Asymmetry of Reputation Loss and Recovery under Endogenous Relationships: Theory and Evidence*

by

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Abstract: We formulate a dynamic investment model where investors can easily change firms (funds) and firms’ actions are subject to imperfect monitoring. We show that there is an asymmetry of fast customer loss and slow recovery, without learning or asymmetry in feasible actions at different states. The key factor is endogenous relationships. It is easy to lose customers but it is not easy to get them back, because without an ongoing relationship, investors care more about the currently owned funds. In a mutual fund market, we give empirical evidence, at an individual firm level, that asymmetry of investor movements exists when all fund managers have similar performance but one fund manager was associated with a bad news.

Key words: reputation, asymmetry, endogenous relationships.

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1 Introduction

Dynamic games with endogenous partnerships is an emerging research field. (See for example, Ghosh and Ray [9], Kranton [16], [17], and Fujiwara-Greve and Okuno-Fujiwara [8].) In this paper we consider investment situations, which is a natural and important application of endogenous partner changes, and examine the structure of dynamic reputation change. In particular, we show an asymmetry of the reputation dynamic, that reputation loss is fast while reputation recovery is slow, at an individual firm level.

There is a growing literature of asymmetric dynamics such as slow booms and sudden crushes (see for example, Veldkamp [24], van Nieuwerburgh and Veldkamp [20] and references therein). This literature is about the dynamics of aggregate economic variables and based on either learning or asymmetric constraints in actions (borrowing constraints, capacity constraints etc.). By contrast, we analyze an individual firm’s customer dynamics based on strategic partner changes. In a homogeneous population of potential partners, once a partnership is terminated, there is no reason to voluntarily return to the old partner. Recovery needs a positive push, such as new entrants or reputation loss for other partners.

Our model is a dynamic, many-to-one, principal-agent model, which extends the basic model of endogenous one-to-one partnership model. Principals are called investors and agents are called (investment) firms. Investors are free to choose which firm to trust, but their observability of firms’ actions is assumed to be limited. Each investor only observes a noisy signal of the action taken by the firm that she is currently patronizing. This informational assumption is in accordance with the no-information-flow assumption of the endogenous partnerships literature, and moreover weakens the perfect monitoring assumption within a partnership. We assume that all investors trusting the same firm observe the same signal and act simultaneously, thus there is no learning/herding aspect.

The main concern of investors is whether to keep trusting the same firm based on the imperfect information. Since they do not have information about other firms, the investors’ choice of future firm is random and they do not plan on come back after they have left a firm. Firms’ concern is whether to make effort even though it is not perfectly observed.

Our model is appropriate in many transaction situations. Non-institutional investors do not have precise information about investment fund managers and they may not collect information
of funds that they are not currently investing in. In repeatable services and goods, such as local 
restaurants and dentists, consumers may not have perfect information of the seller’s action, nor 
collect information of other sellers while they have a regular place to go.

In this imperfect monitoring dynamic game, we construct a cooperative sequential equilib-
rium by quite simple strategies: investors use a symmetric grim trigger strategy such that they 
start with a random firm and trust it as long as a good signal is realized. They move to a random 
new firm immediately after observing a bad signal. Firms play a stationary effort strategy that 
they make effort regardless of history.

Although the strategy combination is simple and intuitive, the construction of such equilib-
nium is a theoretical contribution from at least three aspects. First, the very limited information 
structure of imperfect monitoring and no-information-flow makes enforcement of non-myopic ac-
tions difficult, since a firm’s effort is not directly observed and a bad signal is forgotten once 
current customers move out. Therefore it is worth making an equilibrium with all firms making 
effort. The slow recovery is a result of no-information-flow assumption, since it is impossible for 
investors to make a coordinated come back.

Second, a grim trigger strategy does not constitute an equilibrium in ordinary repeated 
games with imperfect monitoring (see for example, Green and Porter [10]). Unlike the perfect 
monitoring case, a grim trigger strategy must start a punishment with a positive probability 
under imperfect monitoring, and the eternal punishment is not incentive compatible in a repeated 
game where players are confined. By contrast, in our endogenous partnership game, it can be a 
part of a sequential equilibrium because the punishment does not hurt the punishers/investors 
when all firms are making effort, and moreover it is not the eternal punishment for firms, thanks 
to newcomers who randomly choose firms and investors moving from other firms with a bad 
signal. Therefore the combination of grim trigger strategy by investors and constant effort by 
all firms constitutes an equilibrium.

Third, the endogeneity of partnerships creates a technical difficulty: a firm’s long-run opti-
mization problem is not explicitly solvable on its own, because the state variable is not only its 
measure of customers\(^1\) but also all other firms’, since there are investors moving from firms with 
a bad signal. Therefore we need to solve all firms’ optimization problem together.

\(^1\)To distinguish a generic investor and an investor currently investing in a particular firm, we use the term “customer” for the latter.
The equilibrium path of the customer measure of an individual firm displays an asymmetry, with immediate large drop after a bad signal and a gradual increase by newcomers and movers from another firm with a bad signal. The driving force is discipline, not learning or constrained behavior as in the macro literature of asymmetric dynamics.\textsuperscript{2} Then it is an empirical question, whether in fact investors try to discipline firms.

We analyze data from the market of mutual funds in the Swedish pension system from 2000 to 2007. This is an ideal dataset because the investors are amateur investors who are likely to have limited information and focus, and the pension system offers pre-selected funds that are all well-managed and among which investors can easily change funds. Our analysis shows a fast loss of a firm’s reputation when a scandal occurred and a prolonged recovery period, even though the funds performed equally well, as predicted by our theory.

The paper is organized as follows. Section 2 presents a model of endogenous partnerships, and section 3 shows equilibria that enforce all firms’ effort. Section 4 presents the evidence from our analysis of the Skandia scandals. Section 5 concludes the paper.

2 Model

Consider a continuum of homogeneous investors (principals) of measure 1 and a finite number $N > 1$ of ex-ante homogeneous investment firms (agents) playing the following infinite-horizon game. Time is discrete and denoted as $t = 1, 2, \ldots$. At the beginning of the game, all investors are “newcomers” who do not have information regarding any firm’s past behavior. At the end of each period, $(1 - \delta)$ (where $\delta \in (0, 1)$) of the investors leave the market for exogenous reasons, which we call “death”. Each dead investor is replaced by a newcomer so that the population size of the investors is the same over time.

A newcomer investor chooses one of the firms\textsuperscript{3} in $\{1, 2, \ldots, N\}$ with no prior information to start investing, and after that she chooses whether to keep investing in the same firm or move to another firm, depending on her observations. The observations are common among investors.

\textsuperscript{2}As surveyed in van Nieuwerburgh and Veldkamp [20], learning theory argues that the volume or precision of information regarding underlying economic state is different in good times and bad times and that faster learning in good times makes sudden crush, while slow learning in bad times makes slow booms. Other theories include difference in cost of taking actions (Acemoglu and Scott [3]) in good times and bad times, and capacity/borrowing constraints (e.g., Hansen and Prescott [11]).

\textsuperscript{3}If, instead, each investor chooses a set of firms, it is many-to-many relationships. A similar analysis can be done in that case if we assume that each investor chooses actions independently at each firm.
at the same firm and they choose the trust decision simultaneously. Investors at firm $j$ do not observe information regarding other firms $k \neq j$. This is a no-information-flow assumption.

After investors' choices, firms simultaneously choose whether to make effort (action “Effort”) or not (action “Shirk”) in managing the investment. We assume that a firm cannot discriminate among its customers (those investing in the relevant firm) and chooses the same action against all customers. This is the case, for example, if a firm manages a fund that pools all customers' investment, as in mutual funds. Effort action is assumed to be more costly to the firm than Shirk action but generates more payoff to the customers. We denote $H > 0$ as a firm’s one-shot payoff from a single customer when it chooses Shirk, and $L \in (0, H)$ when it chooses Effort.

Firms' actions may not be perfectly observable to investors, and instead we assume that each firm’s “reputation signal” is observed by only its customers (those who are currently investing in the firm), at the end of each period. Since a firm has only two actions, without loss of generality we can assume that there are two signals: Good and Bad. If firm $j$ shirks while all others made effort, firm $j$ gets a Bad signal for sure and all others get a Good signal for sure. If all firms made effort, with probability $1 - \epsilon$, no firm gets a Bad signal, but with probability $\epsilon$, one firm is randomly selected to obtain a Bad signal. Thus each firm has probability $\epsilon/N$ of getting a Bad signal even when all firms are making effort. The assumption that an innocent firm getting a Bad signal is not without grounds. Jonsson et al. [15] showed that a scandal of a company affected an independent firm with the same name. There is abundance of similar examples of loss of reputation by association.5

For other possible combinations of firms' underlying actions which involve multiple firms' Shirk actions, we just assume that the signal structure is the same as all firms' making Effort, since multiple players' deviations are not relevant under Nash based equilibrium notions. Note that when $\epsilon = 0$, we have perfect monitoring when all firms are making effort. The stochastic structure of signals is assumed to be i.i.d. over time.

Investors receive a high one-shot utility $h > 0$ if a Good signal is realized at the firm they are currently trusting and a low utility $-\ell$ (where $\ell > 0$) if a Bad signal is realized. This

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4The assumption that at most one firm gets a Bad signal is for computational convenience. If multiple firms get a Bad signal simultaneously, the possible cases of investor movements become very complex but does not affect the fundamental structure of the equilibrium.

5For example, the Enron scandal tainted the overall reputation of its auditor Arthur Andersen, not just that of the Houston office that handled the Enron account. See Huang and Li [14].
utility structure is not only a standard assumption in imperfect monitoring repeated games to warrant that investors cannot infer the underlying action from the realized utility, but also a formulation to incorporate the psychological effect of the reputation signal. In summary, the one-shot extensive form game between an investor and a firm is essentially the Trust game (e.g., Kreps [18]) with noisy signals as depicted in Figure 1. Note that the probability of Nature’s choice of a Bad signal is dependent on all firms’ action combination.

The one-shot expected utility of a customer of an arbitrary firm \( j \) when all firms are making effort is

\[
(1 - \epsilon + \sum_{k \neq j} \frac{\epsilon}{N}) h - \frac{\epsilon}{N} \ell = (1 - \frac{\epsilon}{N}) h - \frac{\epsilon}{N} \ell.
\]

For simplicity, we assume that there is no cost of moving one’s investment to another firm.\(^6\)

We also assume that

\[
(1 - \frac{\epsilon}{N}) h - \frac{\epsilon}{N} \ell + L > H - \ell,
\]

so that (Trust, Effort) is collectively better than (Trust, Shirk) between an investor and a firm.

\(^6\)This assumption (almost) holds in our empirical case, where investors can use the web or phone calls to change funds. It can be dropped if we modify the equilibrium notion, so that an investor is “satisficing” so that she is indifferent among \( \alpha \)-best responses, and an investor’s cost of moving is less than \( \alpha \). An \( \alpha \)-best response is a strategy that gives long-run payoff not less than the payoff \(-\alpha\) of any other strategy. See Radner [22]. It can be also dropped if we include supermodularity in the investor payoff such that an investor’s payoff increases as the measure of customers investing in the same fund increases. See Section 5.
The firms’ ability to observe each other’s signal history is not relevant in our model. Instead the distribution of investors across firms (denoted as \( x = (x_1, x_2, \ldots, x_N) \in \Delta^{N-1} \), where \( \Delta^{N-1} \) is the \( N - 1 \) dimensional unit simplex) is sufficient information for payoff maximization. The logic is as follows. A firm’s dynamic optimization takes into account one-shot payoff in a period and the expected continuation value. A firm’s one-shot payoff is dependent only on its current customer measure. Its continuation value depends on the expected measure of outflows of customers and inflows of investors. On one hand, the outflow only depends on its signal, which is random, and the current measure of its customers. On the other hand, the inflow depends on other firms’ signals as well as their customer measures. Since signal structure is known and i.i.d., it is sufficient to know the distribution of investors across firms to compute the continuation value.

The probability \( \delta \) of staying in the game is the effective discount factor for each investor. Firms are active in the game forever and thus we assume that they discount payoffs by a common discount factor \( \beta \in (0, 1) \). The game is of complete information.

3 Equilibrium Enforcement of Effort

In this section we define an equilibrium concept and derive equilibria in which all firms always make effort, which is most efficient.

3.1 Strategies and Equilibrium

We first define a general concept of strategies and sequential equilibrium in our model.

**Definition.** For each investor-firm pair, let \( \tau = 1, 2, \ldots \) be the horizon of the partnership. A *signal history* for an investor at the beginning of \( \tau \)-th period in a partnership is

\[
    h_\tau = \begin{cases} 
    \emptyset & \text{if } \tau = 1 \\
    (z_1, \ldots, z_{\tau-1}) \in \{G, B\}^{\tau-1} & \text{if } \tau \geq 2
    \end{cases}
\]

In this definition the signal history is nullified, once a partnership ends.

**Definition.** A *strategy* \( s_i \) of an investor \( i \) is a function that assigns \( a_\tau \in \{\text{Trust, Move}\} \) for each signal history \( h_\tau \) for \( \tau = 1, 2, \ldots \).

In this definition of a strategy two things are included: partner independence (since the signal history restarts in every new partnership) and random choice of a new partner firm (since an
investor only chooses whether to Trust or Move). Both are standard in the no-information-flow model of endogenous partnerships (e.g., Ghosh and Ray [9] and Fujiwara-Greve and Okuno-Fujiwara [8]). In addition, even if investors can simply count some periods to stay away from the firm with a Bad signal, in the meantime they should not ignore the signal of their current firm. Thus it is natural that investors focus on the current partner firm.

From a firm’s point of view, the relevant time horizon is the “calendar time” of the dynamic game \( t = 1, 2, \ldots \). As we discussed in Section 2, a firm’s decisions can be based only on the distribution of investors across firms at that time, which solely determines the firm’s payoff. For each \( t = 1, 2, \ldots \), let \( x(t) = (x_1(t), x_2(t), \ldots, x_N(t)) \in \Delta^{N-1} \) be the distribution of investors.

**Definition.** A strategy \( s^F_j \) of a firm \( j \in \{1, 2, \ldots, N\} \) is a function that assigns \( b_t \in \{\text{Effort}, \text{Shirk}\} \) for each current distribution of \( x(t) \in \Delta^N \) for \( t = 1, 2, \ldots \).

Since the dynamic game is of imperfect information with non-public signals, a natural equilibrium concept is a sequential equilibrium as in the literature, such as Abreu et al. [1], [2]. For compositional simplicity we do not explicitly construct the belief system, but in our pure-strategy equilibrium it is clear.

**Definition.** A sequential equilibrium is a strategy combination of all players such that in each information set of a player,

(i) the continuation strategy of the player is optimal given the belief at the information set (a probability distribution over the decision nodes within the information set) and the continuation strategy of other players; and

(ii) the belief at the information set is probabilistically consistent with the strategy combination.

### 3.2 Groupwise Symmetric Pure-strategy Equilibrium

In this section let us derive a groupwise symmetric\(^7\) equilibrium in which all firms make effort after any signal history and all investors stay at the same firm if and only if the previous signal was Good. To induce a firm’s effort, customers must punish the firm if a Bad signal is observed, even if the true action was to Effort.

Let us define the candidate strategies for an equilibrium.

\(^7\)A strategy combination of two groups of players is groupwise symmetric if all players in a group use the same strategy.
**Definition.** A (Markov) trigger-strategy $s_i^T$ of an investor $i$ assigns, for any $\tau = 2, 3 \ldots$ and any private signal history $h_\tau = (z_1, \ldots, z_{\tau-1})$, 

$$s_i^T(h_\tau) = \begin{cases} 
\text{Trust} & \text{if } z_{\tau-1} = G \\
\text{Move} & \text{if } z_{\tau-1} = B.
\end{cases}$$

Under this strategy the actions are dependent only on the previous period’s signal in the private history. It is also “belief-free” because investors do not make a belief of the underlying actions of firms from the signal to react to it.

**Definition.** A constant effort strategy $s_j^E$ for a firm $j$ assigns, for any $t = 1, 2, \ldots$ and any investor distribution $x(t)$, $s_j^E(x(t)) = \text{Effort}$.

Because newcomers randomly choose a firm, even if a firm shirked, there will be a positive measure of customers in the next period. Thus, if the signal is very imprecise (large $\epsilon$), firms may simply give up on making effort and try to exploit newcomers every period. This implies that we need an upper bound to $\epsilon$ for the equilibrium to hold.

**Proposition 1.** For any $\epsilon \leq L(N-1)/H$, there exists $(\beta, \delta) \in (0, 1)^2$ such that for any $(\beta, \delta) \geq (\beta, \delta)$, the groupwise symmetric pure-strategy combination of $s_i^T$ for all investors and $s_j^E$ for all firms is a sequential equilibrium.

**Proof:** See Appendix.

The intuition is as follows. Investors are ex-ante indifferent among any firm, since all firms have the same strategy and generate the same ex-ante expected utility for investors. Thus it is (weakly) optimal to move to another firm after a Bad signal. (This is similar to the logic in Ely and Välimäki [6] and Piccione [21], to make punishers indifferent between punishing and not punishing. Then there is no need for coordination in punishment.) Note that although investors are indifferent between moving and staying, if they are not moving out after a Bad signal, they cannot enforce firms’ effort. See Corollary 2.

A firm’s long-run optimization problem is heavily dependent on all other firms’ signal histories, as follows. Suppose that firm $j$ has the measure $x_j(t)$ of customers at the beginning of period $t$. Its payoff when it chooses Effort is $L \cdot x_j(t)$ in this period but the continuation payoff depends not only on $x_j(t)$ and its random signal of this period, but also on other firms’ random
signal and their current measure of customers, because some of their customers may move to
firm $j$ after this period. If one of the other firms, say firm $k \neq j$, with the customer measure
$x_k(t)$, got a Bad signal at the end of period $t$ (which implies that firm $j$ did not), then firm $j$’s
customer measure in period $t+1$ will be

$$
\delta x_j(t) + \frac{1-\delta}{N} + \frac{\delta}{N-1} x_k(t).
$$

To explain, the first term is the “stayers” who trusted firm $j$ in period $t$ and did not die. Under
the strategy combination $s^T$, they will trust firm $j$ again. The second term is the fraction of
“newcomers” who randomly chose firm $j$. The last term is the measure of “movers” who trusted
firm $k$ in period $t$, did not die, and randomly chose firm $j$ among the $N-1$ firms after a Bad
signal. Note that each firm has probability $\frac{1}{N}$ of getting a Bad signal under the constant effort
strategy. If firm $j$ itself gets a Bad signal, its next period customer measure drops to $\frac{1-\delta}{N}$, which
is the measure of newcomers only. If no firm got a Bad signal (which occurs with probability
$1-\epsilon$ under $s^E$), the next period customer measure of firm $j$ is $\delta x_j(t) + \frac{1-\delta}{N}$.

Summarizing the above, we can write the value function of firm $j$ in period $t$ as follows.

$$
v\left(x_j(t); x_{-j}(t)\right) = L \cdot x_j(t) + \beta \left\{(1-\epsilon) \cdot v\left(\delta x_j(t) + \frac{1-\delta}{N}; x_{-j}(t+1)\right) + \frac{\epsilon}{N} \cdot v\left(\frac{1-\delta}{N}; x_{-j}(t+1)\right) + \sum_{k \neq j} \frac{\epsilon}{N} \cdot v\left(\delta x_j(t) + \frac{1-\delta}{N} + \frac{\delta x_k(t)}{N-1}; x_{-j}(t+1)\right)\right\},
$$

where $x_{-j}(t) = (x_1(t), \ldots, x_{j-1}(t), x_{j+1}(t), \ldots, x_N(t))$ is the customer distribution of other firms
at $t$. This construction of the value function shows that we cannot solve one firm’s long-run
value function explicitly, without solving the dynamics of all firms’ customer measures.

We therefore solve for the total discounted expected measure of investor distribution of all
firms, starting from an arbitrary distribution $x = (x_1, x_2, \ldots, x_N) \in \Delta^{N-1}$, concatenating all
firm’s dynamic equation of customer measures (not the value functions), as follows.

$$
M\left(\begin{array}{c}
x_1 \\
x_2 \\
\vdots \\
x_N
\end{array}\right) = \beta \left(1-\epsilon\right) \cdot M\left(\begin{array}{c}
\delta x_1 + \frac{1-\delta}{N} \\
\delta x_2 + \frac{1-\delta}{N} \\
\vdots \\
\delta x_N + \frac{1-\delta}{N}
\end{array}\right) + \frac{\epsilon}{N} \cdot M\left(\begin{array}{c}
\delta x_1 + \frac{1-\delta}{N} - \delta x_1 \\
\delta x_2 + \frac{1-\delta}{N} + \frac{1}{N-1} \delta x_1 \\
\vdots \\
\delta x_N + \frac{1-\delta}{N} + \frac{1}{N-1} x_1
\end{array}\right) + \cdots + \frac{\epsilon}{N} \cdot M\left(\begin{array}{c}
\delta x_1 + \frac{1-\delta}{N} + \frac{1}{N-1} \delta x_N \\
\delta x_2 + \frac{1-\delta}{N} + \frac{1}{N-1} \delta x_N \\
\vdots \\
\delta x_N + \frac{1-\delta}{N} - \delta x_N
\end{array}\right),
$$

(3)
We added discounting $\beta$ in this formulation so that $L \cdot M(x')$ becomes the concatenation of value functions of all firms under $(s^T, s^E)$. As in (2), the first term of the RHS is the current period’s investor distribution, the second term is the continuation value when no firm got a Bad signal, the third term is the continuation value when firm 1 got a Bad signal and so on.

Using vector notation, (3) can be simply written as

$$M(x') = x' + \beta \left[ (1 - \epsilon)M(\delta x' + \frac{1 - \delta}{N} e') + \sum_{k=1}^{N} \frac{\epsilon}{N} M(A_k(\delta)x' + \frac{1 - \delta}{N} e') \right],$$

(4)

where $e' = (1, 1, \ldots, 1)'$ is the $N$-dimensional unit column vector and the $N \times N$ matrix $A_k(\delta)$ (which describes investor re-distribution when firm $k$ got a Bad signal) is defined as

$$A_1(\delta) = \begin{pmatrix} 0 & 0 & \cdots & 0 \\ \delta/(N-1) & \delta & \cdots & 0 \\ \vdots & 0 & \ddots & 0 \\ \delta/(N-1) & 0 & \cdots & \delta \end{pmatrix}, \quad A_2(\delta) = \begin{pmatrix} \delta & \delta/(N-1) & 0 & \cdots & 0 \\ 0 & 0 & 0 & \cdots & 0 \\ \vdots & \vdots & 0 & \ddots & 0 \\ 0 & \delta/(N-1) & 0 & \cdots & \delta \end{pmatrix}$$

and so on for each $k = 1, 2, \ldots, n$.

By the vector-matrix representation of (4), it should be clear that $M(\cdot)$ is linear in $x'$ and stationary. Using this fact, we can explicitly solve for $M(x')$. Moreover, in the long run, the $j$-th coordinate of $M(x')$ is independent from other firms’ initial measure of customers. Thus we can denote $M_j(x_j)$ as the total discounted expected measure of customers for firm $j$, dependent only on the initial measure of own customers $x_j$. The total discounted expected payoff of firm $j$ is then $L \cdot M_j(x_j)$. Finally, using the explicit solution of $M_j(x_j)$, we show that no firm would Shirk in one period: for any $x_j \geq (1 - \delta)/N$ (which is the smallest measure of customers a firm can have in a period),

$$L \cdot M_j(x_j) \geq Hx_j + \beta L \cdot M_j\left(\frac{1 - \delta}{N}\right),$$

(5)

if $\epsilon \leq L(N-1)/H$ holds.

Alternatively, when the probability of a wrong signal ($\epsilon$) is large, so that the above condition is violated, the “exit” strategy by all customers is so harsh that firms give up to make effort. Thus, we have a clear condition when exit can/cannot discipline firms, making the theory of Hirshman [12] rigorous.

Next, we investigate properties of the equilibrium. First, the total discounted expected payoff is independent of the probability $\epsilon$ of wrong signal.

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8The notation $x'$ stands for the transpose of the row vector $x = (x_1, x_2, \ldots, x_N)$. 

10
Corollary 1. For any $\epsilon \leq L(N - 1)/H$ and any $(\beta, \delta) \geq (\overline{\beta}, \overline{\delta})$, the equilibrium long-run payoff of a firm is

$$L \cdot M_j\left(\frac{1}{N}\right) = \frac{L}{N(1 - \beta)}.$$

Proof: See Appendix.

This is because a firm not only loses customers stochastically but also gains customers from other firms stochastically, and in the long run these movements cancel out. This also means that the symmetric equilibrium is efficient in the long run, despite the imperfect monitoring. This is a contrast to ordinary repeated games with imperfect monitoring where the gain from other players’ loss of reputation is not considered.

Second, even though investors are ex ante indifferent among firms so that they do not have to move out after a Bad signal, in that case no firm would make effort since the condition (5) does not hold.

Corollary 2. If the measure of customers is unchanged after a Bad signal, then, for any $\beta \in (0, 1)$,

$$L \cdot M_j\left(\frac{1}{N}\right) < H \frac{1}{N} + \beta L \cdot M_j\left(\frac{1}{N}\right)$$

so that firms would not choose Effort in the first period, i.e., no move out by customers and the constant effort strategy by the firms do not constitute even a Nash equilibrium.

Proof: From Corollary 1, we have $L \cdot M_j\left(\frac{1}{N}\right) = \frac{L}{N(1 - \beta)}$. Therefore

$$(1 - \beta)L \cdot M_j\left(\frac{1}{N}\right) = \frac{L}{N} < H \frac{1}{N} \iff L \cdot M_j\left(\frac{1}{N}\right) < H \frac{1}{N} + \beta L \cdot M_j\left(\frac{1}{N}\right).$$

Therefore the combination of the Markov trigger strategy for all investors and the constant effort strategy for all firms is the unique groupwise symmetric pure-strategy equilibrium with constant effort by the firms.

Finally, let us display how the measure of customers changes before and after a reputation loss. At the beginning of the game, all firms receive the same share of customers $\frac{1}{N}$. As long as no firm gets a Bad signal the turnover of investors does not change the symmetric investor distribution: $x_j(t) = \frac{1}{N} \Rightarrow x_j(t + 1) = \delta \frac{1}{N} + \frac{1 - \delta}{N} = \frac{1}{N}$. When a firm gets a Bad signal, the
measure of customers of the firm decreases to \((1-\delta)/N\) in the next period and only slowly increases over time after that, until some other firm gets a Bad signal. Until then, the time-sequence of customers is limited to the accumulation of newcomers so that after \(t\) periods of consecutive Good signals, the measure becomes

\[
\frac{1-\delta}{N} \left( 1 + \delta + \delta^2 + \cdots + \delta^t \right) = \frac{1-\delta}{N} \times \frac{1-\delta^{t+1}}{1-\delta}.
\]

Therefore, if no jump by another firm’s Bad signal occurs, the recovery path is concave in \(t\). When another firm gets a Bad signal, the curve should discretely shift upwards and start another concave path. When this firm gets a Bad signal again, the curve jumps down to \((1-\delta)/N\) and restarts the same way as above. Figure 2 depicts a path of customer measures on the equilibrium play path (from the initial measure \(1/N\)) when firm \(j\) had a Bad signal at \(t = 10\) and no more Bad signals are observed. Notice that it takes a long time to recover to the initial measure \(1/N\).

### 3.3 Weaker Punishment Equilibria

Proposition 1 shows that moving out entirely (except newcomers) from a firm with a Bad signal can be an equilibrium for sufficiently small \(\epsilon\). When \(\epsilon\) does not satisfy the condition \(\epsilon \leq L(N-1)/H\), we should weaken the punishment.

There are at least two ways to weaken the punishment. One way is to allow an asymmetric strategy of investors so that some customers do not move out after a Bad signal, as Hirshman [12] advocated.\(^9\) Alternatively, the same payoff sequence for firms can be generated by a symmetric

\(^9\)Hirshman [12] wrote (page 24), “For competition (exit) to work as a mechanism of recuperation from perfor-
behavior-strategy such that after a Bad signal the customers randomize between moving out and staying.

Let $\alpha > 0$ of the investors use the trigger strategy. The remaining $1 - \alpha$ of the investors use the following inertia strategy.

**Definition.** An inertia strategy $s^I_i$ of an investor assigns, for any $\tau = 1, 2, \ldots$ and any private signal history $h_\tau$, $s^I_i(h_\tau) = \text{Trust}$.

This inertia strategy starts the game with a randomly chosen firm but does not change firms regardless of signal history. Assume that when an investor dies, the newcomer replacing her has the same strategy. Then the population of investors always consists of $\alpha$ of the trigger strategy investors and $1 - \alpha$ of inertia strategy investors. If we use the behavior-strategy interpretation, $\alpha$ is the probability that a customer stays after a Bad signal. Note that when $\alpha = 1$ the strategy combination reduces to the one in Proposition 1.

An analogous analysis to the groupwise symmetric pure-strategy equilibrium implies that firms follow the constant effort strategy if $\epsilon \leq \frac{L(N-1)}{\alpha H}$. Note that $\frac{L(N-1)}{\alpha H} \to \infty$ as $\alpha \to 0$. Thus, even if the probability of wrong signal $\epsilon$ increases, appropriate investor strategies can induce effort of firms.

**Proposition 2.** For any $\epsilon \geq 0$ there exist $(\alpha, \beta, \delta) \in (0, 1)^3$ such that for any $\alpha \leq \alpha_\ast$ and any $(\beta, \delta) \geq (\beta_\ast, \delta_\ast)$, the strategy combination such that $\alpha$ of investors use the trigger strategy $s^T_j$ and $(1 - \alpha)$ of investors use the inert strategy $s^I_j$ and all firms use the constant effort strategy $s^E_j$ is an equilibrium.

**Proof:** See Appendix.

Notice that the equilibrium payoff of a firm is the same as the one of the groupwise symmetric pure-strategy equilibrium, since the rate of losing customers upon a Bad signal does not affect the long-run payoff under the above stationary strategy combination either. Thus payoff efficiency is unchanged while the sufficient condition is weaker.
The weaker punishment equilibria is also important when firms face financial constraints to keep operating. (See for example, Hirshman [12] and Yasuda [25].) If firms need a certain level of payoffs in every period in order to remain in the business, the infinite horizon of the firms is no longer an assumption but must be also endogenously sustained. In order to enforce a non-myopic action by the firms, they need a sufficient probability of being able to stay in business. However, if all current customers move out after a Bad signal, the low future payoff may violate the constraint. In that case we can still construct an effort equilibrium by making enough measure of customers stay even after a Bad signal to meet the constraint. In that case, however, we cannot adjust $\alpha$ freely as in Proposition 2, so that the probability of wrong signal $\epsilon$ must not be too large.

3.4 Other extensions

Although the above model is simple, it has enough capacity to expand to address many empirical issues, without changing the fundamental structure of the grim-trigger and effort equilibrium. Here we mention two extensions which accommodate our empirical example below. More technical extensions are discussed in the concluding remark Section 5.

First, some customers may react to a Bad signal with some delay. Since the signal may not reflect the true action by the firm and investors are indifferent between staying and moving under the constant-effort strategy of all firms, it is also rational for some customers to stay for a while and then move. Such delayed moving strategy can also enforce effort of firms if the loss of future payoffs after a Bad signal is sufficient for a firm. It only complicates the computation of payoffs. Moreover, in reality the interpretation of a news may differ among people and some may wait until others’ reactions to “learn” the meaning of the news. In our empirical example, the news was about a different company with a similar name, and thus it is plausible that some customers may not react right away until they are convinced that the news was a Bad signal.

Second, related to the above, our model is compatible with the herding/learning models of customer behavior. It is quite likely that both forces, discipline and learning, are present when customers react to news. Those who are disciplining react directly to the signal, while those who are trying to learn the “true state” of the investment may react to how others reacted. However, learning of others’ reactions is important only when there is complementarity among customers such as stocks, and it is not important if the return is independent of the number of
investors, such as mutual funds. Still, it is possible that some people act in mutual fund market as if it is a stock market.

4 Firm-Level Evidence

In this section we provide empirical evidence of asymmetry of the reputation dynamic for a firm where the reputation loss occurred by a random Bad signal. Although we have shown a variety of equilibria in the previous section, there is a common property of the equilibrium paths such that the loss of reputation is immediate while the recovery is slow unless a “push” by another firm’s bad signal occurs.

To test our theory of the asymmetry of reputation dynamic, we want a case such that there are comparable funds to invest and investors’ moving cost among funds is not so large. We use the Swedish public pension system’s mutual fund investment data. From year 2000, the Swedish mandatory pension system requires each individual to actively manage a small part of his/her pension. There are many comparable mutual funds available and changing the funds is free of charge through the government system. Therefore the situation for individual investor fits our model well. Moreover, one fund management company, Skandia Fonder, was part of a corporation that had a scandal. Even though the mutual funds and the fund management company were not implicated in the scandal at all, the scandal news were a strong (although imperfect) signal of a bad reputation.

4.1 Skandia Scandals

Skandia AB was established as a casualty insurance company in 1855. Over the years it diversified into life insurance, unit-linked insurance, mutual fund management, and retail banking. Benefiting from the rising stock markets, Skandia AB had by the end of the 1990’s grown into one of the largest global actors in the long-terms savings industry. In year 2000 Skandia AB was valued at over 20 billion USD, making it the second largest Swedish listed firm. Its subsidiaries included firms offering unit-link savings (Skandia AFS) and life insurance (Skandia Life), a bank (Skandia Banken), as well as an asset management firm (Skandia Asset Management, or SAM) and a mutual fund firm (Skandia Fonder).

Although Skandia AB was a hugely popular firm in 2000, media turned critical when Skandia
AB announced the sale of its asset management firm (SAM) to the Norwegian bank DnB for SEK 3.2 billion (approximately USD 320 million) in January 2002. The reason for the media outcry was that industry observers felt the sale would indirectly hurt the customers of the life insurance business of Skandia AB – Skandia Life. The worth of an asset management company is largely determined by its long-term asset management contracts, and it was estimated that two-thirds of the value of SAM came from a contract with the policy holders in Skandia Life. However, all sales proceeds went directly to Skandia AB rather than to Skandia Life. While Skandia Life is an incorporated firm, its bylaws stipulates that it is run as a mutual firm which means that it cannot pay dividend to its owners when there is a surplus, but returns all profits to its policyholders. Subsequent investigations exonerated Skandia AB of any wrongdoing, but industry pundits interpreted the SAM deal as a way for Skandia AB to extract assets from Skandia Life, a practice that was widely seen as opportunistic.

In the April 2002 annual shareholders meeting, the management incentive programs of Skandia AB became intensely debated. A large institutional owner of Skandia AB published a debate article in one of the largest Swedish dailies stating their intention to vote against the suggested incentive program because they found it too expensive and not sufficiently related to the performance of the managers. Following this there was scattered media coverage of Skandia AB and its incentive programs during the entire spring. This was the first ‘Skandia scandal’, but worse events would come later.

In October 2002, there were media reports about ‘apartment dealings’ of the management of Skandia AB. To place this allegation in context, rental apartments in central Stockholm are extremely difficult to get. The market for such contracts has long been under government control, so contracts for rental apartments in central Stockholm are extremely valuable and often carry a hint of patronage. In this particular case the luxury apartment of the financial director of Skandia AB was to be renovated at the expense of Skandia AB without a commensurate raise in the rental cost. While this specific renovation was called off due to the bad publicity it generated for Skandia AB, the media subsequently uncovered a number of other apartment dealings. The most frequent type involved top-level managers at Skandia AB providing their children with rental apartments in real estate owned by Skandia AB. Public outrage was further fuelled by the memory of the recent management compensation debate, which created an impression of
personal enrichment at the expense of the firm. In November 2002 one of the largest business weeklies reported from a poll of a number of market analysts that most of them had no confidence left for the CEO of Skandia AB.

In March 2003, the life insurance subsidiary of Skandia AB, Skandia Life, commissioned an independent investigation into the dealings of Skandia AB and Skandia Life, in particular the sale of SAM to DnB. At the April 2003 annual shareholders meeting of Skandia AB the shareholders forced another independent investigation into the generous incentive program and the apartment ‘scandals.’ The CEO of Skandia AB was fired the day after this shareholder meeting. In September 2003 the Skandia Life investigation presented allegations of wrongdoing by Skandia AB in the sale of SAM. In October, the lawyer leading the Skandia AB investigation into the apartment dealings announced as a preliminary finding that the number of hidden deals involving luxury renovations of the apartments of the management of Skandia AB was much higher than earlier reported in media. This drew intense media attention and the chief prosecutor of Sweden placed the earlier management of Skandia AB under criminal investigation in the following week.

The report on the apartment dealings was released at the end of December 2003, at which media coverage of Skandia AB peaked. A key finding was that the management had extracted larger bonuses than the board had sanctioned, and as a consequence the chairman of the board resigned and an extraordinary shareholder meeting was called for January 2004. Just before the end of the year, Skandia AB filed a lawsuit against its former CEO, finance director, and chairman of the board. In January 2004 a public interest group filed a class action suit against the sale of SAM by Skandia AB. In February 2004 Skandia Life, after pressure from the consumers’ ombudsman, among others, decided to take Skandia AB to arbitration for SEK 2 billion of the 3.2 billion SAM sales proceeds.

These events caused media attention to Skandia AB to be significantly higher than normal during 2002 - 2004, and public confidence in Skandia AB was seriously eroded by the negative publicity. An annual survey of the perceived quality of firms by Swedish consumers (Swedish Quality Index) reported a drop of confidence in the pension operations of Skandia AB of almost twenty points from 2000 to 2004, which is the largest recorded drop in confidence ratings by any firm since measurement began in 1988. Partly as a consequence, Skandia AB was acquired by
the South African insurance firm Old Mutual in 2005.

It is important to note that all the scandal events occurred around a few individuals at the helm of Skandia AB – the CEO, the CFO, and a few other managers. None of the board members or managers of the subsidiaries of Skandia AB were implicated in these stories. In this paper we investigate the transactions of mutual funds under the name “Skandia”, but for three reasons such mutual funds have nothing to do with the above mentioned scandals. First, they were managed by an independent company called Skandia Fonder, and the board members of Skandia Fonder do not overlap with those of Skandia AB. Second, a mutual fund in Sweden, unlike a life insurance or pension fund, is not allowed to own real estate. Thus, it is impossible to have the same type of scandal at Skandia Fonder. Third, the mutual funds under the Skandia brand did not own disproportionately more of the stocks of the scandal-hit firm Skandia AB than other mutual funds. Hence even if the portfolio of the mutual funds may be affected by the scandals, the effect would be the same as other funds investing in Swedish stock. There is thus no rational reason to suspect that the scandals would affect the mutual funds’ performance.

4.2 Data and descriptive analysis

We examine mutual fund transactions in funds with the Skandia brand under the Swedish public pension plan. We obtained data on mutual fund transactions from the Swedish public pension authority *Premiepensions Myndigheten* (PPM). This is the governmental authority that manages the system of mandated individual pension savings that is a part of the new Swedish pension system. In year 2000, the Swedish mandatory pension system was changed from pay-as-you-go where the state managed the entire pension to a defined contribution system where the individual is expected to actively manage a small part of his/her pension (Sunden [23] and Horngren [13]). Two and a half percent of the annual income of every working Swede is put into an individual account, from which the person invests into a set of mutual funds. The PPM acts as a middleman between the individual investor who controls an account with accumulated pension rights and the mutual fund management firm that has a fund registered within the PPM system. The pension rights of an individual must be fully invested at all times – there is no provision for directly holding cash in the system. As a result, all sales of funds in the PPM system are simultaneously purchases of shares in other funds.

Individual investors can change the funds they are currently investing in without paying a
fee. The PPM accumulates the daily trades per fund, executes these as batch orders, and keeps records of the transactions. Thus the mutual fund management firm does not know the identity of each investor, only the PPM has this information.

PPM provided us with daily transaction data per mutual fund from October 2000 (when the system became operational) through December 2007. We also received information on the monthly yield of each mutual fund, its category, and its size at the start of each month. In order to focus the analysis on transactions initiated by individuals from existing funds, the data exclude transactions that were initiated by the PPM when new pension funds are allocated (PPM allocates new money according to an allocation key determined by each individual). The analysis omits the initial period of the PPM system (Oct.-Dec. 2000) and the first 90 days of any fund in order to eliminate the settling-in period when the pension money was initially allocated and a new fund becomes available. Except for these deletions, all available observations are used. The daily transaction data are aggregated to weekly sums of fund sales (outflows) and net flows (buys minus sales) in order to simplify the estimation of lagged effects of news. Preliminary analysis showed that scandal news affected mutual fund flows for two weeks, which is captured by entering the first and second lag of the weekly number of scandal news in the weekly data. The natural logarithm of sales and net flows is analyzed in order to reduce skew (for negative net flows, this involves taking the logarithm of the absolute value of the flow).

The mutual fund data are supplemented by news reports from the most widely read daily business newspaper (Dagens Industri) and the most widely read daily general newspaper (Dagens Nyheter) from January 2001 through September 2006. A text search for Skandia and reading of each article was used to code each occurrence of the phrase ‘the Skandia scandal’, and these were counted for each week of the sample period.

Other variables in the regressions are selected for the potential relevance to buy and sell activity in mutual funds. Monthly yield is the most recent monthly yield, in percent, of the fund. Ln value is the logarithm of the fund size in Swedish Kronor. Ln fund tenure is the logarithm of the time in days that the fund has existed in the PPM system. Fund type is captured through the indicator variables Interest Bearing and Mixed (the omitted category is Equity). Fund focus was coded through the indicator variables Europe, Other Region, and Industrial (the omitted category is Sweden). Some analyses replace two type and focus indicator
variables by an indicator variable for each fund. Table 5 in Appendix B shows the descriptive statistics of the dataset.

Figure 3 shows the sum of weekly sales (left) and net flows (right) of Skandia brand funds expressed as a proportion of the size of the funds at the start of each month, with a count of scandal mentions in the press per week superimposed. To avoid effects of changes in the composition of funds, only funds that existed throughout the sample period are graphed.

There is sustained press attention to the Skandia scandals from October 2002 through February 2005. Before that period there are two scandal mentions, and afterwards there are intermittent scandal mentions but never again more than two mentions in a single week. To separate the heated attention periods and other periods, we later use an indicator variable “scandal phase” for the periods from October 2002 through February 2005 as a control variable.

The graph of sales shows some peaks apparently unrelated to the scandals, but a lengthy run of sales during the early scandal phase followed by two smaller runs starting at the end of the scandal phase and midway through the post-scandal phase, respectively. These sales runs are matched by runs of negative net flows in the right graph, and comparison with the reference line (zero flow) shows that there is negative net flow for most of the time after the scandal broke. Descriptively it appears like Skandia brand mutual funds suffered sales and negative net flows as a consequence of the scandals in Skandia AB.
Figure 4: Comparison of excess return rates with other funds

Figure 4 shows that Skandia brand funds (two left-most lines) had similar performance compared to other funds in terms of return rates. The average 3-month excess daily returns per fund manager over the whole data period was normalized to 0 and selected large fund managers’ (Skandia, Handelsbanken, Storebrand, Folksam and Robur) average excess return rates were plotted for the pre-peak period (Jan. 2001 - June 2004) and post-peak period (July 2004 - Dec. 2007). The cut was made in the mid-point of the scandal phase, to check if fund managers did not shirk after the outbreak of the scandal. The mean and the 5% confidence intervals are shown. All fund managers’ averages are statistically indistinguishable from the market average return rate.10

In sum, we see in these figures that Skandia funds are negatively affected by a Bad signal even though their managers do not perform worse than others. For a more rigorous analysis, we next estimate regression models.

4.3 Method

Modeling mutual fund flow is often done through successive cross-sectional regressions with fund characteristics such as past performance, investment style, and fee as independent vari-

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10Table 6 in Appendix B shows the excess returns for all fund managers. Some smaller or more specialized fund managers do have average excess returns that differ from zero either positively or negatively in the relevant time period.
ables (Fama and MacBeth [7], Berk and Green [4]). Our question concerns the effect of new information (i.e., news about a scandal) on the flow of money to mutual funds rather than the average influence of for instance fee or performance. This brings our modeling needs closer to another line of finance studies that investigates the effect of new information on investor behavior (e.g., Maheu and Mc Curdy [19]). As in this literature, we need models that capture the effects of news items on the demand for a security over short time periods. The supply of stock is constant in the short term, making price changes the best measure of demand changes, but the supply of open mutual fund shares is elastic, making fund inflows and outflows the best measure of demand changes.

We found that the time series of fund sales and net flows have serial correlation in the expectation, which we model through an autoregressive model with first and second-degree terms (an AR(2) model). The time series also have persistence in the volatility term, which we model through a GARCH (1,1) specification (Bollerslev [5]). We used preliminary testing to verify that the AR(2) model with two autoregressive terms fit better than AR(1) and no worse than AR(3). Models replacing the autoregressive terms with moving-average terms had worse fit than the autoregressive model. The final model is:

$$y_t = \beta X_{t-1} + \rho_1 y_{t-1} + \rho_2 y_{t-2} + \varepsilon_t \sigma_t,$$

where $y$ is the dependent variable, $X$ are the independent variables with associated coefficients $\beta$, and $\rho_i$ are the autocorrelation coefficients, as in the usual autoregressive model. The time unit is a week. The error term $\varepsilon$ is multiplied with the volatility term $\sigma_t$ specified as:

$$\sigma_t^2 = \omega_1 + \omega_2 \varepsilon_{t-1}^2 \sigma_{t-1}^2 + \omega_3 \sigma_{t-1}^2.$$  

Theoretically, the autoregression can be due to herding/learning, or the endogeneity of the meaning of the news, as we discussed in Section 3.4. By controlling for this, we can show an additional factor to the fund sales and net flows due to investor movements directly responding to the scandal news.

4.4 Punishment Analysis

The first set of analyses are shown in Tables 1 and 2. This analysis is designed to distinguish the immediate punishment following press mentions of the scandal from the longer term punishment represented by the scandal and post-scandal phase. Immediate punishment would be seen
<table>
<thead>
<tr>
<th>Funds</th>
<th>All funds</th>
<th>All funds</th>
<th>Long lived</th>
<th>Only equity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Indicators</strong></td>
<td><strong>Category</strong></td>
<td><strong>Fund</strong></td>
<td><strong>Category</strong></td>
<td><strong>Category</strong></td>
</tr>
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<td>Monthly yield</td>
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<td>-0.122</td>
<td>-0.403</td>
<td>-1.009</td>
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<tr>
<td></td>
<td>(1.97)*</td>
<td>(0.28)</td>
<td>(0.87)</td>
<td>(2.30)**</td>
</tr>
<tr>
<td>Ln value</td>
<td>0.439</td>
<td>-0.036</td>
<td>0.782</td>
<td>0.497</td>
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<tr>
<td></td>
<td>(8.26)**</td>
<td>(0.28)</td>
<td>(18.00)**</td>
<td>(10.23)**</td>
</tr>
<tr>
<td>Ln tenure</td>
<td>2.085</td>
<td>2.342</td>
<td>1.980</td>
<td>2.190</td>
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<tr>
<td></td>
<td>(16.82)**</td>
<td>(20.52)**</td>
<td>(20.26)**</td>
<td>(18.04)**</td>
</tr>
<tr>
<td>Scandals</td>
<td>0.023</td>
<td>0.034</td>
<td>0.029</td>
<td>0.020</td>
</tr>
<tr>
<td></td>
<td>(1.98)*</td>
<td>(2.78)**</td>
<td>(2.27)*</td>
<td>(1.49)</td>
</tr>
<tr>
<td>Scandals, lag 2</td>
<td>0.028</td>
<td>0.030</td>
<td>0.035</td>
<td>0.025</td>
</tr>
<tr>
<td></td>
<td>(2.49)*</td>
<td>(2.60)**</td>
<td>(3.05)**</td>
<td>(2.03)*</td>
</tr>
<tr>
<td>Scandal period</td>
<td>1.311</td>
<td>0.594</td>
<td>0.710</td>
<td>0.986</td>
</tr>
<tr>
<td></td>
<td>(6.95)**</td>
<td>(4.20)**</td>
<td>(4.74)**</td>
<td>(5.42)**</td>
</tr>
<tr>
<td>Post-scandal per.</td>
<td>1.459</td>
<td>0.795</td>
<td>0.784</td>
<td>1.108</td>
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<tr>
<td></td>
<td>(6.28)**</td>
<td>(4.41)**</td>
<td>(4.28)**</td>
<td>(4.99)**</td>
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<td></td>
<td>(12.55)**</td>
<td>(2.84)**</td>
<td>(19.31)**</td>
<td>(14.26)**</td>
</tr>
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<td>Observations</td>
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<td>4164</td>
<td>3456</td>
<td>3321</td>
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<tr>
<td>Log likelihood</td>
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<td>LR Chi2</td>
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<td>df</td>
<td>14</td>
<td>23</td>
<td>14</td>
<td>13</td>
</tr>
</tbody>
</table>

Note: In all tables, absolute values of z statistics are shown in parentheses. GARCH(1,1) model with AR(2).
* means \( P < .05 \), ** means \( P < .01 \), and + means \( P < .10 \) (in Table 4 only).

Table 1: Regression of weekly sales per Skandia brand fund

through higher sales and net outflows following scandal mentions; lengthy punishment would be seen through higher sales and net outflows in the time periods after the scandal broke.

There is evidence of both immediate and lengthy punishment. In Table 1, both one week and two weeks lags of scandal mentions result in a significant increase in sales in the full dataset. This effect is preserved when the indicators for fund category (type and focus) are replaced with individual fund indicator variables in the next column, and when the data are restricted to only long-lived (third column) and equity funds (fourth column). The net flow analysis shows a similar result, though in that analysis only the second lag has a significant effect on outflows (except in the model with individual fund indicator variables). Hence we can say that
<table>
<thead>
<tr>
<th>Funds</th>
<th>All funds</th>
<th>All funds</th>
<th>Long lived</th>
<th>Only equity</th>
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</thead>
<tbody>
<tr>
<td><strong>Indicators</strong></td>
<td><strong>Category</strong></td>
<td><strong>Fund</strong></td>
<td><strong>Category</strong></td>
<td><strong>Category</strong></td>
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<tr>
<td>Monthly yield</td>
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<td></td>
<td>(5.81)**</td>
<td>(0.18)</td>
<td>(5.96)**</td>
<td>(5.55)**</td>
</tr>
<tr>
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<td>1.157</td>
<td>-4.486</td>
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<td></td>
<td>(31.12)**</td>
<td>(5.20)**</td>
<td>(26.90)**</td>
<td>(29.18)**</td>
</tr>
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<td>Ln tenure</td>
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<td>-2.021</td>
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</tr>
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<td></td>
<td>(5.73)**</td>
<td>(7.55)**</td>
<td>(6.12)**</td>
<td>(7.52)**</td>
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<tr>
<td>Scandals</td>
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<td>0.015</td>
<td>-0.005</td>
<td>-0.004</td>
</tr>
<tr>
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<td>(0.70)</td>
<td>(0.72)</td>
<td>(0.19)</td>
<td>(0.14)</td>
</tr>
<tr>
<td>Scandals, lag 2</td>
<td>-0.071</td>
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<td>-0.065</td>
<td>-0.063</td>
</tr>
<tr>
<td></td>
<td>(3.01)**</td>
<td>(0.44)</td>
<td>(2.78)**</td>
<td>(2.67)**</td>
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<tr>
<td>Scandal period</td>
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<td>-5.318</td>
<td>-2.996</td>
<td>-3.006</td>
</tr>
<tr>
<td></td>
<td>(10.85)**</td>
<td>(15.11)**</td>
<td>(9.19)**</td>
<td>(8.80)**</td>
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<tr>
<td>Post-scandal per.</td>
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<td>-2.496</td>
<td>-2.718</td>
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<tr>
<td></td>
<td>(6.96)**</td>
<td>(15.91)**</td>
<td>(6.18)**</td>
<td>(6.55)**</td>
</tr>
<tr>
<td>Constant</td>
<td>74.933</td>
<td>2.533</td>
<td>88.372</td>
<td>77.296</td>
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<td>(0.90)</td>
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<td>Observations</td>
<td>4164</td>
<td>4164</td>
<td>3456</td>
<td>3321</td>
</tr>
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<td>Log likelihood</td>
<td>-13182.67</td>
<td>-13053.27</td>
<td>-10394.98</td>
<td>-9919.95</td>
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<td>LR Chi2</td>
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<td>2218.33</td>
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<tr>
<td>df</td>
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<td>23</td>
<td>14</td>
<td>13</td>
</tr>
</tbody>
</table>

Table 2: Regression of weekly net flow per Skandia brand fund

punishment happens quickly.

The time-period variables also suggest lengthy punishment. In Table 1, both the scandal and post-scandal phase show inflated sales in all four models. In Table 2, both the scandal and post-scandal phase show higher net outflows in all four models. As the graphs suggested, the sales and outflows are not appreciably weaker in the post-scandal phase, suggesting that there is very little – if any – recovery. Next we turn to an investigation with a new variable of the scandal effect in order to get more precise answers on whether and how recovery occurs.

### 4.5 Recovery Analysis

For the recovery analysis, we made a new variable (named “Total scandals”) that measures the effect of scandal mentions with fading weights on the distant past. To incorporate the distance in
<table>
<thead>
<tr>
<th>Funds</th>
<th>All funds</th>
<th>All funds</th>
<th>Long lived</th>
<th>Only equity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indicators</td>
<td>Category</td>
<td>Fund</td>
<td>Category</td>
<td>Category</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monthly yield</td>
<td>-0.872</td>
<td>-0.123</td>
<td>-0.403</td>
<td>-1.025</td>
</tr>
<tr>
<td></td>
<td>(1.98)*</td>
<td>(0.28)</td>
<td>(0.88)</td>
<td>(2.33)*</td>
</tr>
<tr>
<td>Ln value</td>
<td>0.439</td>
<td>-0.033</td>
<td>0.783</td>
<td>0.500</td>
</tr>
<tr>
<td></td>
<td>(8.25)**</td>
<td>(0.25)</td>
<td>(18.05)**</td>
<td>(10.27)**</td>
</tr>
<tr>
<td>Ln tenure</td>
<td>2.081</td>
<td>2.346</td>
<td>1.973</td>
<td>2.173</td>
</tr>
<tr>
<td></td>
<td>(16.56)**</td>
<td>(20.38)**</td>
<td>(19.85)**</td>
<td>(17.60)**</td>
</tr>
<tr>
<td>Scandal mentions</td>
<td>0.024</td>
<td>0.034</td>
<td>0.029</td>
<td>0.021</td>
</tr>
<tr>
<td></td>
<td>(1.98)*</td>
<td>(2.70)**</td>
<td>(2.30)*</td>
<td>(1.58)</td>
</tr>
<tr>
<td>Scandals, lag 2</td>
<td>0.028</td>
<td>0.029</td>
<td>0.036</td>
<td>0.026</td>
</tr>
<tr>
<td></td>
<td>(2.48)*</td>
<td>(2.55)*</td>
<td>(3.07)**</td>
<td>(2.12)*</td>
</tr>
<tr>
<td>Scandal phase</td>
<td>1.306</td>
<td>0.602</td>
<td>0.700</td>
<td>0.967</td>
</tr>
<tr>
<td></td>
<td>(6.86)**</td>
<td>(4.17)**</td>
<td>(4.60)**</td>
<td>(5.26)**</td>
</tr>
<tr>
<td>Post-scandal ph.</td>
<td>1.464</td>
<td>0.789</td>
<td>0.790</td>
<td>1.124</td>
</tr>
<tr>
<td></td>
<td>(6.28)**</td>
<td>(4.36)**</td>
<td>(4.30)**</td>
<td>(5.04)**</td>
</tr>
<tr>
<td>Total scandals</td>
<td>0.002</td>
<td>-0.002</td>
<td>0.003</td>
<td>0.006</td>
</tr>
<tr>
<td></td>
<td>(0.22)</td>
<td>(0.28)</td>
<td>(0.36)</td>
<td>(0.70)</td>
</tr>
<tr>
<td>Constant</td>
<td>-12.821</td>
<td>-4.925</td>
<td>-18.038</td>
<td>-14.268</td>
</tr>
<tr>
<td></td>
<td>(12.54)**</td>
<td>(2.89)**</td>
<td>(19.31)**</td>
<td>(14.22)**</td>
</tr>
<tr>
<td>Observations</td>
<td>4164</td>
<td>4164</td>
<td>3456</td>
<td>3321</td>
</tr>
<tr>
<td>Log likelihood</td>
<td>-6026.67</td>
<td>-5869.19</td>
<td>-4616.88</td>
<td>-4817.74</td>
</tr>
<tr>
<td>LR Chi2</td>
<td>3582.76</td>
<td>3544.94</td>
<td>3353.45</td>
<td>2682.63</td>
</tr>
<tr>
<td>df</td>
<td>15</td>
<td>24</td>
<td>15</td>
<td>14</td>
</tr>
</tbody>
</table>

Table 3: Regression of weekly sales per Skandia brand fund

In the past, we sum\(^{11}\) the counts of scandal mentions in each week with a monthly discount factor of \(r\), where we varied \(r\) between 0.1 and 0.9 in steps of 0.1 to find the factor that best fit the data. The analyses showed that large \(r\) (i.e., not fading fast, or slow recovery) best fit the data. The optimal \(r\) varied slightly between specifications and data sets, but for most specifications any \(r\) between 0.7 and 0.9 have indistinguishable fit if we apply a Bayesian criterion of a difference in BIC statistic of 6 as presenting strong evidence that the models have different fit. The models with \(r\) between 0.7 and 0.9 also have the same results. In Table 3 and Table 4 we display models that set \(r = 0.8\).

Table 3 displays the analysis of sales. The results are easy to summarize: for sales, there is

\(^{11}\)This variable counts from the third lag to avoid double counting of the first two lags.
<table>
<thead>
<tr>
<th>Funds</th>
<th>All funds</th>
<th>All funds</th>
<th>Long lived</th>
<th>Only equity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indicators</td>
<td>Category</td>
<td>Fund</td>
<td>Category</td>
<td>Category</td>
</tr>
<tr>
<td>Ln value</td>
<td>-3.298</td>
<td>-0.527</td>
<td>-4.468</td>
<td>-4.013</td>
</tr>
<tr>
<td>Ln tenure</td>
<td>-1.684</td>
<td>-2.973</td>
<td>-1.360</td>
<td>-1.120</td>
</tr>
<tr>
<td>Scandal mentions</td>
<td>0.017</td>
<td>-0.014</td>
<td>-0.009</td>
<td>-0.016</td>
</tr>
<tr>
<td>Scandals, lag 2</td>
<td>-0.047</td>
<td>-0.039</td>
<td>-0.067</td>
<td>-0.065</td>
</tr>
<tr>
<td>Scandal phase</td>
<td>-2.769</td>
<td>-2.708</td>
<td>-2.818</td>
<td>-3.447</td>
</tr>
<tr>
<td>Total scandals</td>
<td>-0.042</td>
<td>-0.030</td>
<td>-0.049</td>
<td>-0.068</td>
</tr>
<tr>
<td>Constant</td>
<td>66.660</td>
<td>30.907</td>
<td>87.101</td>
<td>77.481</td>
</tr>
<tr>
<td>Observations</td>
<td>4164</td>
<td>4164</td>
<td>3456</td>
<td>3321</td>
</tr>
<tr>
<td>Log likelihood</td>
<td>-13139.52</td>
<td>-13081.16</td>
<td>-10388.73</td>
<td>-9927.38</td>
</tr>
<tr>
<td>LR Chi2</td>
<td>1933.72</td>
<td>3520.38</td>
<td>2516.09</td>
<td>2099.02</td>
</tr>
<tr>
<td>df</td>
<td>15</td>
<td>24</td>
<td>15</td>
<td>14</td>
</tr>
</tbody>
</table>

Table 4: Regression of weekly net flow per Skandia brand fund

no effect of the total (weighted) scandals in any of the specifications. All the punishment occurs immediately, which is consistent with our theoretical model. Table 4 displays the analysis of net flows. Again the results are easy to summarize: in every specification, the total scandals variable is significant and negative. The negative coefficient means that the net flow is lower when a lot of scandal news were observed recently than when they have happened a while ago. In other words, the net flow analysis shows a gradual return of customers as the time passes since the Bad signal, as our theory predicts. Because we know from Table 3 that existing customers (who can sell) do not react to the recency of scandals, it is a result of new customers purchasing Skandia funds. These findings are also consistent with our theory.
5 Concluding Remarks

We have provided a simple model of endogenous partner changes and showed that although loss of reputation is fast, recovery is slow due to the endogenous partnership formation. Our model extends the endogenous partnership literature to allow many-to-one relationships and imperfect monitoring. Our equilibrium analysis complements the literature of asymmetric fluctuations of economic variables by providing a new source of asymmetry.

Our model is completely symmetric across various states of an investor: newcomers and customers with different observations have the same payoff structure and same activity level (there is no inactive player). Thus, we have shown asymmetry in movements of investors even under a quite symmetric model, which is theoretically quite interesting.

To support this theory, we also gave firm-level empirical evidence. Needless to say, the empirical evidence cannot provide support to every detail of the model. For example, we cannot distinguish whether investors who buy the Skandia funds are “newcomers” to the market or “movers” from other funds. This is because the data has aggregated daily sales by fund, and does not contain personal histories of transactions. In the data there is no other fund with a similar Bad signal during this period, and our model (taken literally) would predict that all buyers are newcomers. However, it is possible that “old” investors who have been active in the market decided to buy Skandia funds, which is a rational behavior as well, since all funds have similar performance. We did not include this possibility in the model simply because it would complicate the model and the equilibrium analysis. As the weaker punishment equilibria in Section 3.3 show, if there is enough loss of customers after a Bad signal, movers can also come even if no other firm had a Bad signal.

To conclude this paper we discuss possible theoretical extensions. Some extensions do not change the fundamental result of asymmetry while others may.

One may be unhappy about the pure-strategy equilibrium where investors are in fact indifferent between punishing and not punishing. The indifference can be broken if a slight synergy is included in the return of investment: the payoff of investment is increased as the measure of customers of the firm increases. Under this supermodularity, the punishment phase becomes a coordination game so that if one expects that other customers move out of the firm, one’s strict best response is to move out as well. In other words, we have shown the effort equilibrium even
without this synergy among investors.

If we allow the synergy among investors, we can also include the cost of moving to another firm, since one strictly prefers moving out after a Bad signal to staying. If the cost of changing firms is small enough, one still wants to move out.

We can extend our model to address business cycles as well. Since we did not specify the reason of a Bad signal, it can be due to the state of the economy. In that case we just allow multiple firms to get a Bad signal simultaneously even if they were making effort. Investors either move to those which are not affected, or stop investing. The latter can be also embedded in the model by adding an artificial “firm” with the meaning of stop investing, until a sign of good economy appears. Then our logic implies that once people stopped investing, it is difficult to come back to it. This also makes recovery difficult, and the story is quite similar to the endogenous information model.

Next, consider population size change. As we found in the empirical data, it is possible that new firms enter the market and/or the population size of investors change over time. Entry of new firms would negatively affect a firm with a Bad signal since fewer newcomers would choose each firm. Thus the all-effort equilibrium would hold more easily but recovery will be slower. Growth of investor population on the other hand benefits a firm with a Bad signal since more newcomers would choose each firm and thus recovery is faster.

However, the payoff structure of firms is crucial in our analysis. Our computation method depends on the linearity of a firm’s payoff on the customer measure. If a firm’s payoff is not linear in the measure of its customers, for example if a firm can save effort cost as the customer size increases by the scale merit, then the computation in the proof of Proposition 1 fails. Endogenous movements of investors make it very difficult to explicitly solve for the total payoff of the dynamic game when this linearity is dropped. In fact, the proof of Proposition 1 is the first one that clearly solved such a dynamic game.

Finally, allowing heterogenous firms is also a complex extension. It is possible that investors have a subjective ranking among firms. (If there is an objective ranking of firms, there is no reason that lower ranked firms survive under competition.) Subjective ranking induces investor-specific movements among firms for each signal history, which will probably make the model intractable.
References


Appendix A  Proofs

Proof of Proposition 1:

Investor: As we argued in the text, investors are ex-ante indifferent among firms when all firms follow the equilibrium strategy.

Firm: Although we simplified the strategy combination as much as possible, the signal structure makes a firm’s long-run payoff heavily affected by other firms’ signal histories by the movement of investors. In fact the individual firm’s value function is not solvable on its own measure of customers. However, as we show below, the distribution of investors as a vector has a recursive structure.

Let $x(t) = (x_1(t), x_2(t), \ldots, x_N(t))$ be the share distribution of investors across firms $\{1, 2, \ldots, N\}$ at the beginning of period $t = 1, 2, \ldots$. By the initial random choice of firms, $x(1) = (\frac{1}{N}, \ldots, \frac{1}{N})$.

Let $M((x_1, x_2, \ldots, x_N)'')$ be the $N$-dimensional (column) vector of total discounted expected measure of customers of all firms, starting with the investor distribution $(x_1, x_2, \ldots, x_N)$ (where $\sum_j x_j = 1$). (However, for notational convenience we allow $M$ to be defined over any $N$-dimensional column vector.) As we explained in the text, $M(x')$ is recursive as in (3), which can be further arranged as follows.

$$M \left( \begin{array}{c} x_1 \\ x_2 \\ \vdots \\ x_N \end{array} \right) = \begin{pmatrix} x_1 \\ x_2 \\ \vdots \\ x_N \end{pmatrix} + \beta (1 - \epsilon) \left[ \delta M \left( \begin{array}{c} x_1 \\ x_2 \\ \vdots \\ x_N \end{array} \right) + (1 - \delta) M \left( \begin{array}{c} 1/N \\ 1/N \\ \vdots \\ 1/N \end{array} \right) \right]$$

$$+ \beta \frac{\epsilon}{N} \left[ \delta M \left( \begin{array}{c} x_1 \\ x_2 \\ \vdots \\ x_N \end{array} \right) + (1 - \delta) M \left( \begin{array}{c} 1/N \\ 1/N \\ \vdots \\ 1/N \end{array} \right) + \delta M \left( \begin{array}{c} -x_1 \\ x_1/(N-1) \\ \vdots \\ x_1/(N-1) \end{array} \right) \right] + \cdots +$$
\[ \beta \epsilon \frac{\eta}{N} \left[ \delta M \left( \begin{array}{c} x_1 \\ x_2 \\ \vdots \\ x_N \\ \end{array} \right) + (1 - \delta) M \left( \begin{array}{c} 1/N \\ 1/N \\ \vdots \\ 1/N \\ \end{array} \right) + \delta M \left( \begin{array}{c} x_N/(N-1) \\ \vdots \\ -x_N \\ \end{array} \right) \right], \quad (8) \]

and therefore,

\[
M \left( \begin{array}{c} x_1 \\ x_2 \\ \vdots \\ x_N \\ \end{array} \right) = \left( \begin{array}{c} x_1 \\ x_2 \\ \vdots \\ x_N \\ \end{array} \right) + \beta \left[ \delta M \left( \begin{array}{c} x_1 \\ x_2 \\ \vdots \\ x_N \\ \end{array} \right) + (1 - \delta) M \left( \begin{array}{c} 1/N \\ 1/N \\ \vdots \\ 1/N \\ \end{array} \right) \right] + \beta \epsilon \frac{\eta}{N} \delta M \left( \begin{array}{c} -x_1 + \sum_{j \neq 1} x_j/(N-1) \\ -x_2 + \sum_{j \neq 2} x_j/(N-1) \\ \vdots \\ -x_N + \sum_{j \neq N} x_j/(N-1) \\ \end{array} \right). 
\]

Using \( \sum_j x_j = 1 \), we have

\[
M \left( \begin{array}{c} x_1 \\ x_2 \\ \vdots \\ x_N \\ \end{array} \right) = \left( \begin{array}{c} x_1 \\ x_2 \\ \vdots \\ x_N \\ \end{array} \right) + \beta \left[ \delta M \left( \begin{array}{c} x_1 \\ x_2 \\ \vdots \\ x_N \\ \end{array} \right) + (1 - \delta) M \left( \begin{array}{c} 1/N \\ 1/N \\ \vdots \\ 1/N \\ \end{array} \right) \right] + \beta \epsilon \frac{\eta}{N} \delta M \left( \begin{array}{c} -x_1 + (1 - x_1)/(N-1) \\ -x_2 + (1 - x_2)/(N-1) \\ \vdots \\ -x_N + (1 - x_N)/(N-1) \\ \end{array} \right). 
\]

Hence the long-run measure of customers is independent from the initial measure of other firms' customers. This is because all firms have the same random signal structure.

By further rearrangements we get

\[
M \left( \begin{array}{c} x_1 \\ x_2 \\ \vdots \\ x_N \\ \end{array} \right) = \left( \begin{array}{c} x_1 \\ x_2 \\ \vdots \\ x_N \\ \end{array} \right) + \beta \left[ \delta M \left( \begin{array}{c} x_1 \\ x_2 \\ \vdots \\ x_N \\ \end{array} \right) + (1 - \delta) M \left( \begin{array}{c} 1/N \\ 1/N \\ \vdots \\ 1/N \\ \end{array} \right) \right] + \beta \epsilon \frac{\eta}{N} \left[ M \left( \begin{array}{c} 1/(N-1) \\ 1/(N-1) \\ \vdots \\ 1/(N-1) \\ \end{array} \right) - \frac{N}{N-1} M \left( \begin{array}{c} x_1 \\ x_2 \\ \vdots \\ x_N \\ \end{array} \right) \right]. 
\]
\[
\begin{pmatrix}
  x_1 \\
  x_2 \\
  \vdots \\
  x_N
\end{pmatrix} + \beta \delta M \left( \begin{pmatrix}
  x_1 \\
  x_2 \\
  \vdots \\
  x_N
\end{pmatrix} \right) + \beta (1 - \delta) M \left( \begin{pmatrix}
  1/N \\
  1/N \\
  \vdots \\
  1/N
\end{pmatrix} \right) + \beta \delta \frac{\epsilon}{N-1} M \left( \begin{pmatrix}
  x_1 \\
  x_2 \\
  \vdots \\
  x_N
\end{pmatrix} \right) - \beta \delta \frac{\epsilon}{N-1} M \left( \begin{pmatrix}
  1/N \\
  1/N \\
  \vdots \\
  1/N
\end{pmatrix} \right) + \beta \delta \epsilon N^{-1} M \left( \begin{pmatrix}
  1/N \\
  1/N \\
  \vdots \\
  1/N
\end{pmatrix} \right).
\]

Finally, multiplying both sides with \((N - 1)\) and moving \(M((x_1, \ldots, x_N)')\) to the LHS, we have an explicit formula:

\[
\{(N-1)(1-\beta \delta)+\beta \delta \epsilon\}M \left( \begin{pmatrix}
  x_1 \\
  x_2 \\
  \vdots \\
  x_N
\end{pmatrix} \right) = (N-1) \left( \begin{pmatrix}
  x_1 \\
  x_2 \\
  \vdots \\
  x_N
\end{pmatrix} \right) + \{(N-1)\beta(1-\delta)+\beta \delta \epsilon\}M \left( \begin{pmatrix}
  1/N \\
  1/N \\
  \vdots \\
  1/N
\end{pmatrix} \right).
\]

In particular, when \(x_j = 1/N\) for all \(j\), (9) gives an explicit solution such that

\[
M \left( \begin{pmatrix}
  1/N \\
  1/N \\
  \vdots \\
  1/N
\end{pmatrix} \right) = \frac{1}{1-\beta} \left( \begin{pmatrix}
  1/N \\
  1/N \\
  \vdots \\
  1/N
\end{pmatrix} \right).
\]

This makes sense, since starting from the same measure of customers and with the stationary and symmetric transition rule, all firms’ total expected measure of customers must be the same and on average \(1/N\). Plugging (10) into (9), we have the total expected discounted measure of customers of firm \(j\), starting from an arbitrary distribution:

\[
M_j(x_j) = \frac{(N-1)x_j + \{(N-1)\beta(1-\delta)+\beta \delta \epsilon\} \frac{1}{(1-\beta)N}}{(N-1)(1-\beta \delta)+\beta \delta \epsilon}.
\]

For any firm \(j\) and any starting measure of customers \(x_j\), the firm does not deviate in one step if and only if

\[
L \cdot M_j(x_j) \geq H \cdot x_j + \beta L \cdot M_j \left( \frac{1-\delta}{N} \right).
\]
By (11), the above no-deviation condition (5) is equivalent to
\[
[L(N - 1) - \{(N - 1)(1 - \beta\delta) + \beta\delta\epsilon\}H]x_j \geq -\frac{\beta\delta\epsilon L}{N}.
\] (12)

When both investors and firms are very patient, \(\beta\delta \to 1\) so that the LHS of (12) converges to \(L(N - 1) - \epsilon H\)\(x_j\). Thus, if \(\epsilon \leq L(N - 1)/H\), then (12) holds for sufficiently large \((\beta, \delta)\).

\[\square\]

Proof of Corollary 1: From (10), when \(x_j = \frac{1}{N}\),
\[
L \cdot M_j\left(\frac{1}{N}\right) = \frac{L}{N(1 - \beta)}.
\] (13)
This is the equilibrium payoff of a firm.

\[\square\]

Proof of Proposition 2: Notice that the only change of \(M(\cdot)\) formulation under the new strategy combination is that, when firm \(k\) gets Bad signal, \(\delta\alpha x_k\) is the measure of movers from firm \(k\), who are distributed among \(N - 1\) other firms. Let us denote the new total discounted expected measure of customers as \(M^\alpha(\cdot)\). (8) now becomes
\[
M^\alpha\left(\begin{array}{c}
  x_1 \\
  x_2 \\
  \vdots \\
  x_N 
\end{array}\right) = M^\alpha\left(\begin{array}{c}
  x_1 \\
  x_2 \\
  \vdots \\
  x_N 
\end{array}\right) + \beta(1 - \epsilon)\left(\begin{array}{c}
  x_1 \\
  x_2 \\
  \vdots \\
  x_N 
\end{array}\right) + (1 - \delta)M^\alpha\left(\begin{array}{c}
  \frac{1}{N} \\
  \frac{1}{N} \\
  \vdots \\
  \frac{1}{N} 
\end{array}\right)
\]
\[
+ \beta\epsilon \left[\begin{array}{c}
  x_1 \\
  x_2 \\
  \vdots \\
  x_N 
\end{array}\right]
\]
\[
\delta M^\alpha\left(\begin{array}{c}
  \frac{1}{N} \\
  \frac{1}{N} \\
  \vdots \\
  \frac{1}{N} 
\end{array}\right) + (1 - \delta)M^\alpha\left(\begin{array}{c}
  \frac{1}{N} \\
  \frac{1}{N} \\
  \vdots \\
  \frac{1}{N} 
\end{array}\right) + \delta M^\alpha\left(\begin{array}{c}
  \alpha x_1/(N - 1) \\
  \alpha x_1/(N - 1) \\
  \vdots \\
  \alpha x_1/(N - 1) 
\end{array}\right)
\]
\[
+ \cdots + \beta\epsilon \left[\begin{array}{c}
  x_1 \\
  x_2 \\
  \vdots \\
  x_N 
\end{array}\right]
\]
\[
\delta M^\alpha\left(\begin{array}{c}
  \frac{1}{N} \\
  \frac{1}{N} \\
  \vdots \\
  \frac{1}{N} 
\end{array}\right) + (1 - \delta)M^\alpha\left(\begin{array}{c}
  \frac{1}{N} \\
  \frac{1}{N} \\
  \vdots \\
  \frac{1}{N} 
\end{array}\right) + \delta M^\alpha\left(\begin{array}{c}
  \alpha x_N/(N - 1) \\
  \alpha x_N/(N - 1) \\
  \vdots \\
  -\alpha x_N 
\end{array}\right)
\]
\] (14)

By similar arrangements as in the proof of Proposition 1, we have an explicit formula:
\[
\{(N - 1)(1 - \beta\delta) + \alpha\beta\delta\epsilon\}M^\alpha\left(\begin{array}{c}
  x_1 \\
  x_2 \\
  \vdots \\
  x_N 
\end{array}\right) = \{(N - 1) + \alpha(1 - \beta) + \alpha\beta\delta\epsilon\}M^\alpha\left(\begin{array}{c}
  \frac{1}{N} \\
  \frac{1}{N} \\
  \vdots \\
  \frac{1}{N} 
\end{array}\right).
\] (15)
When $x_j = 1/N$ for all $j$, we again have

$$M^\alpha \left( \begin{array}{c} 1/N \\ 1/N \\ \vdots \\ 1/N \end{array} \right) = \frac{1}{1-\beta} \left( \begin{array}{c} 1/N \\ 1/N \\ \vdots \\ 1/N \end{array} \right),$$

and thus

$$M_j^\alpha(x_j) = \frac{(N-1)x_j + ((N-1)\beta(1-\delta) + \alpha\beta\delta\epsilon)(1/(1-\beta)N)}{(N-1)(1-\beta\delta) + \alpha\beta\delta\epsilon}.$$

Therefore, the condition that firm $j$ does not deviate in one step;

$$L \cdot M_j^\alpha(x_j) \geq H \cdot x_j + \beta L \cdot M_j^\alpha(1-\delta)$$

is satisfied if and only if

$$[L(N-1) - ((N-1)(1-\beta\delta) + \alpha\beta\delta\epsilon)H]x_j \geq -\frac{\alpha\beta\delta\epsilon L}{N}.$$  \hspace{1cm} (16)

When $\beta\delta \to 1$, this condition converges to

$$[L(N-1) - \alpha\epsilon H]x_j \geq -\frac{\alpha\epsilon L}{N},$$

which is satisfied if $\epsilon \leq \frac{L(N-1)}{\alpha H}$. Hence, for any $\epsilon$, there exists $\alpha > 0$ such that no firm deviates in one step for any $\alpha \leq \alpha$. \hfill \Box
### Variable Mean Std. dev. Min Max

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std. dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ln weekly sales</td>
<td>11.343</td>
<td>2.385</td>
<td>0.000</td>
<td>16.38291</td>
</tr>
<tr>
<td>Ln weekly net flow</td>
<td>-5.421</td>
<td>10.022</td>
<td>-16.38147</td>
<td>16.05789</td>
</tr>
<tr>
<td>Fund type: Interest bearing</td>
<td>.139</td>
<td>.346</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Fund type: Mixed</td>
<td>.202</td>
<td>.402</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Fund focus: Europe</td>
<td>.134</td>
<td>.340</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Fund focus: Other region</td>
<td>.415</td>
<td>.493</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Fund focus: Industrial</td>
<td>.069</td>
<td>.253</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Monthly yield</td>
<td>.002</td>
<td>.045</td>
<td>-.239</td>
<td>.175</td>
</tr>
<tr>
<td>Ln value</td>
<td>18.147</td>
<td>1.560</td>
<td>11.609</td>
<td>20.540</td>
</tr>
<tr>
<td>Ln tenure</td>
<td>6.777</td>
<td>.745</td>
<td>4.500</td>
<td>7.678</td>
</tr>
<tr>
<td>Scandal mentions</td>
<td>.427</td>
<td>.929</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Scandals, lag 2</td>
<td>.433</td>
<td>.933</td>
<td>0</td>
<td>5</td>
</tr>
</tbody>
</table>

Note: 4164 observations, 16 funds, 299 periods for each fund that existed throughout the sample period.

Table 5: Descriptive statistics
<table>
<thead>
<tr>
<th>Fund Manager</th>
<th>Coefficient</th>
<th>Std. error</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMF pre</td>
<td>0.0000314</td>
<td>0.0000823</td>
</tr>
<tr>
<td>AMF post</td>
<td>0.000081</td>
<td>0.0000672</td>
</tr>
<tr>
<td>Carlson pre</td>
<td>6.82e-06</td>
<td>0.0000835</td>
</tr>
<tr>
<td>Carlson post</td>
<td>-0.0000367</td>
<td>0.0000604</td>
</tr>
<tr>
<td>Carnegie pre</td>
<td>0.0000532</td>
<td>0.0000685</td>
</tr>
<tr>
<td>Carnegie post</td>
<td>0.0000592</td>
<td>0.0000672</td>
</tr>
<tr>
<td>Didner pre</td>
<td>0.001258</td>
<td>0.000137</td>
</tr>
<tr>
<td>Didner post</td>
<td>0.000027</td>
<td>0.000132</td>
</tr>
<tr>
<td>Enter pre</td>
<td>0.0000179</td>
<td>0.000137</td>
</tr>
<tr>
<td>Enter post</td>
<td>0.0000375</td>
<td>0.000132</td>
</tr>
<tr>
<td>Finter pre</td>
<td>0.0002187</td>
<td>0.0001562</td>
</tr>
<tr>
<td>Finter post</td>
<td>0.0003076</td>
<td>0.000137</td>
</tr>
<tr>
<td>Folksam pre</td>
<td>-0.0000395</td>
<td>0.0000416</td>
</tr>
<tr>
<td>Folksam post</td>
<td>0.000043</td>
<td>0.0000399</td>
</tr>
<tr>
<td>Handelsbanken pre</td>
<td>-0.0000212</td>
<td>0.0000487</td>
</tr>
<tr>
<td>Handelsbanken post</td>
<td>0.000166</td>
<td>0.000048</td>
</tr>
<tr>
<td>HQ pre</td>
<td>-0.0000884</td>
<td>0.0000791</td>
</tr>
<tr>
<td>HQ post</td>
<td>2.07e-06</td>
<td>0.0000772</td>
</tr>
<tr>
<td>Ikano pre</td>
<td>-0.0000709</td>
<td>0.000137</td>
</tr>
<tr>
<td>Ikano post</td>
<td>0.0000104</td>
<td>0.000132</td>
</tr>
<tr>
<td>Kaupthing pre</td>
<td>-0.0001476*</td>
<td>0.0000685</td>
</tr>
<tr>
<td>Kaupthing post</td>
<td>-0.0000933</td>
<td>0.0000823</td>
</tr>
<tr>
<td>Lansforsakringer pre</td>
<td>-0.0002152**</td>
<td>0.0000618</td>
</tr>
<tr>
<td>Lansforsakringer post</td>
<td>-0.000119</td>
<td>0.0000666</td>
</tr>
<tr>
<td>Moderna pre</td>
<td>0.000245+</td>
<td>0.0001276</td>
</tr>
<tr>
<td>Moderna post</td>
<td>0.0000228+</td>
<td>0.0000951</td>
</tr>
<tr>
<td>Morgan Stanley pre</td>
<td>0.0002071**</td>
<td>0.0000409</td>
</tr>
<tr>
<td>Morgan Stanley post</td>
<td>0.0000254</td>
<td>0.0000502</td>
</tr>
<tr>
<td>Nordea pre</td>
<td>5.08e-06</td>
<td>0.0000608</td>
</tr>
<tr>
<td>Nordea post</td>
<td>-0.0000365</td>
<td>0.0000546</td>
</tr>
<tr>
<td>Robur pre</td>
<td>-0.0000538</td>
<td>0.0000465</td>
</tr>
<tr>
<td>Robur post</td>
<td>0.0000241</td>
<td>0.0000419</td>
</tr>
<tr>
<td>Skandia pre</td>
<td>-0.0000769</td>
<td>0.0000559</td>
</tr>
<tr>
<td>Skandia post</td>
<td>-0.0000594</td>
<td>0.0000542</td>
</tr>
<tr>
<td>SPP pre</td>
<td>0.0000466</td>
<td>0.0000524</td>
</tr>
<tr>
<td>SPP post</td>
<td>-0.0000187</td>
<td>0.0000546</td>
</tr>
<tr>
<td>Storebrand pre</td>
<td>-2.26e-06</td>
<td>0.0000578</td>
</tr>
<tr>
<td>Storebrand post</td>
<td>-0.0000815</td>
<td>0.0000618</td>
</tr>
</tbody>
</table>

Note. Regression contains only equity funds that have a category reference index: Swedish large-cap, Swedish small-cap European, US, Japanese, and global funds. The dependent variable is the fund daily excess return (alpha) from a regression against its category reference index using three months of data.

Table 6: Regression of 3-month Excess Returns per Fund on Fund Manager, Pre- and Post-Peak of Scandal Phase