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Relative Performance, Risk and Entry in the Mutual Fund Industry

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Abstract

This paper analyses the impact of the emergence of new funds on the portfolio decisions of mutual fund managers who are evaluated on the basis of relative performance within a dynamic model. Recent theoretical literature has pointed to the inefficiencies in portfolio selection caused by relative performance evaluation of fund managers. We find that the on-going process of the creation of new funds, by posing an entry threat to the incumbent fund managers, greatly alleviates these inefficiencies. Hence the transitory market structure that characterises the mutual fund industry could explain why relative performance evaluation is widely in use.

Keywords: Relative performance evaluation, fund management industry, ranking objectives, family of funds.

JEL Classification: L10, G11, G24.

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1 Introduction

This paper analyses the impact of the emergence of new funds on the portfolio decisions of mutual fund managers who are evaluated on the basis of relative performance within a dynamic model.

Among practitioners there is no dispute on the fact that competition between fund managers is based on relative, rather than absolute performance. From the early 90s a revived research interest on the relationship between past performance, fund flow and managers' compensation has developed. Sirri and Tufano [21] study the flow of funds into and out of equity mutual funds and find that clients invest disproportionately more in funds that performed very well in the previous period. Similarly Chevalier and Ellison [6], looking at a sample of growth and income funds, find significant non-linearities in the shape of the relationship between fund flow and past performance. Thus mutual fund managers with asset-based compensation schemes would like to maximise the ranking of the fund in order to achieve maximal investment inflow[1].

The fact that fund managers are motivated by relative performance incentives raises efficiency concerns. Agency theory provides a rationale for relative performance evaluation (Holmström [9] and Mookherjee [17]). However the nature of the mutual fund industry is such that delegated portfolio management differs from a standard principal-agent relationship at least in two ways: it is typically dynamic, and it involves not only effort exertion but also decisions about the risks to be taken. Meyer and Vickers [16] show that, in a dynamic setting, comparative performance evaluation has an ambiguous impact, and that it is not guaranteed that it enhances efficiency. Moreover, Hvide [10] points out that relative performance evaluation might be undesirable when agents not only choose the level of effort (expected return) but also the riskiness of their actions (variance).

Several empirical studies have tested the hypothesis that risk-taking decisions by fund managers are affected by relative performance incentives. Brown et al [2] and Chevalier and Ellison [6] find that riskiness profiles of funds' portfolios are altered during the course of the calendar year as if fund managers were involved in a tournament where each fund aims at market leadership. Managers with very good mid-year

[1] Similar behaviour can result from the need to retain existing clients (Heinkel and Stoughton [11]).

performances tend to lock in their gains in more conservative positions; worse performing funds take higher risks in order to gamble their way up the yearly rankings. This evidence has recently been challenged by Busse [3] and Goriaev et al [8]. By using daily rather than monthly data on US equity funds, they find little evidence in support of the tournament hypothesis for mutual fund managers and claim that previous results are spurious due to neglected auto-correlation [3] and cross-correlation [8] of fund returns.

This recent debate on the tournament hypothesis does not challenge the fact that relative performance incentives are in place, but rather it focuses on the impact that they may have on fund managers' risk-taking decisions. From a theoretical point of view, this poses the question of why fund managers would not respond to their incentives when choosing the riskiness profile of their portfolios.

In this paper we take the view that the impact of relative performance incentives on fund managers' risk-taking behaviour will be attenuated by the process of the emergence of new funds. We show that relative performance evaluation need not result in inefficient risk-taking behaviour when the market in which the fund managers operate is contestable. A poorly performing fund faces a higher probability of losing its leadership versus a potential entrant. In the presence of contestability, fund managers who compete on the basis of rank still aim at a high absolute performance in order to deter entry.

There is ample evidence that the mutual fund industry is characterised by an on-going process of emergence of new funds, often launched by the same mutual fund groups as part of a larger *family of funds*. In any given year during the 80s and early 90s, 6% of all fund assets were held by new funds that had been in existence less than 1 year and 25% in funds that had existed less than 2 (Khorana and Servaes [14]). Assets in the US-based mutual funds increased 24% in 1999: investment performance accounted only for two-thirds of the growth; the remainder was attributable to net new cash flow and the emergence of new funds (Mutual Fund Fact Book 2000 [13]).

We model a two-period game played by two incumbent fund managers who at the beginning of each time period choose the riskiness profile of their portfolios. We first analyse the game with no entry and find that fund managers who compete for rank condition their portfolio choices in the second stage on their relative performance in the first stage: past winners act conservatively and past losers gamble.

We then ask how the presence of entry affects fund managers' behaviour. We assume that there is a third fund that might decide to enter the market in the second stage of play. Our main result is that entry alleviates the inefficiencies in risk-taking behaviour caused by relative performance incentives. The presence of an entrant has a positive impact both in the second stage of play, when it results in increased competition, and in the first stage of play, where the entry threat induces the incumbent fund managers to take more efficient portfolio choices in order to deter entry.

We model competition across fund managers as a tournament where competitors only win if they obtain the highest rank: with more competing managers the probability of obtaining the highest rank by investing in the safer asset class decreases; hence funds prefer to invest in the risky portfolio in order to outperform a larger number of competitors. The impact of increased competition on risk-taking is greater when the probability of success of the risky portfolio is not too small: hence fund managers will choose the risky portfolio when this is more likely to be the optimal choice from the point of view of the investors. We assume that there is a small positive cost to entry; hence the third fund will only enter the competition if there is a strictly positive probability that he may win the tournament. Very high levels of interim performance will make it impossible for the entrant to catch up; given that the two incumbent funds prefer the entrant not to enter (expected payoffs are lower with a larger number of competitors), they will tilt their portfolio decisions to the riskier asset class, hoping to obtain higher interim performances that would deter entry. The implicit cost of entry deterrence consists of the fact that, in order to avoid increased competition in the second stage, each of the incumbents may have to choose a portfolio other than that which he would have chosen in order to outperform his current competitor in the interim stage. When the probability of success of the risky portfolio is very small, entry deterrence through higher risk taking is both unlikely to be effective and very costly; hence entry deterrence will only tilt portfolio decisions of fund managers towards the risky asset class when this is the efficient investment.

This paper contributes to the literature on mutual fund tournaments. Most of this literature is empirical and aims at assessing the validity of the tournament hypothesis[2]. Alongside the empirical contributions, there is a growing theoretical lit-

[2] Brown et al [2], Sirri and Tufano [21], Chevalier and Ellison [6], Busse [3], Goriaev et al [8].

erature that considers the risk-taking implications of rank-based competition in a game-theoretic setting. Most of this literature assumes a given market structure: Taylor [22], Goriaev et al [7] and Sciubba [20] provide mutual fund tournament models that can be compared to our benchmark case with no entry[3]. The interplay of relative performance incentives and competition in the mutual fund industry has been studied by Kristiansen [15] and Palomino [19]. Both papers find that increased competition induces higher risk-taking for fund managers. In [15] higher risk-taking may reduce efficiency: fund managers become more prone to risky noise trading than to making informed portfolio choices. Palomino [19] endogenises the level of competition and shows that relative performance incentives result in a positive selection of fund managers: compared to the case where managers are compensated on the basis of their absolute performance, relative performance incentives imply that low quality managers are more likely to stay out of the market. This clearly increases the average quality of competing funds.

As in [19], we consider entry decisions to be endogenous. However the main question we pose is different. Palomino [19] studies the impact of relative performance objectives on the degree of competition, the size of the industry and the selection of good versus bad fund managers. We instead focus on the impact of potential entry and increased competition on risk-taking decisions by fund managers, in the presence of relative performance objectives.

Moreover, in contrast to both Kristiansen [15] and Palomino [19], we have a dynamic model where entry only occurs at an intermediate stage. This allows us to disentangle the two separate reasons whereby entry induces higher risk-taking: increased competition in the second stage, and entry deterrence in the first stage.

The paper proceeds as follows: in section 2 we present the model; in section 3 we derive our results for the second stage of play, both in the benchmark case with no entry and in the presence of a potential entrant; section 4 contains our results for the first stage of play and our characterisation of the two-stage equilibria with and without entry. Section 5 concludes the paper and provides policy implications. For ease of exposition all proofs are in the appendix.

[3] In the context of an R&D tournament, Cabral [4] derives similar results to our benchmark model.

2 The Model

Consider a two-period model of a financial market with two incumbent fund managers and a potential entrant. All funds are endowed with one unit of capital. The two incumbents make portfolio decisions at the beginning of each time period (at $t = 0$ and $t = 1$); the third fund may enter in the second period, after observing the performance obtained by the two incumbents in the first period.

In each period portfolio decisions are made simultaneously. Returns obtained by the incumbents in the first period are entirely reinvested, so that final returns are cumulative. The entrant starts with one unit of capital in $t = 1$ and invests for one period only. There is an arbitrarily small positive cost to entry, so that the third fund prefers not to enter unless entry results in strictly positive expected profits.

Portfolio Choice: Fund managers can form their portfolios from two alternative asset classes, with different expected return and risk characteristics, such as traditional sectors and new technologies. To keep our analysis as simple as possible we assume that it is too costly for fund managers to invest in both asset classes at the same time, so that in each time period they specialise in one or the other sector[4].

In particular, we call portfolio S the investment in the traditional sector, and portfolio R the investment in new technologies. Both portfolios yield binary returns: in case of success portfolio S yields a rate of return s, and portfolio R yields a rate of return r, with $r > s > 0$; in case of failure both portfolios yield 0[5].

We assume that there are no direct links between the two sectors, so that the success of the traditional portfolio is not correlated to the success of the portfolio in new technologies. When the two fund managers invest in different asset classes, portfolio S succeeds with (known) probability p, and portfolio R with (known) probability q, with $p > q > 0$. On the contrary we assume that when fund managers choose to invest in the same asset class, the likelihood of their success displays some positive correlation: the joint probability of success is determined by the risk that is idiosyncratic to each fund as well as by some degree of sectorial risk. In particular, when n funds are investing in the traditional sector, the joint probability of success

[4] Taylor [22] and Sciubba [20] show that, when fund managers have rank based objectives, fund managers choose extreme portfolios even when they are allowed to diversify.

[5] The assumption of positive rates of return is not crucial: allowing for negative and bounded rates of return would not affect our results from a qualitative point of view.

is equal to $p^n \rho^{n-1}$, where $\rho \geq 1$ and $n = 1, 2, 3$. Similarly, when n funds are investing in new technologies, the joint probability of success is equal to $q^n \chi^{n-1}$, with $\chi \geq 1$ and $n = 1, 2, 3$. Clearly the case $\rho = \chi = 1$ corresponds to independence and the case $\rho = 1/p$ and $\chi = 1/q$ corresponds to perfect (positive) correlation[6].

Further, to make the problem interesting, we pose two parametric restrictions. For our results it is important that sectorial risk is not too substantial, so that we rule out very high correlation[7]. In particular we assume:

Assumption 1 $\rho \leq \frac{1}{p}\left[1 - \frac{q}{p}\right]$ and $\chi \leq \frac{p}{q}$

This assumption is not too restrictive if we consider the two asset classes to be broad enough so that the two fund managers can specialise within each class. Moreover, in order not to obtain trivial results, we rule out the case where the difference in returns from the two portfolios is extremely large. In more detail we assume that the cumulative return of successfully investing for two periods in the safer asset is higher than the return obtainable from the risky portfolio in one period only:

Assumption 2 $(1+s)^2 > (1+r)$

Incentives and Compensation: Fund managers in our model only care about their compensation. We assume that managers are not compensated period by period, but rather at a final assessment stage on the basis of their cumulative performance. Performance is measured in relative terms, and "leaders" are more than proportionately compensated with respect to "followers", so that the incentive scheme is convex.

For the purpose of this analysis, we consider the simplest incentive scheme that displays these characteristics, i.e. a bonus contract based on final rank. In a richer model, this type of incentive scheme would result from the interaction between compensation contracts typical to the fund management industry (fees proportional to assets under management)[8] and investors' behaviour in picking up funds (i.e. flocking

[6] The full joint probability matrices are in the appendix.

[7] From an empirical point of view, this is consistent with some recent evidence: Ahmed [1] shows that correlation among equity funds is not too high. Hence a multi-fund portfolio is far less risky than its single-fund counterpart, which also explains why investors often prefer to pursue a multi-fund strategy.

[8] Evidence shows that most contracts do not contain a performance-based fee component. Golec [12] reports that only 6 percent (29 of 476) in his sample of mutual fund managerial contracts contain explicit performance incentives. Furthermore, from a theoretical perspective, Kristiansen [15] shows that, provided the number of competitors is not too large, even in the presence of explicit contractual incentives based on the absolute performance achieved by the fund manager, the implicit incentives based on the rank achieved in a tournament with other fund managers are more important.

to previous winners). Here, for simplicity, we provide fund managers with explicit relative performance incentives.

In more detail, managers are ranked according to their performance at the end of each period; the rank achieved at the end of period 1 (*interim stage*) is observable but has no impact on the manager's compensation; the rank achieved at the end of period 2 (*bonus stage*) fully determines the manager's compensation. The fund manager that achieves first rank obtains a strictly positive bonus, which we normalise to 1; the manager who achieves second (or third) rank obtains a smaller bonus, which we normalise to 0. Convexity of the compensation scheme requires that when fund managers achieve the same (top) performance, their compensation is sufficiently smaller than if they were first rank; for simplicity we assume that in the case of a tie, fund managers are compensated as if they achieved second rank.

Optimal Investment: Here we do not explicitly model the investors' objective function. A very risk-averse investor may prefer that the fund manager invests in the safer asset class; on the contrary, a mildly risk-averse investor may prefer that the fund manager invests in the riskier assets, as long as its expected return is sufficiently high. In general, investors' preferences will depend on how the expected values of the two portfolios compare to their riskiness. When the riskier asset pays out only a marginally higher return with a very small probability, rational investors will typically find the safer asset more desirable. On the contrary, if the riskier asset pays out a significantly higher return, with a probability that is not too small compared to the safer asset, only extremely risk-averse investors would prefer the fund managers to invest in the safer asset, and most rational investors would find the riskier asset more desirable.

In absence of a specific objective function for the investors, we are not able in general to draw welfare conclusions. However, under assumptions 1 and 2 there certainly exist parameters such that the safe portfolio is more desirable for *any* rational investor (consider $s \to r$ and $q \to 0$ as an extreme example). Moreover, despite our parametric assumptions give some advantage to the safer asset class, they nevertheless allow for the case where the risky portfolio has a much higher expected return than the safe, so that all except very risk-averse investors would find the risky portfolio more desirable.

3 Bonus Stage

3.1 The Benchmark Case: No Entry

Suppose that there is no entrant in the second stage. We can solve the game between fund managers backwards: call the two stages of play interim stage and bonus stage respectively, and focus on the bonus stage first.

In order to analyse the bonus stage, we need to fix a history for the interim stage which consists of the actions played and of the realisations for the risky and safe portfolios. A convenient feature of this setting is that the bonus subgame will only depend on the interim relative performances and not on the interim absolute performances and the actual actions played. The following definition provides us with a useful notion of interim relative performance between the two incumbent fund managers.

Definition 1 *If, at the end of the first stage, players 1 and 2 display performances* $(1+x)$ *and* $(1+y)$ *respectively, we call* $|x-y|$ *the performance gap between the two incumbents.*

One can easily verify the following:

Remark 1 *The subgame in the bonus stage only depends on the performance gap between the two incumbents.*

At the end of the interim stage each fund has an endowment equal to either 1, or $(1+s)$ or $(1+r)$. According to the realisation of the performance gap we can distinguish four different scenarios after the interim stage: performance gap equal to 0, s, $(r-s)$ and r. We define a useful notion of "size" for the performance gap:

Definition 2 *We call the performance gap large if it is larger than* $(r-s)$*; and small otherwise.*

Notice that, given the discrete nature of returns that we consider here, the performance gap is small only if it is equal either to 0 or to $(r-s)$; it is large[9] only if it is equal either to s or to r.

[9] Notice that assumption 2 implies that $(r-s) < s$.

The lemma below provides a full characterisation of the equilibrium in the second stage of the game.

Lemma 1 (Bonus subgame - No entry) *Under assumptions 1 and 2, when the performance gap is small the unique NE of the bonus subgame is (S, S); when the performance gap is large (S, R) is the unique NE of the subgame.*

The intuition for these results lies in the behaviour of the interim follower that faces a given performance gap. When the performance gap is small, the follower may potentially catch up with the leader by using either investment strategy. In this scenario both players will invest in the portfolio which succeeds with the higher probability. When the performance gap is large, playing risky becomes a dominant strategy for the follower, given that only the superior return provided by the risky portfolio, when successful, would allow him to close the large interim performance gap. Given that the follower plays risky, the interim leader will best respond by investing in the portfolio that pays out with the higher probability, hence maximising his chances of not losing ground. Finally, when the performance gap is extremely large so that the follower has no chance of outperforming the leader, he will be indifferent between the two portfolios: we assume[10] that he will invest in the risky portfolio.

These results are in line with the empirical findings by Brown et al [2] and Chevalier and Ellison [6]. In the pre-assessment period (here the bonus stage), funds have an incentive to alter their riskiness profiles. In particular, funds that are ahead of the market lock in their gains in conservative positions, while worse-performing funds attempt to gamble their way up the rankings.

3.2 Entry

Suppose that there is a third fund that might decide to enter at the end of the first stage and compete for market leadership alongside the two incumbents in the second stage. The entrant observes the interim performance of the two incumbent funds

[10]The reason why the follower is indifferent between safe and risky portfolios is that the latter is not "risky" enough and does not allow him to catch up with the leader. In such a circumstance it seemed reasonable to assume that the follower, when indifferent, would still go for the risky portfolio. This would certainly happen in a richer model with a larger choice set of risky options.

at the end of the first stage, and decides whether to enter. There is a (small) cost to entry, hence the new fund will only come into the picture if he faces a strictly positive probability of obtaining market leadership. Market leadership is achieved on the basis of cumulative performance. Hence the two incumbents have an advantage in that they accumulate returns over two periods, while the entrant only has one period of investment to catch up. In this set-up, high interim performances may discourage entry.

Alternative ways of comparing performances across the incumbents and the entrant fund are: comparing only the second period performance, or comparing the average two-period performance of each of the two incumbents to the one period performance of the entrant. Both alternatives imply that returns obtained in the second stage by the entrant are overweighted, so that entry can never be deterred through a high level of interim performance. We believe that our modelling choice, although stylised, is closer to what may happen in practice when investors choose among funds with a different length of track records. Funds with shorter track records appear to have a disadvantage with respect to longer-established funds.

In the bonus stage of the game with entry, not only the performance gap but also the actual strategies played by the managers in the interim stage matter. This is because the absolute performance of both funds (and not only their relative performance) is important in determining what is the chance that an outperforming entrant might appear. Hence we need to distinguish more cases than in the benchmark, and in particular we need to distinguish within the 0-performance gap subgames those where the two incumbent funds have an interim performance of 1 (0 gap at 0); interim performance of $1+s$ (0 gap at s); interim performance of $1+r$ (0 gap at r).

Below we follow the convention that the first player is the interim leader, the second player is the interim follower and the third player is the entrant. If the entrant does not enter, no investment choice is given for the third player.

One can easily prove the following:

Remark 2 *The entrant decides not to enter if either of the two incuments has interim performance equal to* $(1+r)$.

An immediate consequence of the remark above is that in the game with entry, the subgames with 0 gap at a performance of r, with $(r-s)$ gap, and with r gap, are the same as in our benchmark case with no entry. Hence in order to complete our analysis, we will only need to obtain equilibria for those subgames where the entrant does enter.

Lemma 2 (Bonus stage - zero gap at 0) *Consider the bonus subgame after 0-performance gap at 0. Under assumptions 1 and 2:*

(a) iff $q < p(1-p\rho)^2$ then (S,S,S) is the unique NE of the bonus subgame;

(b) else (S,S,R), (S,R,S) and (R,S,S) are NE of the bonus subgame.

As for the case with no entry, the 0-performance gap subgame is symmetric and all players (including the entrant) face the same chances of obtaining the leadership. With respect to the benchmark case, we observe more risk-taking. In more detail: while in the in the benchmark case both players invest in the safe asset class; with entry, for q sufficiently large, one of the players chooses the risky portfolio in equilibrium. It is not surprising to find that fund managers aiming at maximising their rank choose riskier portfolios when they are faced with a larger number of competitors. Increased competition results in more risk-taking when q is sufficiently large, i.e. when the risky portfolio pays out with a higher probability. In our set-up, this may alleviate inefficiencies induced by relative performance incentives when these result in suboptimally low levels of risk-taking.

Lemma 3 (Bonus stage - zero gap at s) *Consider the bonus subgame after 0-performance gap at s. Under assumptions 1 and 2:*

(a) iff $q < p(1-p\rho)(1-q)$ then (S,S,R) is the unique NE of the bonus subgame;

(b) else (R,S,R) and (S,R,R) are NE of the bonus subgame.

The 0-performance gap subgame at performance of $(1+s)$ is a symmetric game for the incumbents, but not for the entrant, who enters in the second stage with a disadvantage. He can only catch up with the incumbents by investing in the risky portfolio. Hence risky is a dominant strategy for the entrant. For q sufficiently large at least one of the two incumbents will also respond with risky. With respect to the benchmark case with no entry - where neither of the players plays risky - this has clearly more chance of being efficient, given that it applies, in particular, to the case where the expected return of the risky portfolio is much higher than the safe.

It is interesting to assess the impact of absolute interim performance on risk-taking decisions. We can compare the parametric conditions such that increased competition results in more risk-taking in the following two cases: 0 gap at a performance of 1, and 0 gap at a performance of $(1 + s)$. We find that worse-performing funds are more prone to risk-taking. Increased competition clearly poses a higher threat to low-performing funds than to high-performing ones: hence worse-performing funds tilt their portfolios towards risky alternatives for a larger set of parameter values.

We now compare the conditions under which more risk-taking is observed in the 0 gap at 0 and in the 0 gap at s subgames. In the 0 gap subgame at 0, we have more risk-taking if:

$$q \geq p(1 - p\rho)^2 \tag{1}$$

In the 0 gap subgame at s, we have more risk-taking if:

$$q \geq p(1 - p\rho)(1 - q) \tag{2}$$

Clearly a larger set of parameters will satisfy (1) than (2). Define:

$$\begin{aligned} q_0 &= p(1 - p\rho)^2 \\ q_s &= p(1 - p\rho)(1 - q) \end{aligned}$$

Formally we can state the following[11]:

Corollary 1 (Performance and Risk) *In the 0-performance gap subgame worse-performing funds are more prone to choosing the riskier portfolio than better-performing funds. Formally* $q_0 < q_s$.

An intriguing parallel in the case with no entry is the result that, with a large enough performance gap, worse-performing funds (i.e. followers) tend to be riskier than better-performing funds (i.e. leaders). This phenomenon is independent of the absolute performance of the fund. In the case with entry, we find that absolute

[11] The proof is straighforward and it is therefore omitted.

performance matters: even when funds are of equal performance, the probability that they choose the risky investment in the second period decreases with performance.

Let us now consider the subgame that follows an interim performance gap equal to s in the game with entry.

Lemma 4 (Bonus stage - s gap) *Under assumptions 1 and 2, the unique NE of the bonus subgame after s-performance gap is* (S, R, R).

In the s gap subgame both the follower and the entrant can only hope to outperform the interim leader by playing risky. The interim leader best responds by playing safe.

In this subgame increased competition does not alter the risk-taking behaviour of the fund managers with respect to the benchmark case with no entry. This is because, with a large performance gap, risky is a dominant strategy for any competing fund which is not ahead, with or without entry.

4 Interim Stage

In the interim stage we can compute expected payoffs to each player by working backwards (i.e. substituting each subgame with its equilibrium payoffs) and considering the probability with which each of the subgames is reached. However, equilibria in the bonus subgames depend on parametric conditions. Moreover the parametric conditions needed for different equilibria to arise vary across subgames, which makes a complete characterisation of the game in the interim stage quite tedious and - we believe - not particularly illuminating, due to the multiplicity of equilibria.

In what follows we concentrate on two polar cases. We first consider the region of the parameter space where the safe portfolio is likely to be more desirable than the risky. This is a subset of our parameter space where q is very small, and in particular $q < q_0$. Such a parameter region comprises safe portfolios that are certainly efficient: take, as an extreme case, $q \to 0$ and $s \to r$. We then consider the region of the parameter space where the risky portfolio is likely to be more desirable than the safe. This is a subset of our parameter space where q is sufficiently large, and in particular $q > q_s$. Such a parameter region comprises risky portfolios for which the expected value is much higher than the safe, so that all but very risk-averse investors would prefer the risky asset class to the safe.

The presence of a potential competitor affects fund managers' behaviour in the first period of play as well. In our set-up very high interim performances deter entry. If either of the two incumbents displays an interim performance of $(1+r)$, the entrant has no chance of catching up and decides not to enter. Increased competition in the bonus stage clearly lowers expected payoffs for the incumbents, who may then invest in the risky portfolio in order to deter entry.

We find that entry deterrence induces risk-taking only in the case when risk-taking is likely to be optimal, while both incument fund managers still play safe when the safe portfolio is more likely to be desirable. The intuition for our results is as follows. With the presence of a potential entrant at the end of the first stage, fund managers have two objectives: to compete against the other incumbent and to deter the third fund from entry. When q is large, there is no trade-off between these two objectives, as investing in the risky asset serves both. When q is small, entry deterrence is best achieved through playing risky, while the objective of outperforming the current competitor is best served by investing in the safe portfolio. The cost of entry deterrence could be measured by the extent of this trade-off and in particular by how costly it is to play risky in order to deter entry when a safer portfolio would in fact maximise the chance of obtaining interim leadership against the other incumbent. Such costs are weighted against the expected benefits of entry deterrence, measured by the higher continuation payoff in a bonus stage with fewer competitors.

We state our results for the interim stage in two separate propositions: the first one for $q < q_0$; the second one for $q > q_s$.

Lemma 5 (Interim stage - q small) *Under assumptions 1 and 2, and if $q < q_0$, the unique equilibrium in the interim stage is (S, S), irrespective of whether a potential entrant is present.*

In the interim stage, when there is no potential entrant, the two funds stand the same chances of winning the bonus and hence the game is symmetric. Both fund managers will invest in the asset class that maximises the chance of outperforming the opponent: when q is particularly low, such asset class is the safer one. The same occurs also in the presence of an entry threat: with q low, entry deterrence is both very costly and likely to be ineffective. Hence in this parametric case the costs of entry deterrence outweigh the benefits.

We can now fully characterise the equilibrium path of the two-stage game for $q < q_0$.

Proposition 1 (SPE - q small) *Under assumptions 1 and 2, and if $q < q_0$:*
(i) if there is no potential entrant, the game has a unique SPE path: (S, S) in the first stage; in the second stage: (S, S) if the performance gap is zero, (S, R) if the performance gap is s;
(ii) if there is a potential entrant, the game has a unique SPE path: (S, S) in the first stage; in the second stage: (S, S, S) if the performance gap is zero, (S, R, R) if the performance gap is s.

By proposition 1, entry threats have no impact on the risk-taking behaviour of the two incumbents.

When q is sufficiently large, playing risky may serve both the purpose of deterring entry and of outperforming the current competitor. As a result, there is more risk-taking in the interim stage of the game with entry compared to our benchmark case.

Proposition 2 (SPE - q large) *Under assumptions 1 and 2 and if $q > q_s$, both incumbents play safe in the interim stage of any subgame perfect equilibrium of the game with no potential entrant. In the game with entry, there are subgame perfect equilibria where at least one of the two incumbents plays risky in the interim stage.*

In this parametric case, entry threats improve on efficiency. When there is no entrant, rank-based competition may result in inefficiently low levels of risk-taking. By proposition 2, even when the expected return of the risky portfolio is much higher than the expected return of the safe, in all subgame perfect equilibria of the two-stage game both fund managers invests in the safe asset class. Hence fund managers take portfolio decisions which are likely to be detrimental for the investors from an expected value point of view. Entry threats alleviate such inefficiency by inducing higher risk-taking in order to deter entry. Investing in the risky asset class is, in this parameter subspace, particularly effective at deterring entry, because it is very likely that the risky portfolio will obtain superior returns. There are also costs to entry deterrence as it may be best to play safe in order to outperform a current competitor that is investing in the risky portfolio. However, for the parameter region that we consider under proposition 2, the expected benefits of entry deterrence are sufficiently high to outweigh the costs.

5 Concluding Remarks

The main objective of our analysis is to assess whether contestability improves on efficiency in a mutual fund tournament model. There are at least two different perspectives one might want to look at. First of all, one might be interested in assessing whether entry restores fund managers' incentives and aligns them with the best interest of the original investors. Secondly, one might want to ask whether contestability in the fund management industry should be favoured by a benevolent regulator, who may or may not lift, for example, entry restrictions in the market.

The fact that the objectives of fund managers who care about their rank are not aligned with the investors' best interests is not a surprising result: fund managers who have rank based objectives take decisions which are detrimental for the investors from an expected value point of view. We ask whether rank based objectives lead to more efficient outcomes when competition in the market increases and in particular leadership in the sector can be at stake because of new competitors. Our findings suggest that the entry threats posed by the on-going process of creation of new funds make portfolio decisions of fund managers more sensitive to the expected values of investment alternatives.

Clearly this does not yet explain why evaluating fund managers according to relative performance should be preferred to absolute performance evaluation, or alternatively why investors would want to flock to past winners. In our framework the inefficiencies of relative performance evaluation are alleviated but not eliminated. However, in a model where investment outcomes also depend on an unobservable managerial effort (see, for example, [19]), relative performance evaluation could be used to elicit superior performances. The main implication of our analysis is the consideration that in a market where relative performance evaluation has a role in reducing the moral hazard problem, the potential distortion in the form of inefficient risk-taking behaviour can be greatly alleviated by entry threats and increased competition.

From a policy perspective, academics and practitioners alike have often expressed concerns about the effects of relative performance evaluation of fund managers: in particular rank-based competition has frequently been pointed at as one of the main causes of excessive conservatism and herding behaviour among institutional investors[12]. The policy implication that one could draw from our analysis is that regulators need not be too concerned about the unwanted effects of relative performance evaluation, provided that the mutual fund industry is believed to be open to competitive pressure enough so that fund managers face a realistic threat of being displaced by their competitors.

[12] See for example the concerns expressed in the recent Report on Institutional Investment by P. Myners [18].

Appendix

Joint Probability Matrices

Consider three players investing in the safe portfolio. If one of the players is successful (safe portfolio pays out s), the joint prob matrix for the other two players is as follows:

	s	0	Marg. prob.
s	$p^3\rho^2$	$p^2(1-p\rho)$	$p^2\rho$
0	$p^2(1-p\rho)$	$p(1-p\rho)^2$	$p(1-p\rho)$
Marg. prob.	$p^2\rho$	$p(1-p\rho)$	p

If one of the players is unsuccessful (obtains 0), the joint probability matrix for the other two players is as follows:

	s	0	Marg. prob.
s	$p^2\rho(1-p\rho)$	$p-2p^2\rho+p^3\rho^2$	$p(1-p\rho)$
0	$p(1-p\rho)^2$	$1-3p+3p^2\rho-p^3\rho^2$	$1-2p+p^2\rho$
Marg. prob.	$p(1-p\rho)$	$1-2p+p^2\rho$	$1-p$

Consider three players investing in the risky portfolio. If one of the players is successful (risky portfolio pays out r), the joint prob matrix for the other two players is as follows:

	r	0	Marg. prob.
r	$q^3\chi^2$	$q^2(1-q\chi)$	$q^2\chi$
0	$q^2(1-q\chi)$	$q(1-q\chi)^2$	$q(1-q\chi)$
Marg. prob.	$q^2\chi$	$q(1-q\chi)$	q

If one of the players is unsuccessful (obtains 0), the joint probability matrix for the other two players is as follows:

	r	0	Marg. prob.
r	$q^2\chi(1-q\chi)$	$q-2q^2\chi+q^{3\chi 2}$	$q\,(1-q\chi)$
0	$q\,(1-q\chi)^2$	$1-3q+3q^2\chi-q^{3\chi 2}$	$1-2q+q^2\chi$
Marg. prob.	$q\,(1-q\chi)$	$1-2q+q^2\chi$	$1-q$

When there are only two players, the joint probability matrix is easily obtained by the marginal probabilities.

Proof of Lemma 1 (Bonus subgame - No entry). By remark 1, we only need to distinguish between four subgames[13]. Under assumption 2 payoff matrices are as follows:

(1) 0 gap subgame:

	S	R
S	$p\,(1-p\rho)\ ;\ p\,(1-p\rho)$	$p\,(1-q)\ ;\ q$
R	$q\ ;\ p\,(1-q)$	$q\,(1-q\chi)\ ;\ q\,(1-q\chi)$

(2) $(r-s)$ gap subgame:

	S	R
S	$1-p+p^2\rho\ ;\ p\,(1-p\rho)$	$1-q\ ;\ q(1-p)$
R	$1-p(1-q)\ ;\ p(1-q)$	$1-q+q^2\chi\ ;\ q(1-q\chi)$

[13] Here and in what follows we adopt the convention of denoting the interim leader as first player (in the payoff matrices as row player), and the interim follower as second player (in the payoff matrices as column player). The entrant, when present, is the third player.

(3) s gap subgame:

	S	R
S	$1-p(1-p\rho)\ ;\ 0$	$1-q(1-p)\ ;\ q(1-p)$
R	$1-p(1-q)\ ;\ 0$	$1-q+q^2\chi\ ;\ q(1-q\chi)$

(4) r gap subgame:

	S	R
S	$1\ ;\ 0$	$1-q(1-p)\ ;\ 0$
R	$1\ ;\ 0$	$1-q(1-q\chi)\ ;\ 0$

Under assumption 1, it is easy to verify the following: in game (1) safe is a dominant strategy for both players, so that the unique NE is (S,S); in game (2) the unique NE is (S,S); in game (3), playing safe is a dominant strategy for the interim leader and playing risky is a dominant strategy for the interim follower, so that unique NE is (S,R); finally in game (4), S is a dominant strategy for the interim leader and, as for the interim follower, he is indifferent between S and R. By our assumption for the case of indifference, the follower prefers to hold a risky portfolio. Hence the unique NE in game (4) is (S,R). ■

Proof of Lemma 2 (Bonus stage - zero gap at 0). Under assumption 2, payoff matrices are below.

Suppose the entrant plays S, then:

	S	R
S	$p(1-p\rho)^2$ $p(1-p\rho)^2$ $p(1-p\rho)^2$	$p(1-p\rho)\,(1-q)$ q $p(1-p\rho)\,(1-q)$
R	q $p(1-p\rho)\,(1-q)$ $p(1-p\rho)\,(1-q)$	$q(1-q\chi)$ $q(1-q\chi)$ $p(1-2q+q^2\chi)$

When the entrant plays R, the payoff matrix is as follows:

	S	R
S	$p(1-p\rho)\,(1-q)$ $p(1-p\rho)\,(1-q)$ q	$p(1-2q+q^2\chi)$ $q(1-q\chi)$ $q(1-q\chi)$
R	$q(1-q\chi)$ $p(1-2q+q^2\chi)$ $q(1-q\chi)$	$q(1-q\chi)^2$ $q(1-q\chi)^2$ $q(1-q\chi)^2$

Under assumption 1, we can easily show that if $q < p(1-p\rho)^2$, then NE is (S, S, S); if $q > p(1-p\rho)^2$, NE are (R, S, S) (S, R, S) and (S, S, R). ■

Proof of Lemma 3 (Bonus stage - zero gap at s). In the subgame that follows an interim performance of s (here for both incumbents), for the entrant it is a dominant strategy to play risky. When the entrant plays risky, and under assumption 2, the payoff matrix is as follows:

	S	R
S	$p(1-p\rho)(1-q)$ $p(1-p\rho)(1-q)$ $q(1-2p+p^2\rho)$	$p(1-q)$ q $q(1-q\chi)$
R	q $p(1-q)$ $q(1-q\chi)$	$q(1-q\chi)$ $q(1-q\chi)$ $q(1-q\chi)^2$

Under assumption 1, it is easy to verify that if $q < p(1-p\rho)(1-q)$ NE is (S, S, R); when $p(1-p\rho)(1-q) < q$ NE are (S, R, R) and (R, S, R). ■

Proof of Lemma 4 (Bonus stage - s gap**).** When one of the two incuments reaches the interim stage with performance equal to $(1+s)$ for the entrant it is a dominant strategy to play risky. Under assumption 2, the payoff matrix is as follows:

	S	R
S	$p+(1-q)(1-2p+p^2\rho)$ 0 $q(1-2p+p^2\rho)$	$p+(1-p)(1-2q+q^2\chi)$ $q(1-q\chi)(1-p)$ $q(1-q\chi)(1-p)$
R	$q+(1-p)$ $p(1-q)(1-2q+q^2\chi)$ $q(1-q\chi)$	$q+(1-3q+3q^2\chi-q^3\chi^2)$ $q(1-q\chi)^2$ $q(1-q\chi)^2$

For the follower it is dominant to play risky. Recall that by assumption 1 $\chi < \frac{p}{q}$.

Hence we can show that

$$p + (1-p)(1-2q+q^2\chi) > q + (1-3q+3q^2\chi - q^3\chi^2)$$

so that the unique NE for this subgame is (S, R, R). ■

Proof of Lemma 5 (Interim stage - q small) Consider first the interim stage for the benchmark case with no entry. The game is symmetric, hence we only specify payoffs for the first player. Expected payoffs to player 1 from each investment pair in the interim stage are as follows:

$\pi_1(S,S) = p\,(1-p\rho)\,(2-2p+2p^2\rho)$

$\pi_1(S,R) = (1-p)\,(1-p\rho)\,(1-q)\,p + p\,(1-q)\,[1-(1-p)q] + p^2q(1-p\rho)$

$\pi_1(R,S) = (1-p)\,(1-p\rho)\,(1-q)\,p + pq\,(1-q)\,(1-p) + q\,(1-p)\,[1-q(1-p)] + pq\,[1-p+p^2\rho]$

$\pi_1(R,R) = [1-2q+2q^2\chi]\,p\,(1-p\rho) + q\,(1-q\chi)\,[1-q\,(1-p)]$

We show that, under assumption 1 and for ρ and χ sufficiently small, S is a dominant strategy for player 1 (player 2). In fact:

$$\lim_{\rho\to 1}\,[\pi_1(S,S) - \pi_1(R,S)] = p(1-p)^2 + q(1-q) + pq^2 > 0$$

Moreover:

$$\lim_{\rho\to 1,\chi\to 1}[\pi_1(S,R) - \pi_1(R,R)] = (p-q)\left[2pq(1-p) + p(p-q^2) + (1-q)((1-p)-q)\right] > 0$$

By continuity, $\exists\widehat{\rho},\widehat{\chi} < 1$ such that $\forall\rho \geq \widehat{\rho}$ and $\chi \geq \widehat{\chi}$, it is still the case that S is a dominant strategy. Hence (S,S) is the unique NE for the interim stage of the game with no entry.

Consider now the game with a potential entrant. The game is symmetric, hence we only specify payoffs and provide results for the first player. When $q < q_0$ Expected payoffs to player 1 from each investment pair in the interim stage are as follows:

$\pi_1(S,S) = (1-2p+p^2\rho)\cdot p(1-p\rho)^2 + p^2\rho\cdot p(1-p\rho)(1-q) + p(1-p\rho)\cdot[p+(1-p)(1-2q+q^2\chi)] + p(1-p\rho)\cdot(1-p)q(1-q\chi)$

$\pi_1(S,R) = (1-p)(1-q)\cdot p(1-p\rho)^2 + p(1-q)\cdot[p+(1-p)(1-2q+q^2\chi)] + pq\cdot p(1-p\rho)$

$\pi_1(R,S) = (1-p)(1-q)\cdot p(1-p\rho)^2 + p(1-q)\cdot(1-p)q(1-q\chi) + q(1-p)\cdot[1-q(1-p)] + pq\cdot[(1-p)+p^2\rho]$

$\pi_1(R,R) = (1-2q+q^2\chi)\cdot p(1-p\rho)^2 + q^2\chi\cdot p(1-p\rho) + q(1-q\chi)\cdot[1-q(1-p)]$

We show that, under assumption 1 and for ρ and χ sufficiently small, S is a dominant strategy for player 1 (player 2). In fact:

$$\begin{aligned}\lim_{\rho\to 1,\chi\to 1}[\pi_1(S,S)-\pi_1(R,S)] &\geq 0\\ \lim_{\rho\to 1,\chi\to 1}[\pi_1(S,R)-\pi_1(R,R)] &\geq 0\end{aligned}$$

The first inequality can be rewritten as:

$$[\pi_1(S,S)-\pi_1(R,S)]_{\rho\to 1,\chi\to 1} = p(1-p)[(1-q)(1+q)^2-(1-p)(1-p)p]-q+(1-p)(p^3+q^2)$$

Given our parametric restriction on q we have that:

$$[\pi_1(S,S)-\pi_1(R,S)]_{\rho\to 1,\chi\to 1} \geq$$

$$\begin{aligned}&\geq p(1-p)[(1-q)(1+q)^2-(1-p)[1+p(1-p)]]+(1-p)(p^3+q^2)=\\ &= p(1-p)[(2-p)p^2+q(1-q-q^2)]+(1-p)(p^3+q^2)=\\ &= p(1-p)[(2-p)p^2-q^3+q(1-q)]+(1-p)(p^3+q^2)\end{aligned}$$

Applying our parametric restriction on q again (given that $q<p(1-p)^2$) the expression in the square brakets is always positive. This shows that in the interim stage S is a best response to S. We prove below that players prefer to play S also as a response to R.

$$[\pi_1(S,R)-\pi_1(R,R)]_{\rho\to 1,\chi\to 1} =$$

$$
\begin{aligned}
&= p(1-2q) - p^4(1-q) - q(1-q)^2 + p^2[-1+2q+q^3 - p(-2+2q+q^2)] \\
&\geq p(1-2q) - p^4(1-q) - q(1-q)^2 + p^2[1+q^3-q^2] = \\
&= p(1-q) - pq - p^4(1-q) - q(1-q)^2 + p^2 - p^2q^2(1-q) = \\
&= (p^2 - pq) + (1-q)[p - p^4 - q(1-q) - p^2q^2] = \\
&= (p^2 - pq) + (1-q)[p(1+p)(1-p)^2 - q((1-q)+p^2q)]
\end{aligned}
$$

Given that $((1-q)+p^2q) < 1$ and that $q < p(1-p)^2$ the expression in square brakets is positive, hence for $\rho \to 1$ and $\chi \to 1$, S is a dominant strategy for player 1 (player 2). By continuity, $\exists \widehat{\rho}, \widehat{\chi} < 1$ such that $\forall \rho \geq \widehat{\rho}$ and $\chi \geq \widehat{\chi}$, (S, S) is the unique NE for the interim stage. ■

Proof of Proposition 1 (SPE - q small) For the benchmark case, by lemma 1 and 5; for the game with a potential entrant, by lemma 2, 3, 4 and 5. ■

Proof of Proposition 2 (SPE - q large) First consider the game without potential entrant. Notice that in the proof of lemma 5 we have not used the restriction $q < q_0$ in order to establish that (S, S) is the unique NE for the interim stage of the game without entry. Hence the same result holds here. When $q > q_s$, under assumption 1 and for ρ and χ sufficiently small, for $q > q_s$ an identical proof to the one used above for lemma 5 shows that S is a dominant strategy for player 1 (player 2).

Consider now the game with the potential entrant. Recall that when $q > q_s$ there are multiple equilibria in the bonus stage. Hence, for each action choice in the interim stage, there will be more than one continuation payoff for the bonus stage We prove our claim by construction. We show that there exist subgame perfect equilibria for the two-stage game such that in the interim stage one player plays S and the other player plays R. Consider the following (partial description of) candidate equilibrium strategies: player 1 (player 2) plays safe (risky) in the interim stage; risky (safe) in the 0 gap at 0 subgame; safe (risky) in the 0 gap at s subgame. Notice that such a strategy pair induces the highest continuation payoff for player 1 ($\pi_1^{\max}(S, R)$) and the lowest continuation payoff for player 2.($\pi_2^{\min}(S, R)$). Consider now punishment strategies such that, if either player deviates, they obtain the lowest continuation payoff in the bonus stage. Notice that such punishments are credible because the punishing player obtains a (higher) Nash payoff. To prove that neither player deviates, we show that:

$$\left[\pi_1^{\max}(S,R) - \pi_1^{\min}(R,R)\right]_{\rho\to 1,\chi\to 1} > 0$$

Moreover $\exists \overline{p} > 0$ such that $\forall p < \overline{p}$:

$$\left[\pi_2^{\min}(S,R) - \pi_1^{\min}(R,R)\right]_{\rho\to 1,\chi\to 1} > 0$$

where

$\pi_1^{\max}(S,R) = (1-p)(1-q)q + p(1-q)(p+(1-p)(1-2q+q^2\chi)) + pqp(1-p\rho)$

$\pi_1^{\min}(R,R) = (1-2q+q^2\chi)p(1-p\rho)(1-q)+q^2\chi p(1-p\rho)+q(1-q\chi)(1-q(1-p))$

$\pi_2^{\min}(S,R) = \pi_1^{\min}(R,S) = (1-p)(1-q)p(1-p\rho)(1-q) + p(1-q)(1-p)q(1-q\chi) + q(1-p)(1-q(1-p)) + pq(1-p+p^2\rho)$

When $q \to p(1-p)$, the first inequality can be rewritten as:

$$p^2(1-(3-p)(1-p)p(1-(1-p)p))$$

which is always positive for $p \leq 1$.The second inequality can be rewritten as:

$$(1-p)p^2(1-(1-p)p)(2-p(5-2p(2-p)))$$

which is positive as long as p is not very high. ■

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