Emerging Markets and Entry by Actively Managed Funds

Alexander Gümbel[1]
Saïd Business School
University of Oxford
and
Lincoln College
Oxford, OX1 3DR (UK)
Tel: +44 1865 279 782
Fax: +44 1865 279 802
e-mail: alexander.guembel@sbs.ox.ac.uk

16 January, 2001

[1] I wish to thank James Dow, Rainer Kiefer, Colin Mayer and Oren Sussman for helpful comments and discussions. All remaining errors are mine.

Emerging Markets and Entry by Actively Managed Funds

Abstract

This paper investigates the incentives of investors to set up an actively managed fund in an emerging market or asset class. The analysis highlights the role of agency problems between fund managers and investors in determining this entry decision. It is shown that investors may wish to set up a fund in a new market, *only* when another fund is also active in that market. Fund entry into a new market can therefore be subject to a co-ordination problem, which may result in no entry of funds. This problem is acute when fund managers have little information about underlying asset values. Equilibrium wage contracts for managers are derived for the case when one or two managers are active in a market. It is shown that wage contracts induce (i) overly aggressive trading by managers when two funds are active in a market, and (ii) insufficiently aggressive trading when only one manager is active. The evidence of country fund inception for emerging markets is reviewed in light of this analysis and policy implications are presented.

Journal of Economic Literature Classification Numbers: D82, G14, G23

Keywords: Emerging markets, fund management, moral hazard, comparative performance information.

1. Introduction

This paper explores investors' incentives to set up an actively managed fund in a newly created market or asset class. The last two decades have seen the emergence of liberalised stock markets in a large number of less developed countries. It is now well established that the emergence of such markets is of great economic importance to LDCs, as it is associated with increased domestic investment and a reduction in firms' cost of capital (Bekaert and Harvey, 2000, Henry 2000a,b, Kim and Singal, 2000). The inflow of foreign capital through country funds plays an important role in this process (Bekaert and Harvey, 2000). However, little is known about the incentives for such funds to be set up in the first place. Casual empiricism suggests that funds will not necessarily become active as soon as a new market becomes available. For example, Argentina liberalised its capital markets completely in 1989 but no Argentinean country fund existed until two years later. Other countries such as Jordan, Nigeria, Venezuela and Zimbabwe opened markets to foreign investors years ago, but still no specialised country fund for those markets exists.[2]

In this paper we explore the role of performance benchmarks on incentives to set up actively managed funds. Such a benchmark could be an exogeneous index, such as the IFC's emerging market index. Alternatively, it could be a measure of performance of similar funds. The inclusion of a market in an index may affect the portfolio allocation of fund managers. As *Euromoney* writes:

> When the Egyptian Stock Exchange (ESE) joins the IFC's emerging market index next year, it is expected that many fund managers will start adding the ESE to their emerging market risk.
>
> Euromoney, 1996

However, Admati and Pfleiderer (1997) have shown that the use of such exogeneous benchmarks is 'at best useless'. Here, we focus on fund performance relative to a competitor universe, which turns out to be a useful benchmark from a theoretical perspective. In practice, investors and fund managers do care about this kind

[2] This comparison is based on Bekaert and Harvey (2000). Other authors have used different liberalisation dates, e.g. Henry (2000b) who defines the liberalisation date as the date of first country fund introduction in 8 out of a sample of 12 countries.

comparative performance information. In newly emerging markets, however, it cannot be taken for granted that this kind of information is readily available. As the *Global Investor* puts it:

> Other managers say they would prefer to be measured against a competitor universe [rather than an index]. However, one says: "…The consultants have databases of emerging markets managers. But the data just isn't very good. They include managers who define emerging markets quite differently from one another. We have been compared to managers who invest in markets like Finland, Hong Kong and Singapore."
>
> Global Investor, 1993

This paper shows that the lack of comparable funds may render it unattractive for investors to set up a fund, since manager evaluation will be limited to information regarding absolute performance. Thus, an equilibrium may exist in which no fund is set up due to the lack of another actively managed fund in that market. This is the case, even though the market would support more than one actively managed fund in a first best setting. At the same time, another equilibrium may exist in which more than one fund is set up and thus a competitor universe is provided. This allows investors to evaluate manager performance on the basis of both absolute and relative performance. In the presence of a severe agency problem between investors and fund manager, the value of relative performance information may be sufficiently high to deter fund entry into a market unless such information is available.

It is shown that the agency problem becomes more severe when the information on which the fund manager bases his portfolio decision is of lower quality. We would therefore expect the problem of co-ordinating fund entry to be of particular importance in markets where good information is not easily available.

Therefore, if co-ordination problems are of practical importance, we would expect to see funds being set up in bunches. Khorana and Servaes (1999) investigate the determinants of mutual fund starts. Consistent with our hypothesis, they find that once a large fund family sets up a new fund with a particular investment objective, the probability of a new fund opening with the same objective in the subsequent year increases by 86-138%. We find a similar bunching phenomenon for the inception of emerging market country funds.

The driving force behind our results is the agency problem between investor and fund manager. As previous research has pointed out (e.g. Bhattacharya and Pfleiderer, 1985, Stoughton, 1993, Dow and Gorton, 1997), the separation of ownership from control in an actively managed fund may lead to conflicts of interest between investors and fund managers. These can be mitigated through carefully designed wage contracts for fund managers. The agency problem considered in this paper is twofold. Firstly, fund managers need to acquire costly information if they wish to trade profitably in a particular asset (market). Information acquisition is unobservable to investors and thus constitutes a moral hazard problem.

Secondly, managers need to choose how aggressively to trade on their information, i.e. how much information to release through their trades. While several papers have investigated information release through trade (e.g. Admati and Pfleiderer, 1988, Subrahmanyam, 1991, Foster and Viswanathan, 1993), this is to our knowledge the first paper to look into this issue in the context of an agency problem between investors and fund managers.[3] In order to model fund managers' behaviour in an asset market, we consider a simple noise trader model in the spirit of Kyle (1985). Fund managers are assumed to behave as strategic informed traders, maximising the expected utility of their wage income.

Relatively little attention has been paid to the role of comparative performance information (CPI) in wage contracts for fund managers (see Heinkel and Stoughton, 1994, and Maug and Naik, 1996). It is known from agency theory that CPI can improve the insurance-efficiency trade-off of wage contracts (Holmstrom, 1982, Mookherjee, 1984). It can therefore be desirable to make compensation payments contingent on performance relative to that of competitors, if any exist. When the choice of trading intensity is subject to moral hazard, relative performance based wage contracts have a crucial bearing on trading intensity and thus information contained in market prices.

It is shown that trading intensities are above the first best level when managers operate under relative performance contracts (overtrading) while they are below the first best level when wage payment depends solely on absolute performance (undertrading). Moreover, if the information content of the manager's private signal

[3] Palomino (1997) explores the impact of relative performance contracts on agents' trading intensities. However, he does not consider the optimality of such contracts, given their effect on trading intensities.

decreases, the 'undertrading' problem is aggravated. Conversely, 'overtrading' worsens as information contained in the private signal *increases*. Thus, the agency cost associated with a manager's sub-optimal choice of trading intensity (i) decreases with more informative signals when only one manager is active, while (ii) it increases when two managers compete. This affects the decision to set up a fund in a market in which there is potentially no other active manager. In markets that display poor information it is particularly costly to have only one active manager, because severe undertrading would result.

As information quality improves, it may pay to set up a fund even if there is no other active fund in that market. A new market may thus avoid a co-ordination problem in fund entry, by providing better information. This could be achieved by for example setting up brokerage firms that provide research for potential investors. Alternatively, the existence of a fund that has a reputation for always entering a new market could remove co-ordination failure and thus eliminate the no entry equilibrium. In practice, the role of a development agency such as the International Finance Corporation can be interpreted in this light.

The remainder of the paper proceeds as follows. Section 2 presents the model. Section 3 develops the solution to the trading game between managers and the market maker as a function of managers' wage contracts. Section 4 outlines the form of wage contracts and resulting payoffs to investors. Section 5 discusses the entry decision by investors and policy implications. Section 6 concludes. The Appendix contains proofs.

2. The Model

There are four agents in the economy: two principals (investors) P_i (i=1,2) and two fund managers F_i. Each principal employs at most one fund manager, where the fund managers are assigned to a principal before the start of the game. We assume that there are many fund managers of identical ability that could be hired and therefore the principal is able to extract all the surplus from the fund manager's activity.

Before contracting with a manager, each principal decides whether or not to set up a fund in a new market. Assume for simplicity that exactly one asset trades on this market. Denote the decision by principal P_i to set up a fund by $l_i \in \{0,1\}$. For $l_i = 1$ a fund is set up, while for $l_i = 0$ no fund is set up. Both principals simultaneously choose l_i. Setting up a fund is assumed to be costless and publicly observable. However, once the fund has been set up, it is prohibitively costly to reverse that decision.[4]

Subsequently, the principals who chose to set up a fund offer a wage contract to their manager. Managers then decide whether to accept or reject the contract. A wage contract between principal P_i and agent F_i is a triple $C_i = \{a_i,\ b_i,\ g_i\}$, which determines wage payments w_i from principal P_i to agent F_i as

$$w_i\,(t_i, t_j) = a_i + b_i p_i\,(t_i) - g_i p_j(t_j) \qquad i=1,2 \quad j=1,2, \quad i \neq j \tag{1}$$

where p_i denotes agent i's realised trading profits, which is a function of the order size submitted. The wage payment w_i can thus be written as a function of both traders order sizes t_i, t_j. Let $B_i(C_i\,,C_j\,|l_i,\ l_j\,)$ denote principal P_i's payoff when the principals choose contracts C_i, C_j, given their entry decisions l_i, l_j .

Both fund managers have CARA utility, with the same coefficient of absolute risk aversion r:

$$U_i\,(w_i, k) = -\exp\,(-r\,(w_i - k_i))$$

Where $k_i = 0$ if agent i does not acquire information and $k_i = c$ with $c > 0$ if he does. Agents have reservation wage W.

Once managers have accepted a wage contract, its terms become common knowledge to all agents and wage contracts cannot be renegotiated.[5] The managers then decide whether or not to acquire information about the value of the asset and subsequently trade on their information. A market maker in the spirit of Kyle (1985) clears the market. Each manager chooses a trading strategy so as to maximise his expected utility, given the trading strategy of a (potential) competing fund manager.

[4] Typically, funds are set up not by individual investors, but by asset management companies. They then have to raise funds from other institutional or individual investors. Not actually setting up a fund after having raised the necessary funds from investors might be damaging to an asset manager's reputation. Hence, it seems plausible to assume that the decision is only reversable at high cost.

[5] This corresponds to the assumption typically made in the strategic delegation literature, whereby contracts are publicly announced and cannot be secretly renegotiated. Dewatripont (1988) and Caillaud, Jullien, and Picard (1995) find precommitment effects through public announcements of contracts, even when contracts can be secretly renegotiated.

An equilibrium in the trading sub-game is defined as a Nash equilibrium in all active managers' trading strategies and the price setting strategy of the market maker.

When a manager acquires information he receives a noisy signal $\tilde{y}$ for asset value $\tilde{x}$. The *ex ante* relationship between the signal and true value is given by

$$\tilde{x} = \tilde{y} + \tilde{z}$$

where $\tilde{y} \sim N(0,V^y)$, $\tilde{z} \sim N(0,V^z)$. Both random variables are independent of one another and $\tilde{z}$ is the residual noise of asset value after information has been acquired. For simplicity it is assumed that when two managers acquire information, they receive identical signals y.

Subsequently the agent can submit an order t_i for the asset to the market maker who sets the price of the asset at which he is willing to absorb all the order flow. Trading thus results in profits

$$\tilde{p}_i(t_i) = t_i(\tilde{x} - \tilde{p}). \quad (2)$$

Apart from the order by informed speculators, total order flow contains a noisy component $\tilde{n}$, which is normally distributed with mean zero and variance V^n.[6] We assume that all random variables $\{\tilde{y}, \tilde{z}, \tilde{n}\}$ are independent of one another.

Market makers are assumed to be in Bertrand competition in each market, which implies that they set prices so as to break even in expectation. Hence, the price is set such that it equals the expected value of the asset, given the information contained in total order flow. Thus, $p = E[x|T]$, where T denotes total order flow. The presence of noise traders ensures that the speculators' orders do not perfectly reveal their information about asset value.

Stage 1	Stage 2	Stage 3
Principals simultaneously choose whether or not to set up a fund.	Principals simultaneously choose the parameters of the wage contract, given the entry choices at the first stage. Managers accept/ reject the contract.	Managers decide whether or not to produce information. They receive a signal and submit orders to the market maker. Trades are executed.

Table 1: The sequence of stages played between the principals and the agents.

[6] The rationale for the random trading component is the presence of liquidity traders, who may have a hedging need and therefore trade.

Table 1 illustrates the sequence of stages that are played. Stages 1 and 2 of the game have simultaneous moves between the two principals. Stage 3 has simultaneous moves between the two managers and the market maker.

We are only interested in sub-game perfect equilibria of the dynamic game described above. In this game an action chosen at a particular stage is a function of the previous actions. Thus the wage contract C_i chosen by principal P_i is a function $f_i(l_i, l_j)$ of the entry decision l_1 and l_2 chosen at the previous stage of the game. At the last stage of the game, managers choose a trading strategy, which is itself a function of the signal observed, and the market maker chooses a price setting strategy, which is a function of total order flow. Therefore, we need to consider a function that maps the previous choices C_1, C_2, l_1, l_2 onto the space of functions $t_i(y)$ and $p(T)$. Define the operator for the choice of trading strategy by $t_i\,(C_i, C_j, l_i, l_j)$ and for the choice of price setting strategy by $f\,(C_i, C_j, l_i, l_j)$. We can then define an equilibrium of the game as follows.[7]

Definition: An equilibrium is defined as

$\{l_1^*, l_2^*, f_1^*(l_1, l_2), f_2^*(l_2, l_1), t_1^*(C_1, C_2, l_1, l_2), t_2^*(C_2, C_1, l_2, l_1), f^*(C_1, C_2, l_1, l_2)\}$,

such that for $i, j = 1,2$; $i \neq j$ and for $l_i, l_j \in \{0,1\}$:

(i) The price function $p(T)$ and the trading strategy $t_i(y)$ satisfy:

(a) $t_i^*\,(C_i, C_j, l_i, l_j)(y) \in \arg\max E[U_i(w_i(t_i, t_j), c)|C_i, C_j, l_i, l_j, y]$

(b) $f^*\,(C_i, C_j, l_i, l_j)(T) = E[x|T, C_i, C_j, l_i, l_j]$

(ii) The wage contracts $f_i^*(l_i, l_j)$ solve

$$\max_{a_i, b_i, g_i} E[B_i(f_i(l_i, l_j), f_j(l_j, l_i)|\, l_i, l_j)] = (1-b_i)Ep_i(t_i) + g_iEp_j(t_j) - a_i \quad \text{(P)}$$

s.t.

$$E[U_i(w_i(t_i, t_j), c)|\, f_i(l_i, l_j), f_j(l_j, l_i)] \geq E[U_i(w_i(t_i, t_j), 0)|\, f_i(l_i, l_j), f_j(l_j, l_i)] \quad \text{(IC)}$$

$$E[U_i(w_i(t_i, t_j), c)|\, f_i(l_i, l_j), f_j(l_j, l_i)] \geq U(W) \quad \text{(PC)}$$

[7] We are only interested in equilibria that feature contracts that are accepted by the managers and investors being at least as well off by offering a contract that is accepted, as they would be without offering any contract (or contracts that they know will be rejected). The latter type of equilibrium may exist but are not considered here.

(iii) The choice of assets (l_i^*, l_j^*) satisfies:

$$E[B_i(f_i^*(l_i^*, l_j^*), f_j^*(l_j^*, l_i^*)|\, l_i^*, l_j^*)] \geq E[B_i(f_i^*(l_i, l_j^*), f_j^*(l_j^*, l_i)|\, l_i, l_j^*)]$$

(iv) Each principal's expected payoff in equilibrium satisfies an individual rationality constraint

$$E[B_i(f_i^*(l_i^*, l_j^*), f_j^*(l_j^*, l_i^*)|\, l_i^*, l_j^*)] \geq 0.$$

To summarise, each agent chooses a trading strategy maximising his expected utility, given a price function of the market maker, given his own contract and the opponent's contract and given the entry decisions by the principals. Anticipating the managers' behaviour in the trading sub-game, principals choose wage contracts so as to maximise their expected payoff (P), given entry decisions $\{l_1, l_2\}$, where wage contracts have to satisfy the managers' participation constraints (PC) and incentive compatibility constraints (IC). Moreover, we require that the entry decision constitutes a Nash equilibrium in the reduced form game.

3. Equilibrium in the trading sub-game

In this section we solve the last stage of the game as a function of the outcome of the previous two stages. This corresponds to finding a price function and trading strategies according to definition (i). Throughout this section it is assumed that both fund managers accept the contract if offered one, and that the contracts are incentive compatible, i.e. managers actually do acquire information. The wage contracts themselves will be dealt with in Section 4.

There are two different cases that need to be distinguished. Firstly, only one principal may have decided to set up a fund, and therefore only one manager trades in the asset. Secondly, both principals may have decided to enter the market and therefore two managers trade in the asset. As will be shown below, it may be the case that one investor wishes to set up a fund only if the other investor sets up a fund, too. This could be interpreted as herding in the spirit of Brennan (1990) or Froot, Scharfstein and Stein (1992).[8] Therefore, variables pertaining to an equilibrium with

[8] Herding here simply means agents' preference to co-ordinate to take the same action. This contrasts with the use of the term herding in Banerjee (1992) or Scharfstein and Stein (1990). Gümbel (1998)

two active fund managers are given a superscript H (herding). Superscript N (non-herding) is used in the context of equilibrium with only one active fund manager.

3.1 Trading equilibrium with one manager

The derivation of equilibrium in a Kyle type setting is by now standard. Straightforward calculation yields the following result.

Proposition 1: There exists a unique linear equilibrium of the trading sub-game when one manager gets informed about and trades in the asset. Assume (w.l.o.g.) that agent F_1 trades, while agent F_2 does not trade. Then equilibrium order sizes are given by

$$t_1^N = d_1^N y \quad , \tag{3}$$

with

$$d_1^N = \frac{1}{2l^N + rb_1\left(V^z + l^{N2} V^n\right)} \tag{4}$$

and the price setting strategy of the market maker is given by

$$\tilde{p} = l^N\left(\tilde{t}_1 + \tilde{n}\right), \tag{5}$$

$$l^N = \frac{d_1^N V^y}{d_1^{N2} V^y + V^n} \tag{6}$$

Proof see Appendix.

Note that d^N is an implicit function of r, b, V^y, V^z, V^n, given by substituting (6) into (4). Using the implicit function theorem it is straightforward to show that $\frac{\P d^N}{\P b} < 0$ and $\frac{\P d^N}{\P r} < 0$, i.e. the equilibrium trading intensity is a decreasing function of the incentive payment and the degree of risk aversion. From this we can conclude the following.

contains an in depth discussion of the herding interpretation of investors' preference to co-ordinate fund activity in a specific market.

Corollary: *The first-best trading intensity* d^{*} º $d^{N}(r=0)$ *is larger than the one that will be chosen by a risk averse agent whose incentive payment* b *is positive.*

Hence, whenever the fund manager is given an incentive to acquire information, he will reduce his risk exposure by trading smaller amounts. This implies an agency cost due to sub-optimally small trading intensities when the trading decision is delegated to a risk averse agent.

3.2 Trading equilibrium with two managers

Proposition 2: There exists a unique linear equilibrium of the trading game under herding. The equilibrium trading strategy for agent F_i is given by

$$t_i^H = d_i^H y, \qquad i=1,2 \tag{7}$$

with

$$d_1^H = \frac{l^H b_2 (b_1 + g_1) + r b_1 b_2 (b_2 + g_1) B}{(2b_1 l^H + r b_1^2 B)(2b_2 l^H + r b_2^2 B) - (l^H (b_1 - g_1) - r b_1 g_1 B)(l^H (b_2 - g_2) - r b_2 g_2 B)} \tag{8}$$

and $B = \left(V^z + l^{H\,2} V^n\right)$.

Trader 2’s trading intensity d_2^H is also given by equation (8), with indices changed appropriately. The price setting strategy of the market maker is given by

$$\tilde{p} = l^H \left(\tilde{t}_1 + \tilde{t}_2 + \tilde{n}\right), \tag{9}$$

with
$$l^H = \frac{\left(d_1^H + d_2^H\right) V^y}{\left(d_1^H + d_2^H\right)^2 V^y + V^n} \tag{10}$$

Proof see Appendix.

Properties of the trading equilibrium with two active managers

Equation (11) gives trader 1’s best response in order size t_1 as a linear function of the opponent’s order size t_2:

$$t_1 = \frac{b_1 y - t_2 \left(l \left(b_1 - g_1 \right) - r b_1 g_1 \left(V^z + l^2 V^n \right) \right)}{2 b_1 l \ \ + r b_1^2 \left(V^z + l^2 V^n \right)} \tag{11}$$

Interestingly, order size and therefore trading intensities can be either strategic substitutes or complements. Which of the two it is, depends on the degree of managerial risk aversion r, and on how much more sensitively wage payments react to own performance compared to the opponent's performance. The latter is represented by the term b_1-g_1 for manager 1. Note that the market game between two informed *profit* maximising traders is similar to Cournot duopoly in that trading intensities (like output in a product market game) are strategic substitutes. If risk aversion is low and the own profit share b_1-g_1 of a manager is high, trading intensities are strategic substitutes, because managers behave in a similar way to profit maximising traders. When r is large and profit share b_1-g_1 low, agents' behaviour becomes more strongly determined by the desire to reduce wage risk. This in turn leads agents to want to take similar actions, because taking very different positions in an asset increases agent's wage risk. As a result, trading intensities become strategic complements.

This interaction between manager's trading intensities is crucial in determining, the optimal contracts offered to a manager, and the resulting equilibrium trading intensities. In particular, it can be verified easily that in the case of symmetric contracts, perfect insurance for the managers (i.e. b_1=g_1, b_2=g_2) cannot be an equilibrium outcome. Perfect insurance leads to a degenerate equilibrium of the trading sub-game with infinitely sized orders ($d_i^H = \infty$, i=1,2) and zero trading profits, unless the managers are infinitely risk averse. Since managers anticipate the outcome of the trading sub-game, they would never find costly information acquisition incentive compatible under perfect insurance. We can therefore conclude that equilibrium wage contracts under herding cannot feature perfect insurance as long as managers are finitely risk averse. More generally, there is a tension between offering relative performance contracts that feature good insurance, and those that lead to small enough trading intensities so that trading remains profitable. This issue is examined in more detail in Section 4.

4. Payoff from entering a market

Before discussing investors' decisions whether or not to set up a fund in a particular market, we will derive a result regarding the equilibrium wage contract of the reduced form game in which only one investor has decided to set up a fund. Unfortunately, an analogous result for the case with two investors cannot be derived as it lacks a closed form solution. Equilibrium wage contracts for this case are derived numerically and will be discussed below.

4.1 Wage contracts with one active manager

Proposition 3: Suppose only one fund manager is active. Then, for $\exp(2rc) - 1 \leq V^y/V^z$, the optimal contracting parameters are given by[9]

$a^N = W$,

$g^N = 0$,

and
$$b^N = \frac{u}{r}\sqrt{\frac{u\left(V^y + 2V^z\right) + \sqrt{u^2\left(V^{y2} + 4V^zV^y\right) + 4V^{y2}}}{2V^nV^y\left(V^y - uV^z\right)}}, \qquad (12)$$

where $u = e^{2rc}-1$.

If $\exp(2rc) - 1 > V^y/V^z$ no contract exists that satisfies the agent's incentive compatibility constraint.

Proof see Appendix.

Taking the first derivative of b^N with respect to r yields $\frac{\partial b^N}{\partial r} > 0$, i.e. the optimal incentive payment increases with the degree of risk aversion. This contrasts with other results in agency theory (see e.g. Milgrom and Roberts, 1992), where the optimal incentive payment decreases with the degree of risk aversion.

The intuition for this result is as follows. In our setting the incentive compatibility constraint (IC) is directly linked to the degree of risk aversion, because the agent can affect the riskiness of his wage by his trading decision. In particular, if the agent decides not to acquire information, he will optimally not trade at all and thereby cancel out any risk in his wage. The more risk averse an agent is, the higher

[9] Subscripts *i* are omitted as only one agent matters here.

the incentive payment has to be in order to induce him to take the risk that he necessarily incurs when trading.

Note moreover, that, as shown in Section 3, an agent's trading intensity is a decreasing function of b and r. Thus an increase in r not only reduces the chosen trading intensity directly, but also indirectly through an increase in the optimal incentive payment. Hence, as r increases the trading intensity moves further away from its first-best level and the principal's expected payoff decreases.

4.2 Wage contracts with two active managers

Let us now turn to the contracting problem when both investors set up an actively managed fund. As discussed in Section 3.2, managers act as duopolists and the way in which they interact is determined by their wage contracts. This gives rise to strategic interaction between principals when designing the wage contract.[10]

A principal designs the wage contract such that the manager is willing to accept it, and such that acquiring information is incentive compatible. For incentive compatibility we consider the case that each manager is willing to acquire information, given that the other manager is also willing to acquire information and trade on it. Thus we do not consider equilibria, in which both managers do not acquire information, but accept the contract.[11]

On the one hand, principals wish to insure their agents in order to reduce wage payments. On the other hand, they know that better insurance leads to higher

[10] The issue of strategic setting of wage contracts has received some attention in the Industrial Organisation literature. Vickers (1985) first investigated the issue of strategic interaction between firm owners, whose managers compete in the product market. Aggarval and Samwick (1999) built on this by exploring the effect of relative performance contracts for top executives on product market competition.

[11] Generally, it is not possible to exclude the existence of such equilibria for the wage contracts derived here. Eichberger, Grant and King (1999) explore this issue and find that sometimes an equilibrium with relative performance contracts exists, in which managers do not acquire information, trade nonetheless and may be better off than in an alternative equilibrium in which both managers acquire information. They, however, consider a much simplified setting, in which managers only have the choice between 'buy' and 'sell', rather than a whole set of order sizes, as considered here. With such a reduced set of actions, managers relatively frequently take the same action by chance, and thus receive a high payment. In our setting with order sizes chosen from an unaccountably large set, such chance co-ordination has zero probability, making trade without information considerably more costly.

equilibrium trading intensities in the trading sub-game. This is because improved insurance results in a very low equilibrium profit share for the manager. When β close to γ (good insurance), the manager's share in trading profits becomes β-γ in a symmetric equilibrium, which is small. This, in turn, means that a manager cares less about choosing an order size that maximises trading profits, than about choosing an order size similar to the opponent's. As a result, trading intensities become strategic complements.

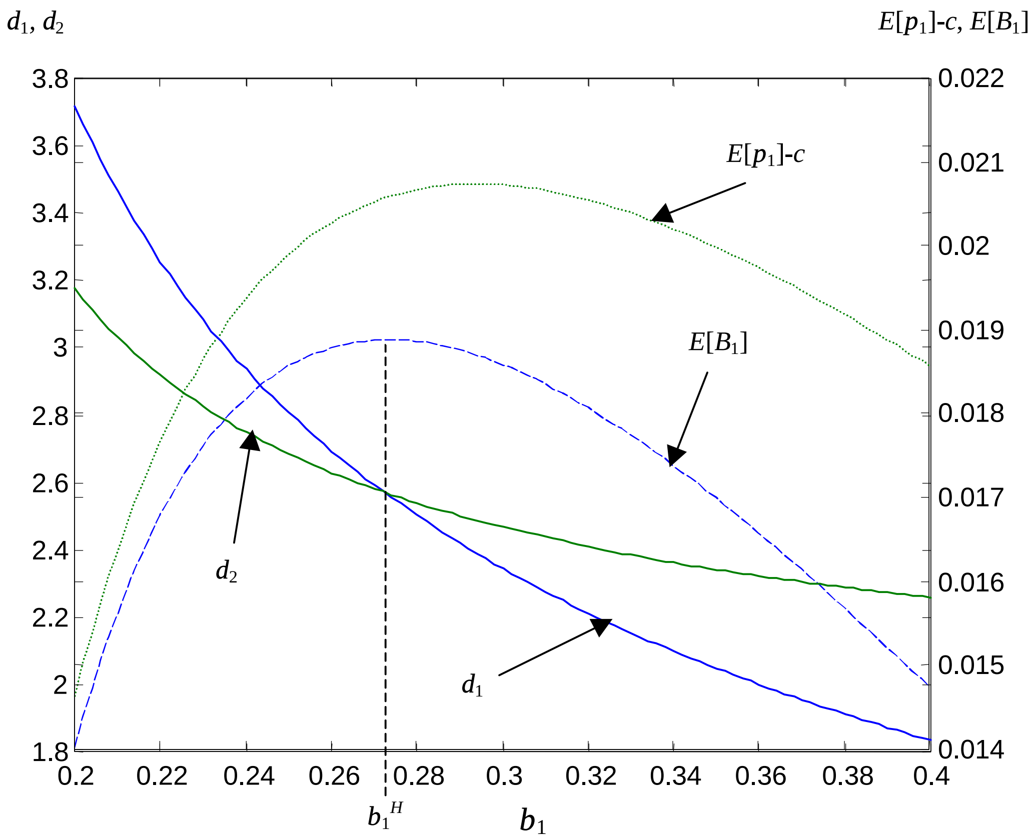

Figure 1: Illustrates the impact of a change in the absolute performance component b_1 of manager F_1's wage contract. The right hand scale gives the values for the expected payoff to the investor and the expected trading profits (net of the cost of information acquisition). The left hand scale gives the values of trading intensities for managers F_1 and F_2. Parameter values are r=1, c=0.05, V^y=0.1, V^z=0.9, V^n=1. The remaining wage parameters {α_1, γ_1, α_2, β_2, γ_2} are such that they constitute an equilibrium with b_1^H for the particular values of r, c, V^y, V^z, and V^n.

Figure 1 illustrates the impact of a change in the absolute performance component b_1 in manager F_1's wage contract on trading intensities, trading profits and investor payoff. All other contracting variables are held constant at their equilibrium values. An increase in b_1 reduces insurance and leads to a decrease in both managers' trading intensities. For b_1 close to γ_1 (good insurance), trading intensities are higher than their profit maximising values. Trading *profits* are maximised for b_1 bigger than its equilibrium value ($b_1 > b_1^H$), i.e. when trading intensities are below their equilibrium values. The investor's expected *payoff* is maximised when trading intensities are above the profit maximising values, because lower trading intensities can only be achieved by providing less insurance (increasing b_1). I.e. cheaper wage contracts have to be traded off against sub-optimal trading behaviour.

When principals design wage contracts, they do not take into account the negative externality that their own agent's trade has on the profitability of the other agent's trade. Therefore, trading intensities under equilibrium wage contracts exceed the trading intensities that obtain under Cournot competition between two *risk neutral* traders. This issue will be examined in more detail below.

4.3 Investor payoffs and incentives to set up a fund

Let us now turn to the actual payoffs to investors who set up a fund.

Proposition 4: There exist parameter values $\{r, c, V^y, V^z, V^n\}$, such that it is only worthwhile for an investor to set up a fund if another investor also sets up a fund in the same market, i.e.

$$E\left[B_i\left(f_i^*(1,1), f_j^*(1,1)\middle| l_i = 1, l_j = 1\right)\right] > 0$$

and

$$E\left[B_i\left(f_i^*(1,0), f_j^*(0,1)\middle| l_i = 1, l_j = 0\right)\right] < 0 \qquad \text{for } i,j = 1,2$$

Proof: It is shown through an example that such parameter values exist. Consider the following parameter values: $r = 1$, $c = 0.06$, $V^n = 1$, $V^y + V^z = 1$. The expected payoff to an investor if only one manager is active in a market is given by

$$E[B_i(f_i^*(l_i, l_j), f_j^*(l_j, l_i) | l_i = 1, l_j = 0)] = \left(1 - b^N\right) d^N \frac{V^y V^n}{d^{N2} V^y + V^n} - a^N ,$$

where b^N and a^N are given in Proposition 3. The expected payoff can thus be calculated explicitly and it is straightforward to show that it is negative for small values of V^y (e.g. for V^y=0.13, see figure 2).

The expected payoff in the case where two managers are active in one market is calculated numerically. In this numerical simulation, the best response function in wage parameters of one investor is calculated as a function of the opponent's wage contract. Subsequently, the fixed point of the best responses is calculated. This yields the equilibrium wage parameters.[12] From this an investor's expected payoff can be calculated. The result of this numerical simulation is given in figure 2.

q.e.d.

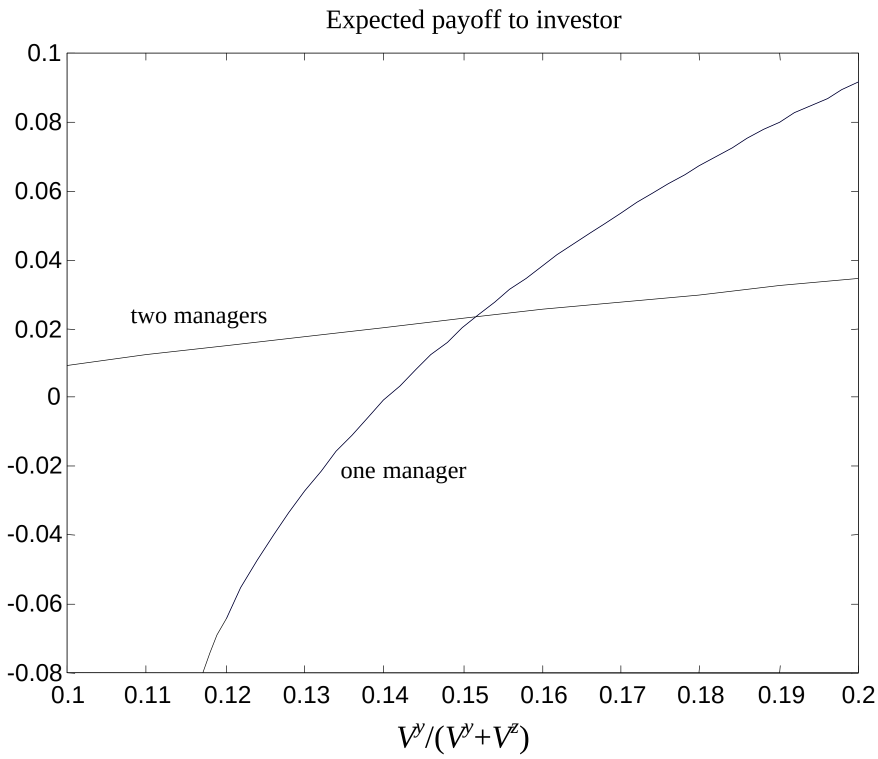

Figure 2: Gives the expected equilibrium payoffs to the investor with either one or two active managers in a market. Parameter values are r=1, V^n=1, V^y+V^z=1, c=0.06. When the manager's private information is of low quality, trading profits have a higher variance and absolute performance contracts become increasingly costly to implement.

This figure shows that there is a region of parameter values such that the expected payoff to an investor is negative, when one manager is active in the market, while it is positive when two managers are active in the market. In particular, when the manager's private signal is not very informative, the payoff to the investor drops off sharply when only one manager is active in the market. The reason for this is the

[12] While no proof is given for uniqueness of such an equilibrium, extensive simulations failed to yield multiple equilbria.

increase in the variance of trading profits that results from trade on a less informative signal. Define the informativeness of the manager's private information as

$$S \equiv \frac{V^y}{V^y + V^z}$$

which is the regression coefficient of y on x. Now, consider the case where $Var(x)$ is a constant $V \equiv V^y + V^z$. Thus we can write $V^z = V(1-S)$. Using equation (1) and the result in Proposition 1, it is possible to calculate the variance of trading profits as

$$Var(\tilde{p}|y) = d^2 y^2 (V(1-S) + l^2 V^n), \tag{13}$$

which is a decreasing function of S for a given value of V.

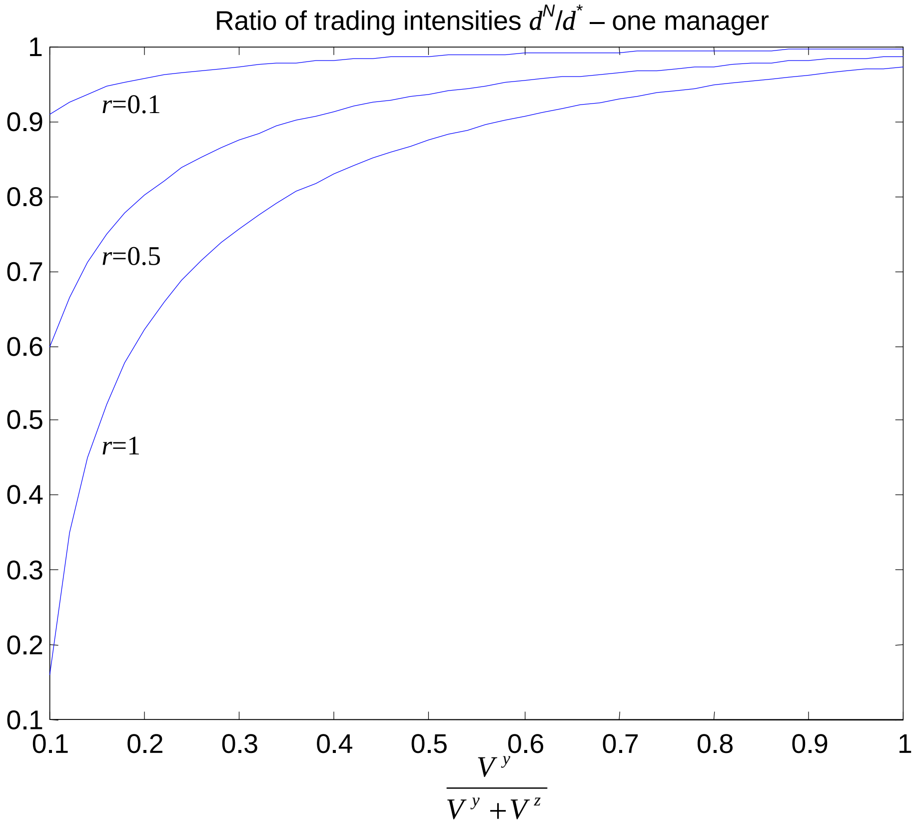

Figure 3: Shows the ratio of trading intensity d^N under optimal wage contracts with one active manager over the trading intensity d^* that would be chosen in the absence of an agency problem. Parameter values are c=0.05, V^n=1, $V^y + V^z$=1. The manager always chooses a trading intensity below the first-best. For low informativeness S of his signal the problem of sub-optimally small order sizes is aggravated. The problem is also aggravated as the manager's degree of risk aversion increases.

As the signal becomes less informative, trading profits become more risky and therefore the value of insurance increases. When only one manager is active in the market, the amount of insurance provided is limited by the need to make the wage contract incentive compatible. The fund manager tries to reduce his risk exposure by choosing smaller order sizes; a problem which becomes more severe as the information contained in his signal decreases. Figure 3 shows the ratio of trading intensities under equilibrium wage contracts when only one manager is active in a market over trading intensities d^* that would obtain in the absence of an agency problem. The latter is just the trading intensity that would be chosen by a monopolistic and risk neutral informed trader.

Under equilibrium wage contracts, a risk averse manager who is the only active manager in a market, always chooses a trading intensity below first-best. This imposes an agency cost on the investor. Trading profits are below first-best, because the manager does not trade sufficiently aggressively on his information. This problem is particularly acute when the manager's private signal is not very informative. As the manager's private signal becomes more informative, he chooses a trading intensity that is closer to the first-best. Also, the problem of sub-optimally sized orders becomes more severe as the degree of managerial risk aversion increases.

As a result, it can happen that for low values of S, the investor's expected payoff is below zero. The only incentive compatible wage contract that would be accepted by a manager, is so expensive that the investor would not find it worthwhile to offer such a contract in the first place.

Trading intensities under equilibrium wage contracts, when two fund managers are active, display a very different pattern. In particular, under equilibrium wage contracts, managers tend to trade too aggressively.

The benchmark for comparison is the trading intensity d^c, which is the outcome of Cournot competition between risk neutral traders. This is the outcome that would obtain in the absence of agency problems: the risk neutral investors would simply compete with each other directly in the financial market. The problem of 'overtrading' is aggravated when the manager's private signal contains more information. Thus, the agency cost of choosing too high trading intensities is reduced as the information contained in the private signal is lower. This contrasts with the result on agency costs when there is only one active fund. In that case, the agency cost *increases* as the informativeness of the private signal falls.

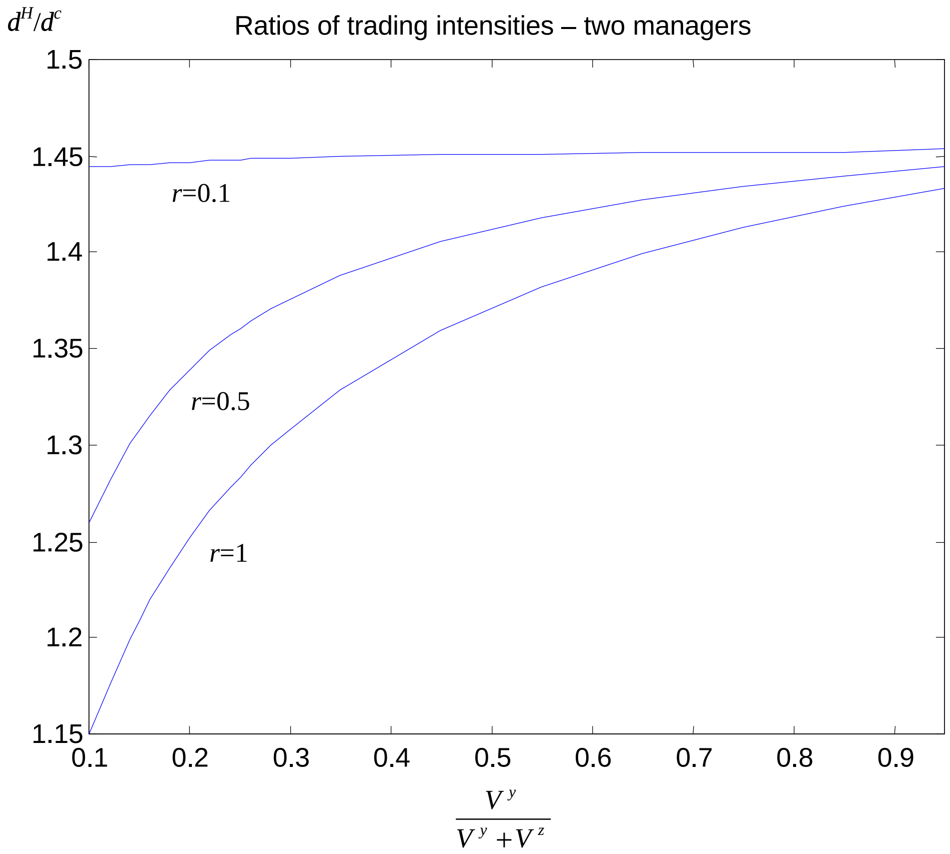

Figure 4: Shows the ratio of the trading intensity the results under equilibrium wage contracts with two active funds, over the trading intensity that would obtain in a Cournot duopoly between risk neutral traders. The parameter values are c=0.05, V^n=1, $V^y + V^z$=1. Wage contracts induce more aggressive trading than would be obtained between two risk neutral, competing traders. For low information content of the manager's signal, managers trade less aggressively in equilibrium. The problem is mitigated for more risk averse managers.

Admati and Pfleiderer (1988), Subrahmanyam (1991) and Foster and Viswanathan (1993) relate trading intensity and market depth (inverse of l) to the number of informed traders. In these models informed traders are expected utility maximising agents who trade on their *own* account. Like these theories, our model also predicts an increase in trading intensity when two instead of only one trader is present. However, we would expect a much more pronounced increase in trading intensity than for example Subrahmanyam (1991). When two instead of one trader are present in a market, they effectively become less risk averse, because they are better insured through relative performance contracts. More importantly, our analysis points out that the number of informed traders in a market depends on fundamentals such as information precision and cost, in different ways than predicted by previous theories.

When testing for the relationship between adverse selection cost of trading and the number of analysts (informed traders) following a security, Brennan and Subrahmanyam (1995) stipulate that the number of informed traders is positively correlated with information precision. From the previous analysis it becomes clear that the relation between information precision and the number of informed traders may be different when risk averse agents do not trade on their own account. In particular, when information precision is low it may be the case that either zero or two informed traders are present, while only one trader is present for higher values of information precision. This, however, would also depend on the trade-off between information precision and the cost of information acquisition. Figure 5 in the following section illustrates this point.

5. Market entry and co-ordination failure

In the previous section it was shown that the expected payoff to an investor may be too low to warrant setting up a fund, *unless* another fund is also active in the same market. We will now examine the implications of this for the decision of investors to set up a fund. This corresponds to an equilibrium choice of entry decision l_i in definition (iii) and (iv). When making their choice, investors take their opponent's choice as given and anticipate the actions induced in the two subsequent stages of the game.

For any choice of $\{l_1, l_2\}$, principals receive the expected payoff as characterised in the previous sections. Denote expected equilibrium payoffs for a given choice of $\{l_1, l_2\}$ by $EB_i^*(l_i,l_j) \equiv E[B_i(f_i^*(l_i,l_j), f_j^*(l_j,l_i)|\ l_i,l_j)]$. Of course, the payoff from not setting up a fund is just zero. Hence, $EB_i^*(0,l_j) = 0$. Payoffs as a function of entry choice can thus be summarised in the following payoff matrix

	$l_2=0$	$l_2=1$
$l_1=0$	0, 0	0, $EB_2^*(1,0)$
$l_1=1$	$EB_1^*(1,0)$, 0	$EB_1^*(1,1)$, $EB_2^*(1,1)$

As was shown in Proposition 4, there are cases in which EB_i^* (1,0)<0, while EB_i^* (1,1)>0. From this follows straightforwardly, that in such cases, there are two Nash equilibria of the reduced form game of the entry decision. No entry (l_1=l_2=0) is an equilibrium, and entry by two funds (l_1=l_2=1) is an equilibrium. Note that since EB_i^* (1,1)>0, both investors prefer the equilibrium in which entry occurs. Without further equilibrium refinements it is unclear which equilibrium will obtain.

5.1 Entry co-ordination

One possible way to eliminate the 'no entry' equilibrium is to introduce a communication stage of the game before the first move is made, i.e. before investors decide whether or not to enter the market. Investors could thus announce their intention to set up a fund in a particular market. Since both investors are better off entering the market, they could thus credibly co-ordinate their entry decision.

In practice, however, such co-ordination might be less straightforward. The parties that set up funds are not usually individual investors, but asset management companies. Communication between two asset management companies might therefore raise the suspicion of anti trust authorities. Moreover, the fact that asset management companies take entry decisions instead of small and dispersed investors, introduces an additional layer of agency problems (see Lakonishok, Shleifer and Vishny, 1992, for a discussion of this double layer of agency problems in the money management industry). In the agency relationship between ultimate investors and asset management companies, relative performance may play an important role, just as it does between the fund managers. Therefore, management of an asset management company may not only be interested in maximising own absolute performance, but also performance relative to its competitors. Consider the effect of this on the pre-play communication stage of the game.

Suppose there are two asset management firms 1 and 2, which decide whether or not to set up a fund in a particular market. The expected payoff to their activities is given by $EB_i^*(l_i, l_j)$ as before. However, an asset manager's *utility* of such a payoff may be a function not only of its absolute value, but also of its value relative to the competitor. Therefore, $EB_1^*(l_1, l_2)$- $EB_2^*(l_2, l_1)$ may enter asset manager 1's utility function. Consider the case when both asset managers communicate to each other that they will both enter the market, i.e. they co-ordinate on the high payoff equilibrium. By going ahead with the equilibrium strategies, both asset managers achieve positive absolute payoffs $EB_i^*(l_i=1, l_j=1)>0$, and zero relative payoffs since $EB_1^*(l_1=1, l_2=1) = EB_2^*(l_2=1, l_1=1)$.

Now suppose that asset manager 1 does not actually enter the market. In that case asset manager 2 will have to go ahead regardless and set up a fund. Since there is now only one active fund manager, the payoff to asset manager 2 will be negative: $EB_2^*(l_2=1, l_1=0)<0$. At the same time asset manager 1's payoff will just be zero. Hence, $EB_1^*(l_1=0, l_2=1) - EB_2^*(l_2=1, l_1=0) > 0$. Thus, compared to when both managers actually do set up a fund, both asset management companies lose in absolute performance, when 1 deviates from the communicated strategy. However, in terms of relative performance, asset manager 1 now fares better than 2. Therefore, it is conceivable that when the relative performance component of an asset manager's utility function is sufficiently important, the pre-play communication ceases to be credible. As a result, it may be impossible for asset managers to co-ordinate setting up a fund in a new market.

One way to overcome this problem would be to introduce a player who will always enter, regardless of the other investor's decision. When interpreting the market under consideration as an emerging stock market, a development agency may play such a role. Such an agency, for example, could have acquired a reputation in the past for entering new markets regardless of whether or not this is profitable. Suppose principal P_2 is such an institution, i.e. someone who will always choose $l_2=1$. In that case the principal P_1 will certainly also play $l_1=1$, whenever $EB_1^*(1,1)\geq 0$.[13] An investor who takes the lead in setting up a fund in a new market, may thus be able to attract further actively managed funds in the same market.

The role of the International Finance Corporation (IFC) in attracting private investment in actively managed country funds can be interpreted in light of this analysis. When considering the actual process of country fund inceptions to date, one finds that, (i) in a majority of cases the IFC actually was key in setting up such a fund, (ii) the inception of the first country fund was practically always followed by the introduction of additional country funds within the following year. Throughout the 1980s and early 1990s the IFC followed a policy of setting up and investing in

[13] Of course, it may still be the case that principal P_1 cares about relative performance as well as absolute performance. He may therefore not enter, even if he knows that P_2 will enter (see previous paragraph). However, if P_2 is indeed a development agency such as IFC, it is plausible to presume that it will not be part of the comparison universe for P_1's relative performance.

emerging market country funds. In more than half the countries, the fund supported by the IFC was the *first* country fund (Carter, 1996). This is consistent with the role of a ‘lead investor’ in overcoming a co-ordination of entry problem. Moreover, in 11 out of the 14 countries used in Bekaert and Harvey (2000), a second country fund was set up within 12 months of the inception of the first fund. This supports the hypothesis that funds enter a market in bunches rather than alone.

5.2 The role of information

Let us now investigate under what circumstances entry co-ordination is likely to be an issue. This corresponds to finding parameter values for which two Nash equilibria exist in the reduced form game of the entry decision. From the discussion in Section 4, it became apparent that low information content of the manager’s signal implies (i) a greater need for insurance, (ii) relatively little overtrading when two managers are active in a market, and (iii) substantially reduced trading intensities when only one manager is active. This suggests that in cases where signal precision is low, investors may only set up a fund in a market if another fund is set up in the same market.

Figure 5 shows the zero expected payoff lines for investors when one manager is active (dotted line) and when two managers are active in a market (solid line). The lines are given as a function of the cost of information acquisition and the precision of private information. Profits increase to the north west of the diagram. For low values of signal precision S, there exist values of c such that the expected payoff from an active fund is positive *only* when another fund is also active in the market. For higher signal precision this changes, so that whenever it is worthwhile to set up a fund in the presence of another active fund, it is also worthwhile to set up a fund without another active fund.

This observation is important for two reasons. Firstly, new markets and emerging markets in particular, are likely to be the ones in which information precision is relatively low. Therefore, they may be more liable to the entry co-ordination failure described above. Secondly, understanding the role of information precision can point the way towards policies to overcome entry co-ordination failure.

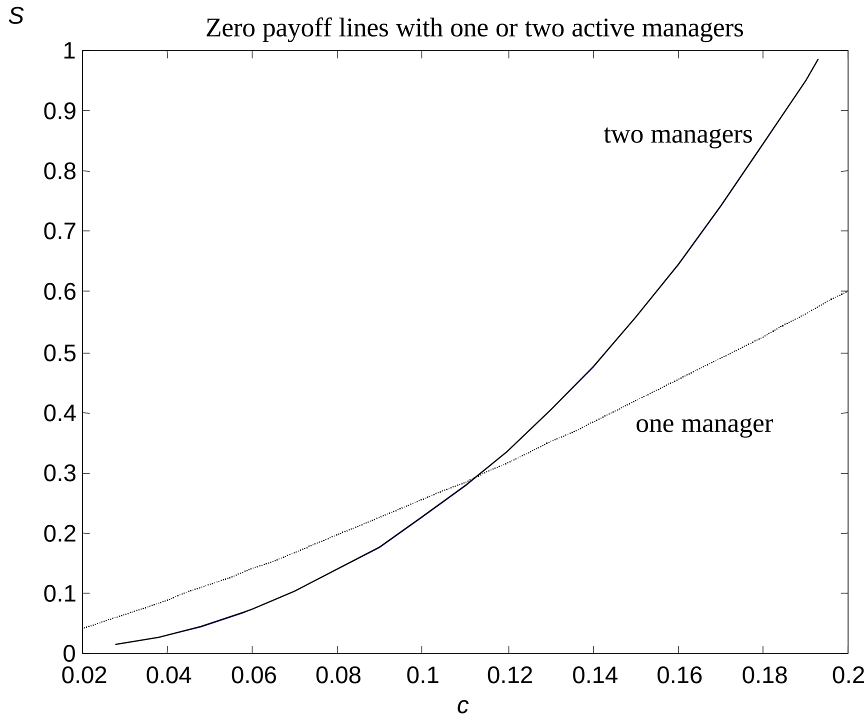

Figure 5: Shows the trade-off between information *S* contained in the signal and cost *c* of information acquisition, such that investors' expected payoffs are zero, when (i) only one manager is active (dotted line), and (ii) when two managers are active (solid line). Expected payoffs increase towards the north-west of the diagram. Parameter values are r=1, V=1, V^n=1. For low values of *S* and *c*, expected payoffs when two managers are active are positive, while they are negative when only one manager is active in the market.

Let us examine each of the above points in more detail. In a recent study of analyst activity around the world, Chang, Khanna and Palepu (2000) find that average forecast errors are lowest in the US (2.3%) and the UK (5.3%) while they are highest in Slovakia (71.2%) and Mexico (47.2%). Analysts' forecasts are publicly available and thus do not themselves constitute managers' private information. However, they are likely to be a good proxy for the precision of fund managers' private information. While a country's stage of development is not the only determinant of forecast errors, Chang et. al. find a strong correlation between the two. This lends support to the hypothesis that emerging markets feature relatively poor information on which managers base their portfolio choice. As such they are likely to suffer the problem of entry co-ordination.

Once it is recognised that low information precision may be a contributing factor to co-ordination failure of fund entry, measures can be taken to alleviate this problem. From the above analysis it is obvious that one way to do so is to increase information precision. Information precision is important, because it reduces the variance of trading profits (see equation 13) and thus improves the insurance-efficiency trade-off of wage contracts. It may therefore be possible to reduce residual noise in trading profits, by making more information publicly available. One way of achieving this might be to facilitate the setting up of brokerage firms in newly developing markets. Many emerging markets suffer from insufficient brokerage services and thus poor quality of information available to foreign institutional investors. As one source puts it…According to the previous analysis we would expect such brokerage firms to attract active fund managers not only because they provide a more hospitable investment environment generally. It is shown that by reducing the residual noise of trading profits, wage contracts for fund managers become cheaper and we might see the inception of funds where otherwise no fund would enter a market.

6. Conclusion

One of the most important roles of financial markets is to provide and aggregate information concerning assets traded in the market. Actively managed funds play a crucial role in producing information, trading on it and thus getting information to be reflected in security prices. The success of an emerging market therefore depends to an important degree on its ability to attract actively managed funds. This paper explores the incentives of investors to set up an actively managed fund in a new asset class. Fund managers who act on behalf of investors are subject to a double moral hazard problem: firstly, they need to acquire costly information, and secondly they need to choose a trading intensity.

The resolution of this agency problem through wage contracts drives a wedge between the first-best outcome of setting up a fund and the actual equilibrium outcome. In particular, it is shown that investors may *only* wish to set up a fund in a new market, when another actively managed fund is present in that market. This gives rise to a co-ordination problem between investors of setting up a fund. The co-ordination problem arises because the presence of another actively managed fund provides the principals (investors) with comparative performance information about their own manager. This in turn allows them to write efficiency improving relative performance wage contracts. When managers trade on relatively poor private information, the residual fluctuations in their wage payments are relatively high, unless wage is based on relative performance. Therefore, comparative performance information becomes more important when managers' signal precision is low.

The co-ordination problem of entering a new market can be overcome in two ways. Firstly, if there is a 'lead investor' who always sets up a fund regardless of whether other funds are being set up, the no entry equilibrium can be eliminated. The role of the International Finance Corporation in setting up early country funds can be interpreted in this way. Secondly, reducing residual noise in asset values by making information public can also reduce the importance of relative performance information and thus eliminate co-ordination failure to enter a new market.

Appendix

Proof of Proposition 1:

Firstly, we have to find the profits from trading amounts t_1 and t_2. From (2) we can write

$$\tilde{p}_1 = t_1(y + \tilde{z} - \tilde{p}) = t_1(y + \tilde{z} - l(t_1 + \tilde{n}))$$
$$\text{and} \qquad (14)$$
$$\tilde{p}_2 = 0$$

where l is the parameter in the linear pricing function of the market maker: $p = l(T+n)$.

The optimal amount of trade is the solution to

$\max_{t_1} E\left[-\exp\left(-r\left(a + bt_1(y + \tilde{z} - l(t_1 + \tilde{n})) - c\right)\right)\right]$.[14]

Since wage is a normally distributed random variable for every given value of y, we can apply certainty equivalent analysis.

Thus, t_1 is the solution to

$$\max_{t_1} \quad CE = a - c + bt_1 y - b\,l\,t_1^2 - r/2*(bt_1)^2(V^z + l^2 V^n)$$

The first-order condition of this optimisation problem is

$$by - 2b\,l\,t_1 - rb^2 t_1(V^z + l^2 V^n) = 0$$

Which yields the solution

$$t_1 = \frac{y}{2l + rb\left(V^z + l^2 V^n\right)}$$

Thus $\quad t_1^N = d_1^N y$

with $\quad d_1^N = \dfrac{1}{2l^N + rb_1\left(V^z + {l^N}^2 V^n\right)}$

This proves the first part of the proposition.

For the following derivation of the price setting strategy, the subscripts for the trader are suppressed, since only one trader matters. The market maker sets price equal to expected value of the asset conditional on order flow, given his knowledge of

[14] Subscripts for the parameters of manager F_i's contract can be omitted here, as only own contracting parameters matter.

the contracting parameters and knowing that only one informed trader submits an order in his market.

$$\tilde{p} = E\left(\tilde{x}\middle|\tilde{t} + \tilde{n}\right) = \frac{Cov\left(\tilde{y} + \tilde{z}, d\tilde{y} + \tilde{n}\right)}{Var\left(d\tilde{y} + \tilde{n}\right)}\left(d\tilde{y} + \tilde{n}\right) \equiv l\left(d\tilde{y} + \tilde{n}\right)$$

Since asset value and noise trade are independent,

$$l = \frac{dV^y}{d^2V^y + V^n}.$$

The price setting strategy of the market maker is thus given by:

$$\tilde{p} = l^N\left(\tilde{t} + \tilde{n}\right),$$

where

$$l^N = \frac{d_1^N V^y}{d_1^{N\,2} V^y + V^n}.$$

For r=0, it is straightforward to show uniqueness of the equilibrium by solving the system (4) and (6) explicitly. By considering the change that an increase in r has on the function $d^N(l)$ it can be shown that uniqueness remains true for any r. A similar proof can be found in Subrahmanyam (1991).

q.e.d.

Proof of Proposition 2:

Agent 1 receives the following wage as a function of his own and agent 2's trading strategy.

$$\tilde{w}_1 = a_1 + \left(b_1 t_1 - g_1 t_2\right)\left(y + z - \tilde{p}\right) \tag{15}$$

where

$$\tilde{p} = l\,(t_1 + t_2 + \tilde{n}).$$

We consider only pure strategies as order sizes, and hence t_2 enters agent F_1's wage as a deterministic variable. It is straightforward to show that agents do not have an incentive to randomise their order sizes. Given this, agent 1 faces the following optimisation problem:

$$\max_{t_1} E\left[-\exp\left(-r\left(a_1 + \left(b_1 t_1 - g_1 t_2\right)\left(y + \tilde{z} - l\,(t_1 + t_2 + \tilde{n})\right) - c\right)\right)\right]$$

Note, that here t_2 is not a random variable, because in equilibrium agent 1 knows agent 2's trading strategy. Again we can use the certainty equivalent of utility to find the optimal trading strategy.

$$CE = a_1 - c + (b_1 t_1 - g_1 t_2)(y - l(t_1 + t_2)) - r/2 * (b_1 t_1 - g_1 t_2)^2 (V^z + l^2 V^n)$$

Taking the first-order condition and solving for t_1 yields equation (11):

$$t_1 = \frac{b_1 y - t_2\left(l(b_1 - g_1) - r b_1 g_1 \left(V^z + l^2 V^n\right)\right)}{2 b_1 l + r b_1^2 \left(V^z + l^2 V^n\right)}$$

Since agent 2 has the same utility function as agent 1, his choice of strategy is given by (11) with appropriately modified indices. Substituting t_2 in (11) by this formula into (11) and solving for t_1 yields the result in Proposition 2, with a trading intensity parameter given by (8).

As before, the coefficient on order flow that determines prices, is the regression coefficient of asset value on observed order flow:

$$\tilde{p} = E\left(\tilde{x} \middle| \tilde{t}_1 + \tilde{t}_2 + \tilde{n}\right) = \frac{Cov\left(\tilde{x}, (d_1 + d_2)\tilde{y} + \tilde{n}\right)}{Var\left((d_1 + d_2)\tilde{y} + \tilde{n}\right)}\left((d_1 + d_2)\tilde{y} + \tilde{n}\right) \equiv l\left((d_1 + d_2)\tilde{y} + \tilde{n}\right)$$

hence, $$l^H = \frac{\left(d_1^H + d_2^H\right)V^y}{\left(d_1^H + d_2^H\right)^2 V^y + V^n}$$

Similar to the uniqueness proof in Proposition 1, it is straightforward to show uniqueness for r=0, by calculating the solution to (8) and (10) explicitly. By a similar argument concerning the change in the shape of $d_1^H(l)+d_2^H(l)$ as r increases, uniqueness follows for any r.

q.e.d.

For the proof of Proposition 3, we need to calculate the expectation of exponential utility when wage is distributed as a quadratic function of normally distributed random variables. To this end we use Lemma 1, which gives a formula to calculate this expectation. A similar lemma and proof can be found for example in Bray (1981).

Lemma* 1:* Let **u** be an m dimensional vector of normally distributed random variables with variance-covariance matrix Σ. Wage w is a quadratic function of **u**, a is the non-random part of wage and c the cost of information acquisition. Expected utility is then given by

$$EU = -\left(|\Sigma||\mathbf{A}|\right)^{-\frac{1}{2}}\exp\left(-r(a-c)\right)$$

where **A** is given by

$$r(w(\mathbf{u})-c)+\tfrac{1}{2}\mathbf{u}'\Sigma^{-1}\mathbf{u} = 1/2\ \mathbf{u}'\mathbf{A}\mathbf{u} + r(a\text{-}c).$$

Proof: Expected utility can be written as

$$EU = -\frac{1}{(2p)^{m/2}}|\Sigma|^{-1/2}\int_{\Re^m}\exp\left(-K\right)d\mathbf{u} \tag{16}$$

and $$K = r(w(\mathbf{u})-c)+\tfrac{1}{2}\mathbf{u}'\Sigma^{-1}\mathbf{u} \tag{17}$$

This simply stems from multiplying the utility function with the density function for multivariate normally distributed random variables.

The next step is to rearrange K such that it is possible to carry out the integration. Thus, define **A** such that

$$K = 1/2\ \mathbf{u}'\mathbf{A}\mathbf{u} + r(a\text{-}c),$$

Next we carry out the following transformation

$$\mathbf{A} = \mathbf{B}\mathbf{B}'.$$

Then we substitute **u** in expected utility (16) by $\mathbf{q} = \mathbf{B}\mathbf{u}'$

This yields

$$\begin{aligned}\int_{\Re^m}\exp(-K)d\mathbf{u} &= \int_{\Re^m}\exp\left(-\tfrac{1}{2}\mathbf{u}'\mathbf{A}\mathbf{u} - r(a-c)\right)d\mathbf{u}\\ &= |\mathbf{A}|^{-\frac{1}{2}}\int_{\Re^m}\exp\left(-\tfrac{1}{2}\mathbf{q}'\mathbf{q} - r(a-c)\right)d\mathbf{q} = (2p)^{m/2}|\mathbf{A}|^{-\frac{1}{2}}\exp\left(-r(a-c)\right)\end{aligned} \tag{18}$$

A sufficient condition for the convergence of the integral is that the matrix **A** is positive definite.

q.e.d.

Proof of Proposition 3:

Suppose w.l.o.g. that principal P_1 sets up a fund (l_1=1). Since there is no other manager to supply comparative performance information (p_2=0), we can safely set g_1^N = 0, although any other value of γ would yield the same outcome.

In order to evaluate the incentive compatibility constraint (IC) we need to calculate the expected utility of the agent under a given contract, taking into account his subsequently chosen trading strategy.

Agent F_1's *ex ante* (i.e. before observing y) wage is a non-normally distributed random variable

$$\tilde{w}_1 = a_1 + b_1 d_1^N \tilde{y}\left(\tilde{x} - l^N\left(d_1^N \tilde{y} + \tilde{n}\right)\right)$$

Under a given contract and equilibrium in the trading game, the agent's expected utility can be calculated with the help of Lemma 1:

$$EU^N = -\left(|\Sigma||\mathbf{A_N}|\right)^{-\frac{1}{2}} \exp\left(-r(a_1 - c)\right) \tag{19}$$

where

$$\mathbf{A_N} = \begin{bmatrix} \frac{1}{V^y} + 2rb_1d_1\left(1 - d_1 l\right) & rb_1d_1 & -rb_1d_1 l \\ rb_1d_1 & \frac{1}{V^z} & 0 \\ -rb_1d_1 l & 0 & \frac{1}{V^n} \end{bmatrix}$$

and

$$\Sigma = \begin{pmatrix} V^y & 0 & 0 \\ 0 & V^z & 0 \\ 0 & 0 & V^n \end{pmatrix}$$

Moreover, d_1 and l are given from Proposition 1.

Furthermore, because of the particular form of matrix $\mathbf{A_N}$, a necessary and sufficient condition for $\mathbf{A_N}$ to be positive definite is $|\mathbf{A_N}|>0$.

The participation constraint (PC) can thus be written as

$$-\left(|\Sigma||\mathbf{A_N}|\right)^{-\frac{1}{2}} \exp\left(-r(a_1 - c)\right) \geq -\exp(-rW_1) \tag{20}$$

Moreover, using (18) the incentive compatibility constraint (IC) can be written as

$$-\left(|\Sigma|\|\mathbf{A}_{\mathbf{N}}|\right)^{-\frac{1}{2}} \exp\left(-r(a_1-c)\right) \geq -\exp(-ra_1) \qquad (21)$$

Substituting the binding inequality (21) into (20) yields

$$a_1 \geq W.$$

Since a_1 cancels out in (21), the optimal choice of a_1 makes (20) binding. Hence, $a_1^N = W$.

In order to calculate the optimal b_1 rewrite (21) as

$$|\Sigma\|\mathbf{A_N}| \geq \exp(2rc)$$

Calculating $|\Sigma\|\mathbf{A_N}|$ yields

$$1+2rV^y b_1 d_1(1-l\,d_1) - r^2 b_1^2 d_1^2 (V^z + l^2 V^n)V^y \geq \exp(2rc) \qquad (22)$$

Suppose $|\mathbf{A_N}| < 0$. In that case (20) could never be satisfied. Hence, every contract that satisfies (20) features $|\mathbf{A_N}|>0$ and therefore the formula in Lemma 1 can be applied. Substituting (4) into (22) and rearranging the terms yields

$$b_1 d_1 \geq \frac{\exp(2rc)-1}{rV^y} \qquad (23)$$

Now calculate the principal's expected payoff, by first calculating expected trading profits

$$\tilde{p}_1^N = d_1^N \tilde{y}\left(\tilde{x} - l^N\left(d_1^N \tilde{y} + \tilde{n}\right)\right)$$

the expected value of which is

$$Ep_1^N = d_1^N\left(1 - \frac{d_1^{N\,2} V^y}{d_1^{N\,2} V^y + V^n}\right)V^y = \frac{V^n V^y}{d_1^{N\,2} V^y + V^n} d_1^N \qquad (24)$$

Thus, using (24) and (P) we can write

$$EB_1^N = \frac{V^n V^y}{d_1^{N\,2} V^y + V^n} d_1^N - b_1 d_1^N \frac{V^n V^y}{d_1^{N\,2} V^y + V^n} - a_1$$

which is a decreasing function in $b_1 d_1^N$. Hence, the optimal b_1 will be chosen such that (23) is binding.

Substituting (6) into (4) and (4) into the binding (23) yields after some simplifications

$$b_1^4\left(\frac{V^n}{V^y}\right)^2 - b_1^2\frac{V^n}{V^y} ra^3 \frac{V^y + 2V^z}{1 - raV^z} - a^4\frac{1 + raV^z}{1 - raV^z} = 0 \qquad (25)$$

where

$$a \equiv \frac{\exp(2rc) - 1}{rV^y}$$

Solving the quartic equation (25) for b_1 yields one positive real root, given by (12) if $\exp(2rc)-1 \leq V^y/V^z$. Otherwise no real root exists, which means that no b exists that satisfies the incentive compatibility constraint.

q.e.d.

References

Admati, A.R. and P. Pfleiderer, 1988, "A Theory of Intraday Patterns: Volume and Price Variability," *Review of Financial Studies*, **1**, 3-40.

Admati, A.R. and P. Pfleiderer, 1997, "Does It All Add Up? Benchmarks and the Compensation of Active Portfolio Managers," *Journal of Business,* **70**, 323-350.

Aggarval, R.K. and A.A. Samwick, 1999, "Executive Compensation, Strategic Competition, and Relative Performance Evaluation: Theory and Evidence," *Journal of Finance,* **54**, 1999-2043.

Banerjee, A., 1992, "A Simple Model of Herd Behavior," *Quarterly Journal of Economics*, **107**, 797-817.

Bekaert, G. and C.R. Harvey, 2000, "Foreign Speculators and Emerging Equity Markets," *Journal of Finance*, **55**, 565-614.

Bhattacharya, S. and P. Pfleiderer, 1985, "Delegated Portfolio Management," *Journal of Economic Theory*, **36**, 1-25.

Bray, M.M., 1981, "Futures Trading, Rational Expectations, and the Efficient Markets Hypothesis," *Econometrica*, **49**, 575-596.

Brennan, M., 1990, "Latent Assets," *Journal of Finance*, **45**, 709-730.

Brennan, M. and A. Subrahmanyam, 1995, "Investment Analysis and Price Formation in Securities Markets," *Journal of Financial Economics*, **38**, 361-381.

Caillaud, B., B. Jullien, and P. Picard, 1995, "Competing Vertical Structures: Precommitment and Renegotiation," *Econometrica*, **63**, 621-646.

Carter, L., 1996, "Investment Funds in Emerging Markets," IFC: Lessons of Experience Series #2.

Chang, J.J., T. Khanna and K.G. Palepu, 2000, "Analyst Activity Around the World," unpublished mimeo.

Dewatripont, M., 1988, "Commitment Through Renegotiation-Proof Contracts with Third Parties," *Review of Economic Studies*, **55**, 377-390.

Dow, J. and G. Gorton, 1997, "Noise Trading, Delegated Portfolio Management, and Economic Welfare," *Journal of Political Economy*, **105**, 1024-1050.

Eichberger, J., S. Grant and S.P. King, 1999, "On Relative Performance Contracts and Fund Manager's Incentives," *European Economic Review*, **43**, 135-161.

Foster, F.D. and S. Viswanathan, 1993, "Variations in Trading Volume, Return Volatility and Trading Costs: Evidence on Recent Price Formation Models," *Journal of Finance*, **48**, 187-211.

Froot, K., D. Scharfstein, and J. Stein, 1992, “Herd on the Street: Informational Inefficiencies in a Market with Short-Term Speculation,” *Journal of Finance*, **47**, 1461-1484.

Gümbel, A., 1998, “Herding in Delegated Portfolio Management: When is Comparative Performance Information Desirable?” EUI, working paper #98/22.

Heinkel, R. and N.M. Stoughton, 1994, “The Dynamics of Portfolio Management Contracts,” *Review of Financial Studies*, **7**, 351-387.

Henry, P.B., 2000a, “Do Stock Market Liberalisations Cause Investment Booms?” *Journal of Financial Economics*, forthcoming.

Henry, P.B., 2000b, “Stock Market Liberalisation, Economic Reform, and Emerging Market Equity Prices,” *Journal of Finance*, **55**, 529-564.

Holmstrom, B., 1982, “Moral Hazard in Teams,” *Bell Journal of Economics*, **13**, 324-340.

Khorana, A. and H. Servaes, 1999, “The Determinants of Mutual Fund Starts,” *Review of Financial Studies*, **12**, 1043-1074.

Kim, E.H. and V. Singal, 2000, “Stock Market Openings: Experience of Emerging Economies,” *Journal of Business*, **73**, 25-66.

Kyle, A., 1985, “Continuous Auctions and Insider Trading,” *Econometrica*, **53**, 1315-1336.

Maug, E. and N. Naik, 1996, “Herding and Delegated Portfolio Management: The Impact of Relative Performance Evaluation on Asset Allocation,” LBS Working Paper #223.

Milgrom, P. and J. Roberts, 1992, *Economics, Organisation and Management*, Prentice-Hall, Englewood Cliffs, N.J., chap. 7.

Mookherjee, D., 1984, “Optimal Incentive Schemes with Many Agents,” *Review of Economic Studies*, **51**, 433-446.

Palomino, F., 1997, “Relative Performance Equilibrium in Financial Markets,” CentER working paper #9799.

Scharfstein, D. and J. Stein, 1990, “Herd Behavior and Investment,” *American Economic Review*, **80**, 465-479.

Stoughton, N.M., 1993, “Moral Hazard and the Portfolio Management Problem,” *Journal of Finance*, **47**, 2009-2028.

Subrahmanyam, A., 1991, “Risk Aversion, Market Liquidity, and Price Efficiency,” *Review of Financial Studies*, **4**, 417-441.

Vickers, J., 1985, “Delegation and the Theory of the Firm,” *Economic Journal, Conference Supplement*, 138-147.