Competition, Cooperation, and Search: Incentives and the Competition for Research Resources in Multidivisional Firms

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Abstract
This study explores the implications of intra-organizational competition between divisions for corporate resources. We incorporate the idea that division managers may view other divisions as relevant for the setting of aspiration levels, and that such a focus on inter-divisional competition in addition to more traditional historical and organizational aspirations that mirror typical incentives provided to managers may have implications for organizational adaptation. We explore the resulting effects on organizational performance and behavior, using a computational model that includes different environmental conditions and different combinations of incentive regimes. The results indicate that intra-organizational competition may be beneficial in more stable environments, whereas it can hurt performance in more dynamic environments when compared with historical and organizational incentives. The results also show that, at least in some cases, the combination of two or more incentive regimes produce behavioral and performance results that are very different from a weighted average of the component pure incentive outcomes. The model has implications for work on intra-organizational competition, the role of incentives in driving managerial behavior, and the link between organizational design, external environment, and performance.

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**Keywords:** Organizational search, organizational adaptation, multi-divisional firm, incentive structures, intra-organizational competition, simulation model
INTRODUCTION

One of the main concerns confronting managers of multidivisional firms is the potential for competition between divisions. Most research on intra-organizational competition has stemmed from Williamson’s (1970; 1975) work on the M-form organization, and has highlighted the extent of diversification (Hill, Hitt & Hoskisson, 1992), incentive structures (Marino & Zábojník, 2004), or if the divisions’ products are substitutes or complements (Carlos Bárcena-Ruiz & Paz Espinosa, 1999) as explanations for whether competition between divisions will be beneficial to organizational performance or not. The main commonality across these studies is that they focus exclusively on competition that takes place in the external product market – whether divisions seek to maximize their own profitability or that of the organization as a whole.

We know, however, that product market competition and divisional value maximization isn’t necessarily the only way in which divisions compete. Burgelman (1994; 1996), for example, tells the story of internal technological competition between the memory and microprocessor units within Intel. In this case, the competition was focused on scarce resources – photolithography equipment. More generally, divisions within a single firm compete for resources frequently – rare raw materials, R&D resources, internal capital, and managerial attention all denote constrained resources that may play significant roles for organizational performance. First Penrose (1959) and later scholars such as Levinthal & Wu (2010) have focused on the role that such constrained resources play in firm evolution and adaptation.

The current study seeks to contribute to and extend this literature on internal, cross-divisional competition for scarce resources by focusing on the innovation process –
how divisions acquire, allocate, and benefit from resources that help to improve the technologies and products that they use for downstream market-based competition. How should corporate managers that want to maximize the performance of their organizations motivate innovation within their divisions? Should managers foster internal competition for scarce resources, e.g., by establishing relative performance measures that encourage social comparison among divisional managers? Or should they rather take action to weed out internal competition, and instead direct the divisions’ attention to the external product market by establishing incentives that reward either divisional or firm performance?

To tackle these issues, we develop a computational model to investigate how different divisional competition or cooperation incentives affect search behavior and eventually organizational performance under different environmental conditions. Our model builds on a foundation that is essentially similar to that used by Levinthal & March (1981), but extends the model structure in fundamental ways to include both a corporate office and multiple divisions that compete for allocations of research resources which facilitate the evolution of their technologies. We also use the insight that, within a single corporation, intentionally created managerial incentives will shape managerial aspirations (Obloj, 2012), which allows us to incorporate prior work on aspirational search behavior (Hu, Blettner & Bettis, 2011; Greve, 2003) to drive our model of organizational and divisional adaptation.

Our initial analyses and investigation present three particularly interesting findings. First, the effectiveness of different incentive regimes varies based on environmental conditions. The pace of competition, the certainty of feedback, and the munificence of the environment all affect the performance implications of incentives that foster cooperation
versus competition between divisions. This finding aligns with work on the contingency approach to organizational design (Lawrence & Lorsch, 1967), and extends prior work that has suggested that divisional competition may evolve based on external characteristics (Birkinshaw & Lingblad, 2005). Specifically, our findings suggest that such heterogeneity in divisional competition – at least concerning the market for corporate resources – can actually be beneficial to organizations. Second, under almost any condition in our model, the most effective incentive structure is not a single dominant incentive regime, but a combination of two or more regimes. Prior research has typically focused on “ideal types” of single incentive structures (e.g., Carlos Bárcena-Ruiz & Paz Espinosa, 1999), despite the fact that firms often employ blended incentives. This study offers insight into why firms may behave in this way by suggesting that each incentive regime involves tradeoffs, and that combining incentives may produce superior organizational results. Third, there appear to be tradeoffs between short-term and long-term performance for different incentive regimes. As a result, the optimal incentive structure may depend in part on how predictable the future is, and on how stringent the selection environment may be in the short term (Levinthal & Posen, 2007).

The rest of the paper is structured as follows. In the next section, we present the intuition and the formal aspects of our model. In section 3, we describe the main results. Section 4 concludes.
MODEL

Motivation and basic structure

To probe how resource competition and corporate incentive structures influence organizational search and adaptation, we develop a simulation model. In doing so, we draw on Levinthal and March's (1981) model of adaptive organizational search (cf. Miller & Arikan 2004). In this seminal model, an organization adapts over time by allocating resources to the refinement of existing technologies (exploitation) or the discovery of new technologies (exploration). The extent to which resources are allocated to these two conflicting demands is regulated by organizational aspirations. If performance is below the aspiration level, the organization allocates more resources to the exploration of new technologies, and vice versa (cf. March 1988; Greve 2003). How resources are allocated to technology development, in turn, influences performance and, hence, future aspirations.

We extend this basic modeling structure in fundamental ways by a) introducing a corporate office that allocates research resources, and b) by considering divisions that compete for resources in order to search for new technologies, or to refine existing ones. The corporate office allocates resources based on its beliefs about the relative performance potential of the two divisions (Noda & Bower, 1997). If corporate performance exceeds firm-level goals, resource allocation follows closely the current beliefs, i.e., the division that performs better will receive more resources for further technology development. If corporate performance is below firm-level goals, in contrast, the corporate office spreads research resources more evenly across the divisions in order to promote firm-wide exploration for new technologies (Greve 2003).
Each division can divide the resources it receives between the refinement of its current technology and the discovery of new, and potentially superior, technologies. Following Levinthal and March (1981), we model technology development as a process of drawing from a probability distribution; establishing distributions with different characteristics allows us to characterize the two search modes we are interested in, i.e., refinement search (exploitation) and discovery search (exploration). Specifically, discovery search, i.e., the generation of new technologies, is modeled as drawing from a lognormal distribution; if a new technology that is generated in this way is finally adopted, the division can further improve it through refinement search. These refinement efforts, in turn, are assumed to improve the mean of a division’s current technology, and to become less effective with repeated effort, as the potential to refine a specific technology is depleted over time. At the same time, the existing technology is subject to performance decay over time, and good technologies may consequently become obsolete. Varying the key parameters of this stochastic process – the refinement potential and the rate of decay – allows us to depict different task environments that the divisions may operate in. Moreover, resources and search are coupled: The more resources a division receives, the more often it can draw from the two probability distributions. After engaging in search, each division chooses the technology that has the highest mean, i.e., either a refinement of its existing technology, an entirely new technology, or the current technology (if none of the innovation efforts yielded a technology that proved to be superior). Divisional performance, finally, is modeled to be a stochastic outcome of adopting and implementing the selected technology.
How divisional managers make use of corporate resources, i.e., whether they allocate them to refinement or discovery, is determined by the organization's incentive structure – the central design element of our model. (Since our goal is to understand how organizational search and adaptation are affected by different incentive regimes that reward different types of performance, we make the assumption that the different incentive regimes align the interests of corporate office and divisions in a perfect manner.) Specifically, the incentives we model can induce three basic types of behavior among the managers of the divisions:

1. In the case of organizational incentives such as employee stock ownership programs or profit-sharing schemes, divisional managers base their behavior on organizational performance and thus essentially follow organizational aspirations. If corporate performance falls below the organizational goals, they allocate higher proportions of their resources to discovery search.

2. In the case of divisional incentives, rewards and behavior are driven by divisional goals and performances. We consider two broad classes of incentives that represent different approaches to goal setting and performance evaluation – historical aspirations and social aspirations. Divisional managers follow historical aspirations, if their goals and rewards depend on the historical track record of their division. A manager ramps up exploration, if performance falls below divisional aspirations.

3. In the case of social aspirations, finally, the relative contribution of a division to overall performance matters. Under this regime, a division also considers the performance of competing divisions when evaluating whether performance goals have been attained, thus capturing ideas of relative performance measurement
(Prendergast 1999). Again, if social aspirations are not met, the divisional manager engages in higher levels of discovery search.

**Implementation**

In sum, the model comprises three main elements: the task environment that is characterized by different probability distributions that describe how technologies can evolve; the corporate office that allocates resources to the divisions; and the actions of divisional managers that allocate resources to discovery search and refinement search, respectively, thereby responding to the organization’s incentive regime. In the following, we describe in detail how we represent each of these elements.

*Task environments*

Organizational performance results from the adoption and implementation of technologies by the divisions. All new technologies are drawn from a lognormal distribution with a mean of 0 and a standard deviation of 1. The model assumes a lognormal distribution, since this distribution accounts for the long tail of innovation outcomes (Levinthal and March 1981; Fleming 2001) and implies that only few new technologies tend to have a very high performance potential. Every time a resource unit is allocated to discovery search, the division receives a draw from the lognormal distribution. The draw signifies the mean of a new technology \( T_n \), and the new technology is adopted if the mean is higher than that of the current technology \( T^* \).

The refinement of technologies, in turn, serves to capture two related aspects. One is that newly conceived technologies may differ in their basic potential for further
refinement; the other is that the potential for further refinements may be exhausted more or less swiftly. Hence, to model these aspects, we define an initial rate of refinement that relates, for each newly-conceived technology, the variance of refinement draws to the initial value of the technology. Furthermore, we assume that the subsequent variance of refinement draws decreases at a fixed rate. Lastly, modeling the flipside of innovation and refinement, we assume that each existing technology deteriorates with a fixed rate. Again, each refinement draw signifies the mean of a new technology $T_{N_i}$ and the new technology is adopted if the mean is higher than that of the current technology $T^*$. 

Choosing different parameter values for the initial and subsequent rates of refinement as well as for the rate of technology decay allows us to depict fundamentally different task environments. A “stable” business environment, for example, is characterized by substantial potential for technology refinement and a very low rate of technological obsolescence. In a “hypercompetitive” environment, in contrast, technologies become outdated very fast (D’Aveni 1994), implying a low refinement potential and a high decay rate.

*Corporate performance, aspirations, and resource allocation*

At each point of time, the total performance of the organization is the sum of the divisional performances:

(1) \[ \Pi_t = \sum_{i=1}^{N} \pi_i \]

The performance of each division is a function of the currently adopted technology and a noise term:

(2) \[ \pi_i = T_{i}^* + \epsilon_i \]
Following Noda and Bower (1997), we assume that the process of allocating corporate resources resembles a reinforcement learning process, in which more (less) successful divisions receive more (less) resources. To model this behavior, we draw on the standard depiction of reinforcement learning (Sutton & Barto 1998). Based on prior performance signals, the corporate office forms beliefs about the relative attractiveness and abilities of the divisions. Specifically, the belief \( E \) about division \( i \) at time \( t \) is the exponentially weighted average of past performance (to allow for the discounting of older information):

\[
E_{i,t} = \beta \pi_{i,t} + (1 - \beta)E_{i,t-1}
\]

(3)

Resource allocation is then a probabilistic choice that is based on the beliefs about each division (e.g. Sutton & Barto 1998; Daw et al. 2006; Fang & Levinthal 2007):

\[
P_{i,t} = \frac{\exp^{E_{i,t}/\tau}}{\sum_{i=1}^{N} \exp^{E_{i,t}/\tau}},
\]

(4)

with \( P_{i,t} \) being the probability of allocating one resource unit out of \( R \) resources to division \( i \) in time step \( t \). The central parameter of equation (4) is \( \tau \) that regulates how closely resource allocation follows beliefs about the performance potential of divisions. Prior studies on organizational learning and adaptation (Greve 2003; Denrell 2008) have shown that organizations tend to become more explorative if performance falls below current aspirations. Hence, in allocating resources, the corporate office tends to disregard (follow) current beliefs when corporate performance \( \Pi_t \) is below (above) corporate aspirations \( A_t \). In that case, parameter \( \tau \) takes on a high (low) value.

Finally, current performance does not only influence resource allocation, but also the formation of aspirations. That is, we assume that corporate goal setting is informed by both corporate history as well as current performance. Formally, the corporate office forms
adaptive aspirations based on an exponentially weighted average of past and current performance (Levinthal and March 1988; Levinthal and March, 1993; Greve 2003):

\[ A_{t+1} = \alpha A_t + (1 - \alpha)\pi_t. \]

**Incentive regimes and divisional resource allocation**

How divisional managers distribute the resources they receive from the corporate office to technology discovery or technology refinement depends on the level of goal attainment. In principle, divisional managers allocate more resources to discovery if they fall short of goals. Different incentive systems then differ with respect to which goals become salient for behavior.

In the case of **organizational aspirations**, divisional managers explore more if corporate performance \(\Pi_t\) is below aspirations \(A_c\). This means that more resources get allocated to the discovery of a new technology, at the expense of further refinement of the current technology. In the opposite case of performance exceeding organizational aspirations, more resources are directed towards refinement.\(^1\)

Similarly, **historical aspirations** represent the setting that divisional goals and rewards depend on the historical track record of a division. The goal formation process is assumed to follow the standard way of forming historical aspirations, with the goal \(G\) of division \(i\) being updated as follows:

\[ G_{i,t+1} = \gamma G_{i,t} + (1 - \gamma)\pi_{i,t} \]

---

\(^1\) For our core results, we only consider extreme reactions (Denrell 2008), i.e., depending on goal attainment, all resources are allocated to either discovery or refinement; we make this assumption because we are primarily interested in how incentive systems shape divisional behavior, rather than in the question of how strongly to respond to a performance shortfall.
In equation (6), parameter $\gamma$ influences how much past performance is discounted in forming new goals. As in the case of organizational aspirations, a divisional manager explores more by allocating resources to discovery, if divisional performance is below the divisional goal. Thus, the primary difference between organizational and historical aspirations is that divisional resource allocation is based on the performance of the business unit rather than on that of the entire firm.

The same general principle also guides how we model social aspirations, with the crucial difference that divisional managers do not consider their performance per se, but relative to organizational performance. Hence, a divisional manager is doing well, if she maintains and improves her relative contribution to overall performance. If the relative share deteriorates, the division responds by allocating resources to technology discovery. Note that a drop in relative share may be caused by the activities of the other division that improves its own performance to a larger extent. Social comparison, in contrast to the other two incentive regimes, therefore explicitly considers the competition for rewards and resources among the divisions. As in the case of historical aspirations, a division’s social aspirations are formed and updated as follows:

$$S_{t,t+1} = \gamma S_{t,t} + (1 - \gamma) \frac{\pi_{t,t}}{\pi_c}$$

Finally, our model structure also allows us to consider mixed incentive regimes. A divisional manager may be evaluated and rewarded based on multiple goals such as organizational and performance. Here, we assume that the probability of allocating resources to technology discovery depends on the number of goals that were not met. For example, if a divisional manager is rewarded based on historical and social comparison (two goals), but only one goal is met, the probability of directing a resource unit to
technology discovery is $p = 0.5$. Similarly, if a managers considers three goals, of which two are not met, she will allocate her research resources to discovery search with a probability of $p = 2/3$. This approach reflects, albeit in a stylized manner, recent empirical and experimental work pointing out how considering multiple reference points simultaneously softens an agent’s willingness to take risks.

Experimental set-up

For our baseline results, we consider the following parameter values. Since we are interested in how a firm’s business environment affects the effectiveness of different incentive regimes for organizational adaptation, we consider two stylized environmental settings: In stable environments, new technologies have a high refinement potential that is not depleted quickly, while the rate of technological decay is low; in hypercompetitive environments, in contrast, new technologies have a low refinement potential that is quickly exhausted, all the while the technology becomes obsolete rapidly. (See Table 1 for the specific parameter values.)

Table 1: Stable vs. hypercompetitive environments

<table>
<thead>
<tr>
<th>Task environment</th>
<th>Initial rate of refinement</th>
<th>Rate of decay</th>
<th>Subsequent rate of refinement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stable</td>
<td>0.9</td>
<td>0.02</td>
<td>0.95</td>
</tr>
<tr>
<td>Hypercompetition</td>
<td>0.5</td>
<td>0.5</td>
<td>0.3</td>
</tr>
</tbody>
</table>

We assume two divisions throughout ($N = 2$), each facing the same task environment. For the updating of goals and aspirations – parameters $\alpha$, $\beta$, and $\gamma$ – we assume values of 0.5 throughout and report variations in the robustness section of the paper. For parameter $\tau$ in equation (4) that regulates corporate resource allocation, we
assume a value of $\tau = 1$ if aspirations are met, and $\tau = 1000$ otherwise. In the case of $\tau = 1$, resource allocation corresponds closely to the beliefs about divisions, while $\tau = 1000$ creates an even distribution that disregards current beliefs. Finally, we make the assumption that the amount of resources that the corporate office can distribute to the divisions is a linear function of organizational performance. We report average results over 5,000 simulation runs, each running for 500 time steps.

**RESULTS**

In the following, we describe the core results from running the model, thereby highlighting three particularly interesting results. First, there appear to be significant tradeoffs between the short-term and long-term performance of the incentives regimes. Second, the effectiveness of the incentive regimes critically depends on the nature of the task environment: Rewards based on a social comparison among divisions tend to provide long-term performance advantages in stable environments, while historical aspirations are most effective in the hypercompetitive setting. Third, in nearly every parameter configuration of our model, blended incentives – the combination of two or more distinct incentive regimes – prove to be more effective than a single dominant reward system.

**Stable task environments**

Figure 1 shows the results for a stable environment. Panel A reports the performance properties of three pure incentive regimes. Social comparison provides long-term performance advantages over both organizational and historical incentives. However, during the first fifty time steps, historical generally outperforms social incentives. This
result suggests that social comparison may result in a disadvantage for organizations that need to rapidly increase performance.

**Figure 1: Effects of basic incentives regimes in stable environments**

Panels B through D provide insights into the processes that underlie these results. There are two underlying aspects of the stable environment that bear noting. First, on average, exploitation of the current technology possessed by each division is likely to produce higher benefits than investment in the exploration of new technologies. The new technologies may be potentially attractive, but in reality the decay rate for existing technologies is so low – lower than the expected increase in performance from exploitation – that any incentive structure that increases the rate of exploration overly much is likely to
result in lower performance. Second, given the improvement potential of technologies in this environmental regime, it is critical that organizations follow any technological switches with sustained focus on exploitative improvement of the new technology.

In the short run, the incentive regimes that disregard competitive resource interactions in the organization – historical and organizational – start out with sustained technology refinement, leading to a virtuous cycle of refinement, performance improvement, and goal attainment. This virtuous cycle continues without interruptions, as long as there remains untapped refinement potential, i.e., as long as the rate of technology improvement is larger than the decay rate. The social comparison regime, in contrast, is somewhat more brittle. Small variations that upset the relative performance contributions lead to a sharp increase in exploration, because one of the divisions falls below targets and responds by directing resources toward technology discovery, despite substantial refinement potential of the existing technology. Thus, in the short run, one or both divisions under the social aspirations regime are likely to abandon their existing technology prematurely, which increases investment in exploration that decreases performance (relative to historical and organizational aspirations).

Matters become more interesting as we move to the longer-run performance outcomes, when the initial technologies have exhausted their refinement potential and the rate of obsolescence (decay) starts to impact performance negatively (around period 30). The primary long-run difference between social comparison on the one hand, and historical and organizational comparison on the other, is that the former goes through a relatively short period of intensive exploration when early performance drops. This results in two outcomes that help the social aspiration condition break from its lower level of
performance. First, one division is likely to produce a technology with exceptionally high current and potential future quality, which boosts its performance. Second, this increasing gap in the relative performance levels of the divisions’ technologies causes the leading division to invest primarily in the refinement of the existing technology (which, in the stable regime, is positive for performance), and the laggard division to invest predominately in exploration to try to catch up. This resource allocation pattern tends to exacerbate the performance gap between the two divisions (Panel D), which makes things difficult for the laggard division but (given the strong potential for refinement in this environmental condition) is good for the firm overall. Thus, organizational performance in the social condition increases dramatically in the long term. At some point, the laggard division experiences its own breakthrough, and the cycle repeats: the historically inferior division becomes more dominant, while the superior division becomes less important and adapts its aspiration, while still retaining the old technology. Thus, the entire organization (one division at a time) goes through cycles of tempered exploration provided by resource competition. In a way, thus, the organization resembles an ambidextrous organization, in which the inferior division explores relatively more. This fact that the laggard division is typically the one that engages in more exploration makes the investment in speculative exploration less costly, because the opportunity cost (in terms of the potential refinement of the laggard technology) is relatively lower. Corporate headquarter reinforces this, because it reallocates resources away from the old technology and discovery to the new technology and refinement. Overall, rewards based on social comparison thereby promote a measured approach to technology refinement and discovery.
The two other incentive regimes, in contrast, are much more prone to over-exploitation, especially the incentives based on organizational aspirations. Firms in the organizational or historical condition may often reach a point relatively early in a given technology’s lifecycle where (probabilistically) one period’s performance improvement is below the decay rate, which then pushes the divisions towards more exploration of new technologies. To the extent that this exploration produces a suitable new technology, the organizational and historical regimes differ in how they respond. As the new technology must be superior to the existing technology of the division in order to prompt a change, the technological switch pushes a firm focused on historical (division) aspirations to shift resources to exploitation, which produces sustained improved performance for a period of time. For a firm focused on organizational aspirations, however, there is a strong likelihood that the incremental improvement from the new technology will not be enough to overcome any decline in the other division’s technology, and thus the technological switch is not followed by sustained exploitation – instead the firm continues to explore in attempt to find a solution. This is a classic example of a “failure trap” (Levinthal & March, 1993), where a firm explores in order to improve performance and continues explore constantly even as performance continues to erode. Thus, precious resources are wasted on further exploration, at the expense of refinement. We see this manifested in different ways in Panels B and C. For the organizational aspiration condition, the firms invest a large volume of resources in exploration, and switches relatively frequently. Given the nature of the external environment, this suggests that these firms are likely abandoning a good technology before it is necessary. We interpret this as indicating that the focus on organizational aspirations does not cause the “right” division to direct resources towards
exploration and switching (e.g., the laggard division), but affects both divisions equally. Performance feedback versus organizational aspirations is quite coarse and disregards the particular situation of the division. That is, the organizations may over-react to bad news, because exploration also affects divisions that should invest into technology refinement to increase performance. For the historical aspiration condition, these firms also invest a good deal of resources in exploration activities, but they actually switch less often, suggesting that these investments are mostly wasted – the division would have been better off exploring less, as the lowered investment in exploitation is counterproductive given the potential of the technologies.

**Hypercompetitive task environments**

Figure 2 reports the results for hypercompetitive environments. In such environments, technologies have low refinement potential and become obsolete rapidly. These features shift the emphasis firmly toward sustained exploration of new technologies. In terms of performance, the tradeoff between the short-term and the long-term disappears. More importantly, social comparison now clearly underperforms the two alternative incentive regimes, a striking reversal of the ranking in the stable environment.
Figure 2: Effects of basic incentives regimes in hypercompetitive environments

Panel A

Panel B

Panel C

Panel D

Social comparison performs badly because the organization settles on a relatively low and declining rate of exploration (Panel B). The lower rate of exploration, in turn, leads to fewer technological switches, as the organization spends too many resources on refining declining technologies. What is happening here is that the balanced approach to technological exploration provided by social comparison turns into a liability. The organization settles on low, but fairly stable performance outcomes in which the relative importance of the two divisions become much less pronounced. In the stable environment, social comparison took advantage of the strong differences between divisions in terms of
technological performance, but this central outcome is notably absent in the hypercompetitive context (Panel D).

Historical and organizational incentives, on the other hand, perform equally well. Interestingly, the two incentive regimes achieve the same performance with markedly different adaptation strategies. In the case of organizational aspirations, the organizational rate of exploration is high, resulting in a rapid rate of technological change-overs. Organizational aspirations thereby create an organizational setting in which performance primarily comes from discovery: The organization spends a significant share of research resources on exploration (> 60%, Panel B), while investing relatively less into refinement. This improves the likelihood of adopting a new technology rapidly. Since the rate of exploration depends on organizational aspirations, the organization goes through cycles of exploration by both divisions, discovery of a new technology and performance improvement, a brief period of refinement while aspirations are met, and a rejuvenation of exploration as soon as performance falls again. Performance is thus stabilized by quickly replacing declining technologies. In contrast, historical aspiration regimes spend significantly more resources on refinement. Here, the divisions decide when to switch from refinement to discovery. If organizational performance drops below aspirations, research resources are allocated away from the leading division to the laggard, exactly where technology discovery has the highest probability of finding a better-performing new technology. The division explores as long as performance is below divisional goals and, because of rapidly deteriorating technological performance, a change-over happens only if exploration uncovers a new better technology that improves overall performance.
Overall, social comparison is not effective in hypercompetitive environments, because the system learns to accept low-performance outcomes and primarily responds to environmental turbulence by lowering its targets, both on the organizational and the divisional level. The other two structures provide feedback mechanisms that prevent this downward spiral. In the case of organizational aspirations, this is provided by the massive switch over to exploration if performance targets are not met, while in the case of divisional aspirations, performance shortfalls reinforce resource allocations and, thus, exploration, in the laggard division.

**Mixed incentive systems**

Exploring the effects of mixed incentives systems, rather than pure types only, yields a set of intriguing results. To some extent, combining incentive regimes produces results that mirror the best performing of the individual regimes, but the results also suggest that performance may actually decline from combining too many regimes at the same time.

Consider, first, the dynamics in stable environments (Figure 3). While social aspirations had been the most effective pure incentive type, we find that any incentive mix that contains social considerations results in similar performance trajectories and levels (Panel A). This is interesting because, from a performance perspective, the combinations seem to be embodying the benefits of the best-performing incentive structure without any of the negatives. When we look to more details about organizational behavior, however, we see that the different incentive regimes that contain social aspirations exhibit highly different exploration patterns (Panel B). While most result in higher exploration rates than social aspirations alone, blending of all three incentive types results in considerably less
exploration. Thus, while Panel B suggests that the combination of any two incentive regimes produces a rate of exploration that is near the average of the two pure type rates of exploration, the combination of all three incentive regimes produces a very different rate of exploration, in this case the lowest of all possible incentive structures. Despite these differences in the rate of exploration in Panel B, we find that the rate of switches (Panel C) and the differences in technologies between the divisions (Panel D) look more like the curves for overall performance – any combination that includes social seems to perform the best, and to perform at a level relatively comparable with social alone. These results strengthen our earlier finding that incentives based on social comparison and resource competition perform best in fairly stable environments.
Figure 3: Effects of mixed incentives regimes in stable environments

These dynamics and performance implications are driven by mixed incentives (that contain social aspirations) establishing a more nuanced approach to exploration within both divisions, while at the same time devoting sufficient resources to reap the refinement potential of the technologies in this kind of environment. For mixed incentives that contain social incentives, exploration is triggered not only if the relative performance targets are not met, but also if any other aspiration level is not achieved. Because often only a single aspiration level is not met at any given time, a division does not always allocate all of its resources to exploration, but only a fraction. In consequence, the overall level of
exploration does increase, but the leading division still devotes sufficient resources to refinement, thus increasing the performance gap to the laggard division.

In the case of hypercompetitive environments (Figure 4), there are both similarities and differences with the case of the stable environment. In this case, any pairwise combination that contains either historical or organizational aspirations results in a similar performance trajectory than the two pure types alone (Panel A). The clearly notable exception, however, is the case of all three incentive regimes being combined. Such a combination produces dramatically lower – and consistently declining – overall performance. This pattern shows up in Panels B through D, as well, as the three-way combination consistently produces a lower share of exploration, a lower rate of switches, and minimal technological performance differences between divisions. It appears that the full combination of incentive regimes leads the organization on downward spiral that cannot be broken, as (presumably) aspirations continue to be scaled back and the organization becomes content with its decline.
Figure 4: Effects of mixed incentives regimes in hypercompetitive environments

For the other combinations, the results appear more expected. Any combination that includes historical or organizational aspirations outperforms the purely social aspirations, and in general the combinations that include social aspirations produce lower rates of exploration (Panel B) and technological switching (Panel C) than those combinations that do not include social aspirations. Thus, the deleterious effect of social comparison in the hypercompetitive world seems to spill over to behaviors for combined incentive regimes, but interestingly produces very minimal differences in overall performance. Though the differences are small, the combined historical and organizational produces the highest performance, and it does so despite having a lower level of exploration and switching than
the purely organizational level. This may suggest that too much exploration is a bad thing even in the hypercompetitive context, or at the least that the wrong division is the one allocating more resources to exploration in the purely organizational condition.

CONCLUSION

This study sought to explore the effects of social comparison between divisions within a multidivisional firm. Specifically, we used a computational model to investigate the extent to which competition between divisions for scarce research resources affected the behavior and performance of the two divisions. We found that, in stable environments, the effect of social comparison and competition is actually beneficial for performance, as this tends to minimize resources allocated to finding new technologies that are less vital in a stable world. By contrast, social comparison is detrimental to performance in the more hypercompetitive environment largely for the same reason – it produces a lower rate of exploration. The organizational and historical incentives perform relatively similarly, but do so through different behaviors in terms of resource allocation. And the combination of incentives – especially the combination of all three incentive structures – can produce very different results from just a weighted average of the three pure-type incentive regimes. We discuss the implications of these findings in greater detail below.

First, our finding that social comparison and inter-divisional competition is good under stable environments but bad under more dynamic environments has important implications for the infrequent but ongoing discussions about the role of intra-organizational competition (e.g., Hill, Hitt & Hoskisson, 1992; Marino & Zábojník, 2004). Much of the work focused on intra-organizational competition has dealt primarily with
end-market competition, where one division may cannibalize the other division’s sales. We show that such a direct interrelationship between divisions is not the only type of competition that matters, but that any competition for a scarce resource (in this case, R&D opportunities) may have theoretical and real world implications for organizational behavior. The fact that social comparisons are beneficial in stable conditions but damaging in dynamic conditions suggests that senior managers may need to be very careful about promoting or encouraging intra-organizational rivalry, depending on the state of the external environment. These findings produce some empirically testable hypotheses – namely that multidivisional firms (where rivalry is at least possible) may behave differently from single division firms, and may provide additional insight into the mixed findings on the performance of diversified organizations (e.g., Villalonga, 2004; Markides & Williamson, 1994).

Second, our findings related to the similarities and differences between organizational and historical aspirations speak to the existing literatures on typical incentive structures for managers. While boards of directors and senior managers tend to adopt organization-level incentives primarily to reduce agency costs, our results suggest that at least within the realm of resource allocation and R&D decisions, the two incentive structures (one focused more on a baseline of prior divisional performance while the other setting the baseline on organizational performance) produce relatively similar (positive) results in hypercompetitive worlds, but different results in more stable environments. Specifically, our results suggest that in stable environments, organization-level incentives encourage managers to explore and switch technologies too frequently, and this is specifically because the feedback and incentives are so coarse – what is right for one
division that is struggling may not be right for another division that is performing better. Thus, the blanket usage of organizational incentives may produce behavior that is counterproductive, as it uses the same incentive and feedback mechanisms for two division managers that may have very different circumstances and behavioral needs to improve performance.

Finally, the interesting results concerning the combination of the different incentive regimes suggest that such combinations may not always produce expected results. The logical expectation would be that a combination of two pure-type incentives would produce behavior that falls between the behavior of the pure-type incentives, but this often is not true. In some cases (namely the combination of social aspirations with any other aspirations in the stable environment), the results suggest that the combination has the attributes of the best-performing pure incentive, ignoring the other included incentive structures. In other circumstances (namely the case of the three combined incentive types in the hypercompetitive regime), a combination may outperform or underperform any of the underlying pure-type incentives. Given the proclivity of firms to offer combination-type incentives to managers, that as important implications. More work should be done on diagnosing both the mathematical and behavioral reasons why incentive combinations may not be simple linear combinations.

Overall, this study focuses on the implications of intra-organizational competition for scarce R&D resources, and compares aspirational search based on divisional rivalries with more traditional divisional and organizational incentive schemes. The results contribute both to the narrow literature on intra-organizational competition, but also to
broader topics in strategy and organizations dealing with diversification and appropriate incentive structures.
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