition, both the cost of capital \( E(\tilde{f} - \tilde{p}^*) \) and return volatility \( \sigma(\tilde{f} - \tilde{p}^*) \) are U-shaped in \( \tau_\eta. \) This non-monotonic pattern is driven by the interaction between two effects. The direct effect of \( \tau_\eta \) is to reduce \( E(\tilde{f} - \tilde{p}^*) \) and \( \sigma(\tilde{f} - \tilde{p}^*) \) for a given \( b. \) The indirect effect works through the endogenous \( b^* \): increasing \( \tau_\eta \) raises \( b^* \) and makes institutional investors more risk averse, which tends to increase \( E(\tilde{f} - \tilde{p}^*) \) and \( \sigma(\tilde{f} - \tilde{p}^*). \)

6. Empirical Implications

We now briefly discuss empirical predictions from the analysis conducted in Sections 4 and 5. Some of these predictions help to explain a wide range of empirical patterns on fund industry and asset prices, which have been documented and appear to be puzzling in the empirical literature. Other predictions offer new opportunities to help us understand financial phenomena by testing our theory.

6.1. Predictions about Institutionalization

Over the past few decades, the asset management industry has become intensively competitive due to the huge influx of new financial institutions such as mutual funds. One would conjecture that this intensive competition among funds should generate dramatic downwards pressure on management fees. However, the reality does not
provide strong support for this conjecture. For instance, French (2008) documents that the expense ratios in mutual funds do not change too much over time (96 bps in 1988, 98 bps in 2002, and 85 bps in 2006), and that management fees charged by hedge funds in the U.S. market even seem to be increasing from 1996 to 2007. By examining mutual fund fees around the world, Khorana, Servaes, and Tufano (2009, p. 1304) find that “concentration in the fund management industry is associated with lower management fees” and they conclude that “(t)his result may appear counterintuitive.” Sun (2014) finds that the new entry of index funds increases fund management fees, and he explains this finding from a perspective of client heterogeneity.

Part 1 of Proposition 4 sheds lights on those observations about management fees. The contract slope $b$ in our setting corresponds to the base fee in Das and Sundaram (2002). The base fee, sometimes called “flat fee” or “fraction of funds” fee in the money management industry, captures that portion of the fees that are based solely on the size of assets under management. According to Part 1 of Proposition 4, the contract slope $b^*$ increases with the mass $\lambda$ of funds. This result provides a force through which fund competition drives up management fees, to the extent that more funds lead to more competition and less concentration. This delegation channel therefore helps to explain the empirical puzzle of why fund fees decline only slowly or even increase over time, despite sharply rising competition in the money management industry.

Part 2 of Proposition 4 shows that institutionalization improves price informativeness. As mentioned in Section 1.1, this result differentiates our theory from the career-concern channel explored in Breugem and Buss (2018) by confirming some recent time-series and cross-sectional evidence. For instance, Bai, Philippon, and Savov (2016) find that price informativeness for firms in S&P500 has increased since 1960. This increase in informativeness overlaps with the trend of institutionalization, which provides time series evidence for Part 2 of Proposition 4.  

12Farboodi, Matray, and Veldkamp (2017) document that price informativeness is trending upward only for large firms but that there is a stagnation, or even slight decline, for others. To the extent
informativeness and institutional ownership are found to be positively correlated (e.g., Boehmer and Kelley, 2009; Bai, Philippon, and Savov, 2016; Kacperczyk and Nosal, 2018). This is also consistent with Part 2 of Proposition 4.

Part 3 of Proposition 4 demonstrates a non-monotonic pattern between institutionalization and the cost of capital as well as return volatility. The cost of capital result provides new testable predictions, and the volatility result suggests an explanation for the existing findings on return volatility and institutional ownership. Specifically, Campbell, Lettau, Malkiel, and Xu (2001) document an increasing trend in idiosyncratic volatility in the U.S. during the 1962-1997 period. Malkiel and Xu (2003) and Bennett, Sias, and Starks (2003) show that the rising trend in idiosyncratic volatility in their samples is linked to increasing institutional involvement in the equity market. Brandt, Brav, Graham, and Kumar (2007) find that among low-priced stocks, a higher level of institutional ownership predicts lower idiosyncratic volatility and that among high-priced stocks, the opposite is true. Since low-priced stocks are dominated by retail traders and high-priced stocks are dominated by institutional investors, the finding of Brandt, Brav, Graham, and Kumar (2007) suggests a U-shaped relation between return volatility and institutional ownership. This finding squares perfectly with our delegation-based theory, or more precisely, with the right bottom panel of Figure 2. This further differentiates our story from the career-concern story studied by Breugem and Buss (2018) who show that benchmarking monotonically increases return volatility and by Basak and Pavlova (2013) who show that return volatility is hump-shaped in institutionalization.

6.2. Predictions about Public Disclosure

There is a voluminous empirical literature that studies the association between disclosure and the cost of capital, and the evidence is mixed. Researchers have documented evidence that disclosure can either decrease, increase, or have no effect on a firm’s

that institutions are more likely to trade large firms, our theory is more relevant to these firms.
cost of capital. Panel B of Figure 3 suggests that the relationship between disclosure and the cost of capital is non-monotonic. This helps to reconcile the mixed empirical findings on the cost of capital effect of disclosure documented in the literature, since anything can happen if researchers use different samples to run simple linear regressions. Panel B of Figure 3 also suggests a non-monotonic relation between disclosure and return volatility, which can be potentially tested with nonlinear regressions.

7. Conclusion

We develop a model of delegated portfolio management to analyze the effects of institutionalization on the asset management industry and asset prices. The key insight emerging from our analysis is that institutionalization raises the incentive part of the equilibrium contract, which increases the effective risk aversion of institutional investors. This implies that institutionalization has two opposing effects on market outcomes. First, institutionalization directly brings more informed traders (and information) into the market, since in equilibrium portfolio managers are motivated to acquire and trade on information. More informed trading tends to improve price informativeness and reduce the cost of capital and return volatility. Second, by raising the incentive part of the contract, institutionalization makes each institutional investor more risk averse and trade less aggressively on information. This second indirect effect works against the first direct effect. As a result, institutionalization can non-monotonically affect the cost of capital and return volatility (but not price informativeness). We also find that releasing public information has similar effects as institutionalization through changing the equilibrium contract and institutional investors’ risk aversion. Overall, our theory provides a delegation perspective of

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13 For instance, in a survey article, Beyer, Cohen, Lys, and Walther (2010, p. 309) write: “(o)verall, the empirical evidence on the relation between voluntary disclosures, financial reporting quality attributes, and cost of capital is still inconclusive. We cannot draw unambiguous conclusions whether the theory and the related empirical evidence so far supports a significant statistical and economic link between information quality and cost of capital.”
understanding the determination of institutional investors’ risk attitude and the implications of institutionalization. Our analysis is helpful for understanding a wide range of empirical findings about fund fees and asset returns and also suggests new testable predictions.
Appendix: Proofs

Proof of Proposition 1

Proposition 1 follows directly from Part 1 of Proposition 5 with $\tau_\eta = 0$. In particular,

$$\begin{align*}
a_0 &= -\frac{Q}{\gamma + \gamma \tau_v + T(\gamma + \gamma \tau_v + T)}, \\
a_v &= \frac{(1-\lambda)\tau_p}{\gamma + \gamma \tau_v + T(\gamma + \gamma \tau_v + T)}, \\
a_\xi &= \frac{(1-\lambda)\tau_p}{\gamma + \gamma \tau_v + T(\gamma + \gamma \tau_v + T)} + 1.
\end{align*}$$

(A1) (A2) (A3)

The expression of $\tau_p$ follows from equation (A14).

Proof of Corollary 1

Given the expression of $\tau_p$ in (21), we can take derivatives and show that $\frac{\partial \tau_p}{\partial b} < 0$ and $\frac{\partial \tau_p}{\partial \lambda} > 0$.

Proof of Proposition 2

Proposition 2 follows from Part 2 of Proposition 5 with $\tau_\eta = 0$.

Proof of Proposition 3

Part 1 of Proposition 3 follows directly from Part 1 of Proposition 6 with $\tau_\eta = 0$. In particular,

$$\begin{align*}
a_0 &= -\frac{Q}{\gamma + \gamma \tau_v + T(\gamma + \gamma \tau_v + T)}, \\
a_v &= \frac{(1-\lambda)\tau_p}{\gamma + \gamma \tau_v + T(\gamma + \gamma \tau_v + T)}, \\
a_\xi &= \frac{(1-\lambda)\tau_p}{\gamma + \gamma \tau_v + T(\gamma + \gamma \tau_v + T)}.
\end{align*}$$

(A4) (A5)
\[ a_\xi = \frac{1 + \frac{(1-\lambda)\tau_p}{\gamma + \gamma \tau + \tau_p + T(\tau_u + \tau_p)}}{\frac{\lambda}{T} + \frac{(1-\lambda)(\tau_u + \tau_p)}{\gamma + \gamma \tau + \tau_p + T(\tau_u + \tau_p)}} \],
\]
with
\[ \tau_p = \frac{\lambda^2}{T^2} T \xi. \]

We now prove Part 2. From (A7), it is clear that \( \frac{\partial \tau_p}{\partial \lambda} > 0 \). Using the expressions of \( a_\xi \)’s in (A4)–(A6), we can take derivatives and show that \( \frac{\partial E(\tilde{f} - \tilde{p})}{\partial \lambda} < 0 \) and \( \frac{\partial \text{Var}(\tilde{f} - \tilde{p})}{\partial \lambda} < 0 \).

**Proof of Proposition 4**

**Proof of Parts 1 and 2**

The equilibrium value \( b^* \) is determined by the IC, which is given by equation (A18) with \( \tau_\eta = 0 \) as follows:
\[ \frac{b_\gamma \tau_\varepsilon}{b_\gamma \left( \frac{\lambda^2 \tau \xi^2}{(b_\gamma + T \tau_\varepsilon)^2} + \tau_\varepsilon \right)} + T \tau_\varepsilon \left( \frac{\lambda^2 \tau \xi^2}{(b_\gamma + T \tau_\varepsilon)^2} + \tau_\varepsilon \right) = e^{2\gamma c} - 1. \]

Applying the implicit function theorem to the above equation, we can prove Part 1 of Proposition 4. Part 2 follows immediately from the expression of \( \tau_p \) in (A14).

**Proof of Part 3**

Suppose \( \lambda \to 0 \). Direct computation shows that \( \lim_{\lambda \to 0} \frac{\partial E(\tilde{f} - \tilde{p})}{\partial \lambda} \) and \( \lim_{\lambda \to 0} \frac{\partial \text{Var}(\tilde{f} - \tilde{p})}{\partial \lambda} \) have the same sign. By Proposition 1, we have
\[ E(\tilde{f} - \tilde{p}) = \frac{Q}{F(\lambda)}, \]
where function \( F(\lambda) \) is defined as follows:
\[ F(\lambda) = \frac{\lambda}{b_\gamma \frac{1}{\tau_\varepsilon} + T} + \frac{(1 - \lambda)(\tau_\varepsilon + \tau_p)}{\gamma + T(\tau_\varepsilon + \tau_p) + \gamma \frac{\tau_\varepsilon + \tau_p}{\tau_\varepsilon}.} \]

As \( \lambda \) is close to 0,
\[ \frac{\partial F}{\partial \lambda} \approx \frac{1}{b_\gamma \frac{1}{\tau_\varepsilon} + T} \frac{\gamma + (1 - b)\gamma \frac{\tau_\varepsilon + \tau_p}{\tau_\varepsilon}}{\gamma + T(\tau_\varepsilon + \tau_p) + \gamma \frac{\tau_\varepsilon + \tau_p}{\tau_\varepsilon}} + \frac{\partial}{\partial \lambda} \gamma + T(\tau_\varepsilon + \tau_p) + \gamma \frac{\tau_\varepsilon + \tau_p}{\tau_\varepsilon}. \]

Since in an empirically relevant equilibrium, we have \( b^* \to 1 \), the first term in the above condition is positive. Direct computation shows \( \frac{\partial}{\partial \lambda} \frac{\tau_\varepsilon + \tau_p}{\gamma + T(\tau_\varepsilon + \tau_p) + \gamma \frac{\tau_\varepsilon + \tau_p}{\tau_\varepsilon}} > 0 \). Thus, we have \( \lim_{\lambda \to 0} \frac{\partial f}{\partial \lambda} > 0 \), which implies that \( \lim_{\lambda \to 0} \frac{\partial E(\tilde{f} - \tilde{p})}{\partial \lambda} < 0 \) and \( \lim_{\lambda \to 0} \frac{\partial \text{Var}(\tilde{f} - \tilde{p})}{\partial \lambda} < 0 \).
Suppose $\lambda \to 1$. Using Proposition 1, we can directly compute
\[
\lim_{\lambda \to 1} \frac{\partial E(f - \tilde{p})}{\partial \lambda} = \left( \frac{b\gamma}{\tau_\epsilon} + T \right)^2 \left[ \frac{\tau_v + \tau_p}{\gamma + \frac{\gamma (\tau_p + \tau_v)}{\tau_\epsilon} + T (\tau_p + \tau_v)} + \frac{\partial b}{\partial \lambda} \right] - \frac{1}{b\gamma + T},
\]
\[
\lim_{\lambda \to 1} \frac{\partial \text{Var}(f - \tilde{p})}{\partial \lambda} = \frac{2a\xi \left( \frac{b\gamma}{\tau_\epsilon} + T \right)^2}{\tau_\xi} \left[ \frac{\tau_v}{\gamma + \frac{\gamma (\tau_p + \tau_v)}{\tau_\epsilon} + T (\tau_p + \tau_v)} + \frac{\partial b}{\partial \lambda} \right] - \frac{1}{b\gamma + T}.
\]
Thus, a sufficient condition for $\lim_{\lambda \to 1} \frac{\partial E(f - \tilde{p})}{\partial \lambda} > 0$ and $\lim_{\lambda \to 1} \frac{\partial \text{Var}(f - \tilde{p})}{\partial \lambda} > 0$ is
\[
\frac{\tau_v}{\gamma + \frac{\gamma (\tau_p + \tau_v)}{\tau_\epsilon} + T (\tau_p + \tau_v)} + \frac{1}{b\gamma + T} > 0,
\]
which can be re-expressed as
\[
\frac{\tau_v}{\lambda^2 \tau_\xi (\tau_\xi + T \tau_\epsilon)} + \frac{b\gamma + T \tau_\epsilon}{b\gamma + T \tau_\epsilon} > 1.
\]

Now suppose $\tau_v \to \infty$ and $\lim_{\tau_v \to \infty} \frac{\tau_\xi}{\tau_v} >> e^{2\gamma c} - 1$ (so that condition (24) in Proposition 2 is satisfied). It is easy to show that condition (25) in Proposition 2 also holds and hence $b \in (0, 1)$. Now we prove that condition (A8) is satisfied as well. Specifically, as $\tau_v \to \infty$ and $\lim_{\tau_v \to \infty} \frac{\tau_\xi}{\tau_v} >> e^{2\gamma c} - 1$, the left-hand-side of (A8) is close to
\[
\frac{1}{b\gamma + T \tau_\epsilon} \approx 1 + \frac{b\gamma}{b\gamma + T \tau_\epsilon} > 1,
\]
since $b > 0$ and $\frac{\partial b}{\partial \lambda} > 0$.

**Proof of Proposition 5**

**Part 1: Financial Market Equilibrium**

The CARA-normal setup implies that the demand functions of institutions and of retail investors are, respectively,
\[
D_I(\tilde{v}) = \frac{E(f|\tilde{v}) - \tilde{p}}{b\gamma \text{Var}(f|\tilde{v}) + T},
\]
\[
D_R(\tilde{p}, \tilde{y}) = \frac{E(f|\tilde{p}, \tilde{y}) - \tilde{p}}{\gamma \text{Var}(f|\tilde{p}, \tilde{y}) + T}.
\]

We can directly compute the conditional moments of institutional investors as
follows:

\[ E(\tilde{f} | \tilde{v}) = \tilde{v} \text{ and } Var(\tilde{f} | \tilde{v}) = \frac{1}{\tau_{\tilde{v}}} \text{.} \]

For retail investors, note that their information set \( \{\tilde{p}, \tilde{y}\} \) is equivalent to \( \{\tilde{s}_p, \tilde{y}\} \), where \( \tilde{s}_p \) is defined by (32). Applying Bayes’ rule, we can compute

\[ E(\tilde{v} | \tilde{p}, \tilde{y}) = \frac{\tau_{\tilde{y}} \tilde{y} + \tau_{p} \tilde{s}_p}{\tau_{v} + \tau_{p} + \tau_{\tilde{y}}} \text{ and } Var(\tilde{f} | \tilde{p}, \tilde{y}) = \frac{1}{\tau_{v} + \tau_{p} + \tau_{\tilde{y}}} + \frac{1}{\tau_{\tilde{v}}} \text{.} \]

Inserting these moment expressions into the respective demand functions and then plugging the demand expressions into the market clearing condition, we obtain

\[ \tilde{p} = \frac{\lambda}{\tau_{\tilde{v}} + T} \tilde{v} + \frac{1 - \lambda}{\gamma + T(\tau_v + \tau_p + \tau_y) + \gamma^\tau_{p} + \tau_{\tilde{y}}} \tilde{y} + \frac{1 - \lambda}{\gamma + T(\tau_v + \tau_p + \tau_y) + \gamma^\tau_{p} + \tau_{\tilde{y}}} \left( \tilde{v} + \frac{a_{\xi} \tilde{\xi}}{a_v} \right) + \tilde{\xi} - Q \text{.} \]

(A9)

Compared (A9) with the conjectured price function (31), we have

\[ a_0 = - \frac{\lambda}{\tau_{\tilde{v}} + T} + \frac{(1 - \lambda)(\tau_v + \tau_p + \tau_y)}{\gamma + T(\tau_v + \tau_p + \tau_y) + \gamma^\tau_{p} + \tau_{\tilde{y}}}, \quad (A10) \]

\[ a_v = \frac{\lambda}{\tau_{\tilde{v}} + T} + \frac{(1 - \lambda)(\tau_v + \tau_p + \tau_y)}{\gamma + T(\tau_v + \tau_p + \tau_y) + \gamma^\tau_{p} + \tau_{\tilde{y}}}, \quad (A11) \]

\[ a_y = \frac{\lambda}{\tau_{\tilde{v}} + T} + \frac{(1 - \lambda)(\tau_v + \tau_p + \tau_y)}{\gamma + T(\tau_v + \tau_p + \tau_y) + \gamma^\tau_{p} + \tau_{\tilde{y}}}, \quad (A12) \]

\[ a_{\xi} = \frac{\lambda}{\tau_{\tilde{v}} + T} + \frac{(1 - \lambda)(\tau_v + \tau_p + \tau_y)}{\gamma + T(\tau_v + \tau_p + \tau_y) + \gamma^\tau_{p} + \tau_{\tilde{y}}}. \quad (A13) \]

Note that in the above expressions, \( \tau_p \) and \( \frac{a_{\xi}}{a_v} \) are still unknown. To find out these variables, we divide (A13) by (A11) and have

\[ \frac{a_{\xi}}{a_v} = \frac{1}{\lambda} \left( \frac{b \gamma}{\tau_{\tilde{v}}} + T \right). \]

Inserting the above expression into (20), we have

\[ \tau_p = \frac{(\lambda \tau_{\tilde{v}})^2 \tau_{\xi}}{(b \gamma + T \tau_{\tilde{v}})^2}. \quad (A14) \]
Part 2: Incentive Equilibrium

At the contract determination stage, we seek an equilibrium with the following two features: (1) all institutions design contracts to motivate their managers to acquire and trade on information; and (2) the incentive part $b^*$ of the equilibrium is empirically relevant, i.e., $b^* \in (0, 1)$.

Consider fund $i \in [0, \lambda]$. She chooses $(a_i, b_i)$ to maximize her expected payoff (12) subject to the optimal portfolio investment rule, the incentive compatibility constraint (IC), and the participation constraint (PC). We can compute the PC as follows:

$$
- \frac{1}{1 + \frac{b_i \gamma}{\sigma \tau + T}} \exp \left( -a_i \gamma - \frac{1}{2} \frac{b_i \gamma}{\sigma \tau + T} \left( 1 + \frac{\alpha^2}{\sigma \tau + T} \right) \right) \geq -e^{-\gamma (v - p)},
$$

where

$$\alpha \equiv E(\tilde{v} - \tilde{p}) \quad \text{and} \quad \beta \equiv Var(\tilde{v} - \tilde{p}).$$

Fund $i$ always sets the fixed part $a_i$ of the compensation at a value such that the PC is binding. Thus, we have

$$a_i = c + \tilde{W} - A_i,$$

where

$$A_i = \frac{1}{2\gamma} \left[ \ln \left( 1 + \frac{b_i \gamma}{\sigma \tau + T} \right) + \frac{b_i \gamma}{\sigma \tau + T} \left( 1 + \frac{\alpha^2}{\sigma \tau + T} \right) \right].$$

Inserting (A15) and (A16) into fund $i$’s objective function, we can express fund $i$’s payoff as a function of $b_i$. With some algebra, we can show that fund $i$’s payoff is decreasing in $b_i$. However, the IC puts a lower bound on the choice of $b_i$. Specifically, we can follow Grossman and Stiglitz (1980) and compute the IC as follows:

$$
\frac{b_i \gamma \tau}{\tau_v + \tau_p + \tau_\eta + T \tau} \left( \tau_v + \tau_p + \tau_\eta \right) \geq e^{2\gamma c} - 1.
$$

Note that the left-hand-side of the above condition is increasing in $b_i$ and thus, fund $i$ will choose an equilibrium value of $b^*_i$ such that the IC holds with equality.

We consider a symmetric equilibrium with $b^*_i = b^*$ for $i \in [0, \lambda]$. Thus, using the expression of $\tau_p$ in (A14) and the above IC expression (A17), we know that $b^*$ is
determined by the following condition:

\[ b\gamma \tau \epsilon \left( \frac{\lambda^2 \tau \epsilon \tau^2}{(b\gamma + T\tau \epsilon)^2} + \tau \nu + \tau \eta \right) + T\tau \epsilon \left( \frac{\lambda^2 \tau \epsilon \tau^2}{(b\gamma + T\tau \epsilon)^2} + \tau \nu + \tau \eta \right) = e^{2\gamma c} - 1. \]  
(A18)

We can further simplify (A18) as a quadratic equation

\[ G(b) \equiv B_1 b^2 + B_2 b + B_3 = 0, \]  
(A19)

where

\[ B_1 = \gamma^2 \left[ (e^{2\gamma c} - 1) (\tau \nu + \tau \eta) - \tau \epsilon \right], \]  
(A20)

\[ B_2 = \gamma T \tau \epsilon \left[ 2 \left( e^{2\gamma c} - 1 \right) (\tau \nu + \tau \eta) - \tau \epsilon \right], \]  
(A21)

\[ B_3 = \left( e^{2\gamma c} - 1 \right) \tau^2 \left( (\tau \nu + \tau \eta) T^2 + \lambda^2 \tau \epsilon \right). \]  
(A22)

If \( B_1 > 0 \), then \( B_2 > 0 \). Since \( B_3 > 0 \), we have \( G(b) > 0 \) for all \( b > 0 \). Given that we consider an equilibrium with \( b^* > 0 \), we require \( B_1 < 0 \), which is equivalent to condition (34) in Proposition 5.

When \( B_1 < 0 \), the quadratic function \( G(b) \) has two roots, one positive and one negative. The positive root of (A19) delivers the expression of \( b^* \) in equation (36).

Condition (35) in Proposition 5 is imposed to ensure that \( b^* < 1 \).

After we figure out the value of \( b^* \), the value of \( a^* \) is given by equation (A15) with

\[ A = \frac{1}{2\gamma} \left[ \ln \left( 1 + \frac{b^* \gamma}{b\gamma \tau \epsilon + T} \right) + \frac{b^* \gamma}{b\gamma \tau \epsilon + T} \right] . \]  
(A23)

Proof of Proposition 6

Part 1: Equilibrium Characterization

We still first figure out the financial market equilibrium for a fixed \((a, b)\), and then compute the incentive equilibrium \((a^*, b^*)\).

At the date-1 trading stage, the demand function for fund \( i \) is

\[ D_I(\tilde{v}) \equiv \arg\max_{\tilde{W}_i} E \left[ \tilde{W}_i - S(\tilde{W}_i) \right] = \frac{\tilde{v} - \tilde{p}}{T} . \]

For an uninformed investor, we compute the demand function as

\[ D_R(\tilde{p}, \tilde{y}) = \frac{\tau \eta \tilde{y} + \tilde{p}^2 \tilde{S}_p - (\tau \nu + \tau \eta + \tau \eta) \tilde{p}}{\gamma + \gamma \tau \nu + \tau \eta + \tau \eta + T (\tau \nu + \tau \eta) } . \]

Inserting the above demand functions into the market-clearing condition (13), we
compute the implied price function as follows:

\[
\hat{p} = \frac{T \hat{v} + \frac{(1-\lambda)\tau_p}{\gamma + \gamma \frac{\tau_v + \tau_p + \tau_n}{\tau_e} + T(\tau_v + \tau_p + \tau_n)} \left( \hat{v} + \frac{a\xi}{a_v} \right) + \hat{\xi} - Q}{\frac{\lambda}{T} + \frac{(1-\lambda)(\tau_v + \tau_p + \tau_n)}{\gamma + \gamma \frac{\tau_v + \tau_p + \tau_n}{\tau_e} + T(\tau_v + \tau_p + \tau_n)}}.
\]

Comparing the above price function with the conjectured price function (31), we have

\[
a_0 = -\frac{\hat{\lambda}}{\hat{T}} + \frac{(1-\lambda)(\tau_v + \tau_p + \tau_n)}{\gamma + \gamma \frac{\tau_v + \tau_p + \tau_n}{\tau_e} + T(\tau_v + \tau_p + \tau_n)},
\]

\[
a_v = \frac{\hat{\lambda}}{\hat{T}} - \frac{(1-\lambda)(\tau_v + \tau_p + \tau_n)}{\gamma + \gamma \frac{\tau_v + \tau_p + \tau_n}{\tau_e} + T(\tau_v + \tau_p + \tau_n)},
\]

\[
a_y = \frac{\hat{\lambda}}{\hat{T}} + \frac{(1-\lambda)(\tau_v + \tau_p + \tau_n)}{\gamma + \gamma \frac{\tau_v + \tau_p + \tau_n}{\tau_e} + T(\tau_v + \tau_p + \tau_n)},
\]

\[
a_\xi = \frac{\hat{\lambda}}{\hat{T}} + \frac{(1-\lambda)(\tau_v + \tau_p + \tau_n)}{\gamma + \gamma \frac{\tau_v + \tau_p + \tau_n}{\tau_e} + T(\tau_v + \tau_p + \tau_n)} \cdot \frac{a\xi}{a_v} + 1.
\]

Using (A25) and (A27), we can show

\[
\frac{a_\xi}{a_v} = \frac{T}{\hat{\lambda}}.
\]

Thus,

\[
\tau_p = \left( \frac{a_\xi}{a_v} \right) \tau_\xi = \frac{\lambda^2}{T^2} \tau_\xi.
\]

Now, we go back to date 0 to solve the incentive equilibrium. Managers’ information acquisition and trading behavior are observable and contractible, so that there is no moral hazard. Therefore, fund i’s problem is

\[
\max_{(a_i, b_i)} E \left[ \tilde{W}_i - S(\tilde{W}_i) \right]
\]

subject to

\[
\tilde{W}_i = D_i^* (\tilde{f} - \tilde{p}) - \frac{1}{2} T D_i^* 2;
\]

\[
S(\tilde{W}_i) = a_i + b_i \tilde{W}_i;
\]

\[
D_i^* = \arg \max_{D_i} E \left[ \tilde{W}_i - S(\tilde{W}_i) \mid \tilde{v} \right] = \tilde{v} - \tilde{p} / T;
\]

\[
E \left[ -e^{-\gamma (a_i + b_i \tilde{W}_i - c)} \right] \geq E \left( -e^{-\gamma \tilde{W}} \right).
\]

Similar to the setting with moral hazard (see the proof of Part 2 of Proposition...
5), each fund will choose $a_i$ such that the PC holds with equality. That is,

$$a_i = c + \bar{W} - A_i,$$

(A29)

where

$$A_i = \frac{1}{2\gamma} \left[ \ln \left( 1 + \frac{\gamma b_i}{T} \left( 1 - \frac{\gamma b_i}{T \tau \epsilon} \right) \beta \right) + \frac{\gamma b_i}{T} \left( 1 - \frac{\gamma b_i}{T \tau \epsilon} \right) \frac{\alpha^2}{1 + \frac{\gamma b_i}{T} \left( 1 - \frac{\gamma b_i}{T \tau \epsilon} \right) \beta} \right],$$

(A30)

where $\alpha = E(\tilde{v} - \tilde{p})$ and $\beta = Var(\tilde{v} - \tilde{p})$. Inserting the above two equations into fund $i$’s objective function $E \left[ \tilde{W}_i - S(\tilde{W}_i) \right]$, we can express $E \left[ \tilde{W}_i - S(\tilde{W}_i) \right]$ as a function of $b_i$ only, denoted by $h(b_i)$. With some algebra, we can show that $\frac{\partial h(b_i)}{\partial b_i} < 0$. Thus, all funds optimally set $b_i = 0$.

**Part 2: Implications of Public Information**

By the expression of $\tau_p$ in (A28), we have $\frac{\partial \tau_p}{\partial \tau_q} = 0$. Still, the cost of capital is $E(\tilde{f} - \tilde{p}) = |a_0|$. Using the the expression of $a_0$ in (A24), we can show $\frac{\partial E(\tilde{f} - \tilde{p})}{\partial \tau_q} < 0$.

The return volatility is

$$\sigma(\tilde{f} - \tilde{p}) = \sqrt{(1 - a_v - a_y)^2 \frac{1}{\tau_v} + a_x^2 \frac{1}{\tau_x} + a_y^2 \frac{1}{\tau_y} + \frac{1}{\tau_e}}.$$

Direct computation shows $\frac{\partial \sigma(\tilde{f} - \tilde{p})}{\partial \tau_q} < 0$.

**Proof of Proposition 7**

We apply the implicit function theorem to equation (A18) and get Part 1. Part 2 follows immediately from the expression of $\tau_p$ in equation (A14).
References


