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Organizational Structure and Firm Innovation in a Retail Chain

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Abstract

Two organizational structures for a retail chain are examined for their effect on the rate of firm innovation. A centralized organization is defined as one in which store practices are mandated from corporate headquarters (HQ) and this results in HQ being the sole source of new ideas. A decentralized organization gives freedom to store managers to adopt their own ideas and disseminates innovations made by store managers. The difference in average profit between the centralized and decentralized organizations is found to be a non-monotonic function of innovative opportunities. The centralized organization is preferred when innovative opportunities are moderate while the decentralized organization is preferred when such opportunities are rich. Centralization also tends to fare better in environments in which ideas are relatively complex.

Keywords: organizational structure, innovation, retail chains

1. Introduction

A fundamental question related to the firm is how centralized it should be. With a retail chain, this question takes the form of how much discretion corporate headquarters should give to store managers. Should a tightly-controlled set of operating procedures be mandated or should store managers be given considerable leeway with respect to running their stores in the anticipation that this will induce an entrepreneurial spirit. Historically, different retail chains have answered this question in different ways in that chains have varied in the degree of discretion which is left to store managers. A classic example is Montgomery Ward and Sears, Roebuck during the 1930s and 40s.

> A pair of companies and a pair of men offer interesting contrasts: Montgomery Ward and Sears, Roebuck; Sewell Avery and General Wood. Avery was one of the most autocratic big businessmen of this century; Wood, one of the most democratic. Ward's under Avery was tightly centralized and rigidly controlled; Sears under Wood was highly decentralized and permissive to a degree unique in large-scale organizations.
>
> (Worthy 1984: xiv)

More recently, decentralization has been partially credited with the success of several retail chains. Many industry analysts and company founders stress the importance of giving store managers the freedom to act.

> At [Wal-Mart's] size today, there's all sorts of pressure to regiment and standardize and operate as a centrally driven chain, where everything is decided on high and passed down to the stores. In a system like that, there's absolutely no room for creativity, no place for the Maverick merchant that I was in the early days at Ben Franklin, no call for the entrepreneur or the promoter.
>
> (Walton 1992: 218)

> [A] manager of 20 Nordstrom stores in southern California describes the Nordstrom style: "Many times I've seen Mr. Jim [Nordstrom, co-chairman] get up and say: 'This is your own business. Do your own thing. Don't listen to us in Seattle. Listen to your customer. We give you permission to take care of your customer'."
>
> (Lubove 1995: 45)

> [Bernie] Marcus [co-founder of Home Depot] gives regional and store managers a great deal of autonomy so they can make buying decisions.
>
> (*Discount Store News* 1995: 29)

> Bed Bath & Beyond has remained true to three founding principles: minimal advertising (except for new store introductions), very little warehouse space and store autonomy. Each store is decentralized and managers are given a great deal of freedom in all facets of merchandising.
>
> (Wilson 1993: 23)

What difference does the organizational structure make for the performance of a retail chain? How does the amount of discretion given to managers influence store and corporate performance? One important dimension of performance is the rate of innovation particularly with respect to store practices. There would seem to be the following trade-off associated with a more decentralized structure. Giving discretion provides managers with the opportunity to implement better ways of doing things that they discover as a byproduct of operating a store. When combined with an effective procedure for identifying attractive ideas and disseminating them throughout the chain, a decentralized structure may be a powerful engine for improving store efficiency. The downside to giving managers discretion is that it may result in them adopting a lot of bad ideas and rejecting a lot of good ones; perhaps more so than if corporate headquarters mandated what they considered to be best practices. While having headquarters mandate practices would take care of that problem, it would prevent managers from experimenting with their own ideas and thus neutralize them as a source of new ideas. Robert E. Wood, who as president engineered Sears' immensely successful expansion from mail-order to retail, describes this trade-off and provides his own opinion on how these factors net out:

> ... it is essential that the responsibility be placed on the [store] manager. If his initiative ... is removed and if he is visited constantly by supervisors and inspectors and representatives of the parent organization, it is only a matter of time before his morale will break down ... The natural human tendency for the men at the top and for the bright young members of their staff, if they discover a weakness is to set up a system of checks and inspection that will obviate that weakness, forgetting that in most cases the remedy finally turns out to be worse than the disease. While systems are important, our main reliance must always be put on *men* rather than systems. If we devise too elaborate a system of checks and balances, and have too many inspectors going out as representatives of the parent organization, it will be only a matter of time before the self-reliance and initiative of our managers will be destroyed and our organization will be gradually converted into a huge bureaucracy ...
>
> (Robert E. Wood as quoted in Worthy 1984: 119–120)

A consistent view is provided by outside observers:

> The Sears principle of decentralized retail administration is now the cornerstone of organization policy, responsible to a great extent for the company's retail success, as well as for some difficulties which occur now and then, such as local overpricing of goods, poor service, out-of-stock conditions, and excessive and unbalanced inventories. But company officers believe strongly that the advantages of decentralization far outweigh its disadvantages.
>
> (Emmet and Jeuck 1950: 371–372)

Our research objective is to develop insight into the determinants of the appropriate organizational structure and, in particular, to further our understanding as to how the characteristics of a firm's environment determines which organizational form will do well. For example, which type of organization will perform better in an industry rich in innovative opportunities? What about an industry in which operating practices are relatively complex? While our focus is on retail chains, much of what we have to say will be relevant to multi-plant manufacturers.

2. An Organizational Model of a Retail Chain

In modelling firm innovation, we have in mind ideas, perhaps many of them minor, that improve practices at the store level; what Nelson and Winter (1982) might refer to as "routines". Examples would include a "greeter" at the store entrance (introduced by a Wal-Mart store manager to control theft; Walton 1992), selling individual glasses and not just sets of glasses (introduced by a store manager at Bed, Bath and Beyond), a co-branded credit card (first introduced by Kroger in 1993; *Chain Store Age Executive* 1995), and a convenience store within a store (as Kmart has recently developed; Liebeck 1996). While the incentive contracts provided to store managers are clearly relevant to the amount of innovation coming out of stores, our focus at this stage is on a much more primitive factor: the implications of organizational structure on innovation through its effect on the ability of store managers

to act. Organizational structures are presumed to differ by the extent of discretion given to store managers. As described by Arthur Martinez, current CEO of Sears, Roebuck:

> [Our policies and procedures are described by] two very simple booklets. We call them "Freedoms" and "Obligations". We're trying to tell our managers what they're responsible for, what freedoms they have to make decisions, and where to turn if they need help. (*Fortune* 1995: 98)

The focus of this research is then on that component of organizational structure which determines how many tasks are defined as "freedoms" and how many as "obligations".

A crucial presumption of our analysis is that a store manager is a minimal source of innovation if he is not given the right to implement his own ideas. For a store manager to be a productive source of ideas for improving practices, he must first be given the responsibility to determine the practices of his own store.[1] Obviously, there are certain operational rules that coordination and efficiency demand all store managers to follow. Our concern is then with those tasks that realistically could be left to the discretion of store managers. This might include pricing, product mix, promotion, display, and hiring and training practices.

In our framework, greater decentralization means that more tasks are left to the discretion of store managers. We limit our attention to two extreme organizational forms.[2] The *centralized organization* is one in which all store practices are mandated by corporate headquarters (HQ) and this has the implication of stultifying the innovativeness of store managers. The sole source of new practices is then HQ.[3] The *decentralized organization* gives considerable freedom to store managers and, as a result, has two distinct sources of innovation: store managers and HQ. Each store manager comes up with ideas and decides whether or not to implement them. Within this structure, HQ has two tasks. First, it invests resources to develop new practices. In the spirit of providing discretion, HQ can only recommend ideas with their implementation being the prerogative of store managers. Second, HQ identifies, evaluates, and potentially recommends those ideas implemented by store managers. This function is presumably performed by district managers who lie between the top levels of management and store managers:

> ... the real job of a district manager [at J.C. Penney] is to bring information and guidance from the central office to the store manager and to bring to the central office information they gather from the stores; but, more than that, to pollenize all stores in their territories with whatever useful information they gather while visiting them. (Beasley 1948: 235)

Our plan is to compare the rate of innovation associated with these two organizational forms. As described below, the innovation process is modelled as having two components: discovery and evaluation. Whether it is a store manager or a member of the HQ R&D staff, discovery means coming up with an idea and this is presumed to be stochastic. Of course, not every idea need be implemented. Each idea will be evaluated which is itself a process fraught with uncertainty. Ideas are implemented only if they pass muster upon inspection.

2.1. *Decentralized Organization*

Consider a two-level hierarchical firm. At the top level is corporate headquarters (HQ) and at the bottom level are n stores where $n \geq 1$. Store i is represented by a pair of probability distributions: $(F_i(\cdot), G_i(\cdot))$; where $F_i(\cdot) : \mathbf{R} \to [0, 1]$ and $G_i(\cdot) : \mathbf{R} \to [0, 1]$. As to be made clear below, $F_i(\cdot)$ and $G_i(\cdot)$ describe the stochastic possibilities associated with the discovery process and evaluation process, respectively, of store i. HQ is represented by a pair of probability distributions: $(H(\cdot), K(\cdot))$; where $H(\cdot) : \mathbf{R} \to [0, 1]$ and $K(\cdot) : \mathbf{R} \to [0, 1]$. $H(\cdot)$ and $K(\cdot)$ describe the stochastic possibilities associated with the discovery process and evaluation process, respectively, of HQ. HQ decides how many draws, m, to make where $m \in \{0, 1, \ldots\}$ and m draws cost $f(m)$. It is assumed that $f(\cdot) : \{0, 1, 2, \ldots\} \to \mathbf{R}_+$ where cost and incremental cost are increasing in the number of draws: $f(m'+1) > f(m')$ and $f(m'+2) - f(m'+1) > f(m'+1) - f(m')$ for all $m' \in \{0, 1, \ldots\}$.

The following three-stage process takes place. In stage 1, each store makes a single discovery. For store i, this is represented as a draw from $\mathbf{R}$ according to the c.d.f. $F_i(\cdot)$. The value of a draw measures the contribution to store profit if it is adopted. This draw is presumed to be costless as we imagine store managers serendipitously discovering new operating practices. Having come up with a new idea, a store manager evaluates it and then decides whether to adopt it. The adoption rule will be described momentarily. In stage 2, HQ decides on how many ideas to generate with m ideas costing the firm $f(m)$. Each idea is represented as an independent draw from $\mathbf{R}$ according to the c.d.f. $H(\cdot)$. We imagine ideas being generated by a R&D staff where more ideas require more staff. Alternatively, we could state the problem as one in which HQ decides how much to invest in R&D where an expenditure of z yields $f^{-1}(z)$ ideas. Also as part of stage 2, HQ observes (with some probability) and then evaluates each of the stage 1 ideas adopted by the stores as well as its own m ideas and decides which if any to pass along to the stores. Hence, a store idea is only considered by HQ for dissemination to other stores if it is adopted by the store manager that discovered it.[4] In stage 3, the stores receive those ideas from HQ that were acceptable to HQ, which can be as few as zero and as many as $m+n$, evaluates each of them, and decides which if any to adopt. A store manager does not re-evaluate his own idea, however. The change in profit of store i equals the sum of the values of all adopted draws. The change in firm profit is the sum of the changes in the profits of the n stores less the cost of the HQ's draws.

With HQ making m draws, there are a total of $m+n$ draws or ideas: $\{x_1, \ldots, x_m, x_{m+1}, \ldots, x_{m+n}\}$; where we have numerated them so that the first j values represent HQ's ideas and the $m+i$th value is store i's idea. As mentioned above, HQ and stores evaluate all ideas with which they are confronted. This evaluation is done only with error. Store i's evaluation of an idea with a true value of x_j is represented as a noisy signal equal to $x_j + \epsilon_{i,j}$ where the evaluation error, $\epsilon_{i,j}$, is randomly drawn from $\mathbf{R}$ according to $G_i(\cdot)$. HQ receives a signal $x_j + \epsilon_j$ when it evaluates a draw with true value of x_j where the evaluation error, ϵ_j, is randomly drawn from $\mathbf{R}$ according to $K(\cdot)$.

Having evaluated an idea, we assume each agent is endowed with a rule for adopting it. These rules, described in (1)–(3), are normalized so that an idea is rejected if the signal is

negative and is adopted otherwise.

Store i adopts its own idea if and only if: $x_{m+i} + \epsilon_{i,m+i} \geq 0$. (1)

HQ passes along its own jth idea to all stores if and only if: $x_j + \epsilon_j \geq 0$. (2)

Store i adopts HQ's jth idea if and only if: $x_j + \epsilon_j \geq 0$ and $x_j + \epsilon_{i,j} \geq 0$. (3)

The first condition in (3) ensures that HQ passes the idea along to the stores while the second condition results in store i adopting the idea. With some probability $p \in [0, 1]$, a store's adopted idea is observed by HQ. In that event, we define (4).

With probability p, store k's idea is passed along to all stores (by HQ)
if and only if: $x_{m+k} + \epsilon_{k,m+k} \geq 0$, and $x_{m+k} + \epsilon_{m+k} \geq 0$. (4)

The first condition in (4) results in store k adopting its own idea, as only then does HQ have the opportunity to observe it, while the second condition results in HQ passing the idea along to the other $n - 1$ stores. Once again assuming that HQ observes the adopted idea of store k, we have

With probability p, store k's idea is adopted by store i ($\neq k$) if and only if:
$x_{m+k} + \epsilon_{k,m+k} \geq 0$, $x_{m+k} + \epsilon_{m+k} \geq 0$, and $x_{m+k} + \epsilon_{i,m+k} \geq 0$. (5)

The first two conditions result in store i learning of store k's idea while the third condition results in store i adopting it.

Given these adoption rules, the change in firm profit under the decentralized structure, denoted π_d, is defined by: $\pi_d = \sum_{i=1}^{n} \pi_i$, where π_i is the change in store i's profit; and its expectation is:

$$E[\pi_d(m)] = m\int x[1 - K(-x)] \sum_{i=1}^{n} [1 - G_i(-x)]\, dH(x) - f(m) + \sum_{i=1}^{n} \int x[1 - G_i(-x)] \left\{ 1 + p[1 - K(-x)] \left[\sum_{\substack{j \neq i \\ j=1}}^{n} [1 - G_j(-x)] \right] \right\} dF_i(x). \quad (6)$$

Given the decentralized structure, HQ is assumed to choose m so as to maximize $E[\pi_d(m)]$.

2.2. *Centralized Organization*

Under centralization, all ideas are generated by HQ. HQ decides on how many draws and then mandates that all stores adopt its jth draw iff: $x_j + \epsilon_j \geq 0$, $j \in \{1, \ldots, m\}$. Letting

π_c denote the change in chain profit, its expectation is:

$$E[\pi_c(m)] = nm \int x[1 - K(-x)]\, dH(x) - f(m). \tag{7}$$

For the centralized organization, HQ chooses m to maximize $E[\pi_c(m)]$.

2.3. Measuring Relative Performance of Organizational Structures

The rate of innovation is measured by the average change in profit. We define V to assess how organizational structure influences the rate of innovation.

$$V \equiv E[\pi_c^*] - E[\pi_d^*], \tag{8}$$

where

$$E[\pi_c^*] = \max_{m\in\{0,1,2\ldots\}} E[\pi_c(m)] \quad \text{and} \quad E[\pi_d^*] = \max_{m\in\{0,1,2\ldots\}} E[\pi_d(m)].$$

While HQ is modelled as optimally choosing the number of draws, adoption rules are exogenously specified. The rationale for this asymmetry is that there is much more discretion over the amount of R&D the firm does than over agents' adoption rules. For the purpose of taking account of how parameters in the model influence the choice of R&D, the number of draws is specified to be that which maximizes expected profit given the organizational structure. The exogenous specification of adoption rules is predicated upon the view that the evaluation of ideas is subjective. Adoption rules represent the mental process by which someone, either at HQ or at a store, comes to the conclusion that he "likes" or "dislikes" an idea. We are then viewing this subjective evaluation process as an individual trait which is no more subject to control than one's risk preferences and degree of optimism. While we believe there is definite validity to this specification, it is admittedly extreme as one would expect a store manager to view an idea differently depending on whether it was his own or had been recommended by HQ. At present, such factors are not taken account of.

Our formulation of the firm is most closely related to that developed in (Sah and Stiglitz 1986).[5] They compare a hierarchy (which is basically our decentralized organization) with a polyarchy (which has ideas being evaluated by two parallel divisions). A key assumption in their model is that the process by which ideas are generated is independent of the organizational structure so that the structures differ only in the evaluation and adoption of ideas. Our model, of course, encompasses the implications of organizational form for discovery as well as evaluation. We will see that an important determinant of the relative performance of these organizational forms is how discovery interacts with evaluation.

A second related work is (Rotemberg and Saloner 1993) which examines how innovative opportunities influence the relative performance of various leadership styles. They consider a structure in which a manager must decide whether to invest effort in researching a project. The manager then decides whether to recommend the project for implementation and his superior—the CEO or "leader"—decides whether or not to implement it. Leadership styles considered range from "authoritative" to "participatory", in which a more participatory

leader corresponds to a more decentralized organization in that the manager has more control over what is implemented. Measuring innovative opportunities in a manner similar to how we have measured them, they find that the authoritative style yields higher expected profit when innovative opportunities are sufficiently poor and the participatory style yields higher expected profit when innovative opportunities are moderate. The two styles have equivalent outcomes when innovative opportunities are large. By focusing on a different dimension to the organization, this work is complementary to ours.

3. The Effect of HQ and Store Managers on the Rate of Innovation

Our analysis involves exploring how various factors influence the relative attractiveness of the centralized and decentralized organizations. Most of it is conducted through numerical simulation because analytical methods are generally intractable.[6]

3.1. Method of Simulation

All of our simulations are performed assuming identical store managers, $G(\cdot)$, $H(\cdot)$, $F(\cdot)$, and $K(\cdot)$ are normal distributions, and $f(m) = \theta m^2$. The baseline simulation assumes: $n = 10$, $p = 0.25$, $\theta = 0.3$, and $G(\cdot)$, $H(\cdot)$, $F(\cdot)$, and $K(\cdot)$ are standard normal distributions (that is, mean of 0 and standard deviation of 1). Unless stated otherwise, all results are generated for when parameters are set at their baseline values. Each simulation involved 2000 draws. We use the following notation:

$mi1$ = mean of HQ's discovery draw (or idea)
$si1$ = standard deviation of HQ's discovery draw
$me1$ = mean of HQ's evaluation error
$se1$ = standard deviation of HQ's evaluation error
$mi2$ = mean of a store manager's discovery draw
$si2$ = standard deviation of a store manager's discovery draw
$me2$ = mean of a store manager's evaluation error
$se2$ = standard deviation of a store manager's evaluation error

Thus, 1 refers to HQ and 2 refers to store managers. Also, one can think of "*i*" denoting "innovation" and "*e*" denoting "evaluation".

3.2. Efficacy in Discovery

In our model, there are two sources of discovery: HQ and the store managers. Our purpose in this section is to establish the specific relationships between the efficacy in discovery of these sources and the difference between expected profit under centralization and decentralization, V.

We first consider the effect of the average value of a store manager's idea, $mi2$, on V. Recall that the store managers are a source of innovation only under decentralization. Any impact that $mi2$ has on V, hence, is only through expected profit under decentralization. The relationship tends to be monotonic and its associated intuition rather straightforward. When store managers are sufficiently inept in discovering useful innovations, they tend to

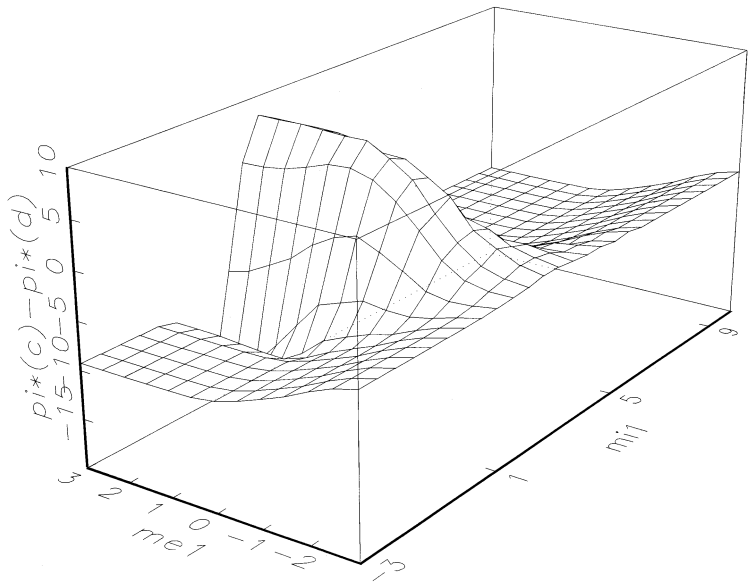

Figure 1. $V(mi1, me1)$.

reject all of their ideas so that there is little impact of changing store manager efficacy in discovery on the profit differential between the two organizational forms. When instead store managers are sufficiently good at discovery, some of their ideas are adopted so that improving the quality of those ideas raises the profit generated by decentralization. This makes V decreasing in $mi2$ because only the decentralized structure draws on the innovativeness of store managers.

Property 1. When store managers are sufficiently good at discovery, the relative attractiveness of the decentralized organization is increasing in the efficacy of store manager discovery.

Turning to the effect of changing the efficacy of HQ discovery, figure 1 shows V as a function of the average value of a HQ idea, $mi1$, for $me1 \in [-3, 3]$. As can be seen, the relationship between V and $mi1$ is highly non-monotonic for all values of $me1$. In order to explore the precise relationship between V and $mi1$, let us focus on $V(mi1)$ for the baseline case of $me1 = 0$. This corresponds to the cross-section of the surface in figure 1 at $me1 = 0$. When $mi1$ is sufficiently negative ($mi1 \leq -1$), the relative attractiveness of the centralized structure (as measured by V) is independent of the average value of a HQ idea for the simple reason that there is no HQ R&D: $m_c^* = 0$ and $m_d^* = 0$. When $mi1$ is at worst moderately negative ($mi1 \geq -1$), it is optimal for HQ to invest in R&D. Note that this occurs when the average draw is negative because selective implementation results in the average value of an adopted draw being positive. Now that HQ is engaged in discovery, the relative attractiveness of the centralized structure *declines* with an improvement in the efficacy of HQ discovery. The basis for this result rests in a crucial distinction between

the two organizational forms. Centralization involves a single screen for HQ ideas while decentralization involves two screens: HQ and store managers. When HQ ideas are, on average, negative, the second screen is quite valuable in weeding out bad draws since a majority of draws are bad. This is more acute as the number of HQ ideas increases which occurs when $mi1$ is higher. This results in V being decreasing in $mi1$ for $mi1 \in [-1, -0.5]$. Since the value of the second screen lessens as the proportion of HQ ideas that are bad declines, the conservatism implicit in the decentralized structure becomes less useful as $mi1$ increases and ultimately becomes counterproductive when $mi1$ is no longer low. This results in V being increasing in $mi1$ for $mi1 \in [-0.5, 2]$. What is also true, however, is that when $mi1$ is high enough, further increases in $mi1$ reduces the disparity between having one and two screens since, due to the high quality of the ideas, a higher fraction of ideas will pass both screens. This implies that the value of HQ innovation is converging under the two structures and therefore it is innovations generated by store managers under decentralization that increasingly becomes the distinguishing factor. This results in V being decreasing in $mi1$ for $mi1 \geq 2$. Finally, when $mi1 \geq 6$, almost all HQ ideas are adopted under both structures and, as a result, $m_c^* \cong m_d^*$. V then measures the innovative contribution of stores so that it is independent of $mi1$.

Property 2. When HQ is neither poor nor great at discovery, the relative attractiveness of the centralized organization is initially increasing then decreasing in the efficacy of HQ discovery.

3.3. Biasedness in Evaluation

As described above, the relationship between V and $mi1$ is heavily influenced by the conservatism inherent in the decentralized structure in that it has store managers as well as HQ evaluating ideas. One would then expect the difference between the two organizational forms to be exacerbated when $me1$ is raised as then HQ becomes more liberal in its adoption policy. This is indeed the case. Figure 1 reveals that the pattern described as Property 2 is more pronounced, the less conservative HQ is in evaluating innovations. As $me1$ rises, stores reject an increasing proportion of those ideas accepted by HQ due to HQ being relatively liberal in what they choose to pass along. Since such ideas are adopted under the centralized structure but not under the decentralized structure, the average value of those ideas influences the relative performance of the two structures making V more sensitive to $mi1$.

Property 3. The less conservative is HQ in evaluating innovations, the more sensitive is the relative attractiveness of the centralized organization to the efficacy of HQ discovery.

By the same logic, the relationship between V and $mi1$ should be more pronounced as we make store managers more conservative. This is confirmed in a simulations not reported here in which $V(mi1)$ is explored for $me2 \in [-3, 3]$. Recall that the higher is $me2$, the less discriminating are store managers in adopting ideas. When $me2$ is strongly negative, store managers are very conservative. This compounds the conservatism of the decentralized

structure and thereby makes the centralized structure much more attractive when HQ is moderately skilled at discovery. When *me*2 is strongly positive, store managers adopt most of what HQ recommends so that it is comparable to HQ mandating its ideas.

Property 4. The more conservative are store managers in evaluating innovations, the more sensitive is the relative attractiveness of the centralized organization to the efficacy of HQ discovery.

3.4. Efficacy of Evaluation

Note from Property 2 that V is increasing in the average value of a HQ idea for moderately positive values of *mi*1 but is decreasing when *mi*1 is sufficiently high. In simulations not reported here, this relationship is found to be more pronounced, the less skilled are store managers in evaluating ideas (the higher is *se*2). The benefit from HQ being more productive in discovery is increasingly squandered under decentralization as store managers are poorer evaluators (higher *se*2). Thus, higher values of *se*2 increase the disparity in the profit generated by HQ innovation under the two structures and thereby yields Property 5.

Property 5. The less skilled are store managers in evaluating ideas, the more sensitive is the relative attractiveness of the centralized organization to the efficacy of HQ discovery.

Since HQ R&D would be increasingly squandered with store managers who are less capable of evaluating them, Proposition 1 shows that HQ engages in less R&D under decentralization when store managers are poorer evaluators. Proofs are in the Appendix.

Proposition 1. *Assume $G_h(\cdot)$ and $G_h^0(\cdot)$ have density functions that are symmetric around zero. If $G_h^0(\cdot)$ is derived by performing a mean-preserving spread on $G_h(\cdot)$ then $m_d^*(G_h(\cdot)) \geq m_d^*(G_h^0(\cdot))$.*

Proposition 2 proves that the relative attractiveness of the centralized organization improves when store managers are less capable at evaluating ideas.

Proposition 2. *Assume $G_h(\cdot)$ and $G_h^0(\cdot)$ have density functions that are symmetric around zero. If $G_h^0(\cdot)$ is derived by performing a mean-preserving spread on $G_h(\cdot)$ then $V(G_h^0(\cdot)) > V(G_h(\cdot))$.*

Figure 2 considers the impact of HQ evaluative skills. First note that the pattern identified in Property 2 is robust with respect to *se*1. The more interesting feature to explore, however, is the effect of *se*1 on V. When HQ is neither sufficiently poor nor great at discovery, the relative attractiveness of the centralized organization rises as HQ becomes better at evaluation (that is, *se*1 is lower). However, when HQ is either sufficiently poor or great at discovery, having more capable evaluators at HQ reduces the relative attractiveness of the centralized organization. This intriguing result highlights the two roles that HQ plays under decentralization. First, it engages in discovery. If HQ is less skilled at evaluating its own ideas, it is then more valuable to have store managers as a second screen which is one

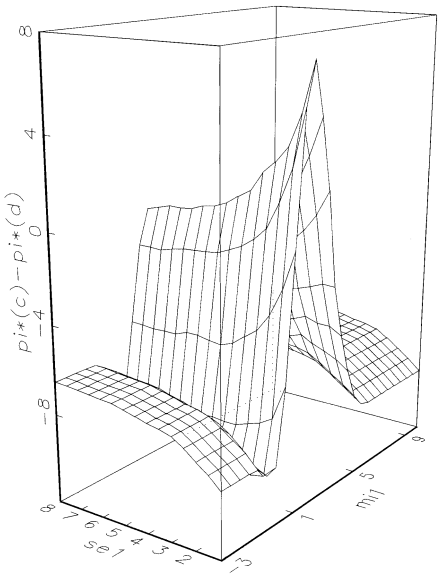

Figure 2. $V(mi1, se1)$.

of the features of the decentralized structure. This effect causes V to be decreasing in $se1$. Second, HQ is a discriminating conduit through which innovations pass from one store to another. As $se1$ rises, HQ becomes less effective in identifying worthwhile store innovations which makes the expected profit under decentralization lower. This effect causes V to be increasing in $se1$. When $mi1$ is strongly negative then HQ engages in minimal discovery so that the first effect is inoperative. While when $mi1$ is very high, for at least this range of values for $se1$, the evaluative skills of HQ are irrelevant as almost all of their discoveries are adopted. Similarly, the first effect is inoperative. Thus, when $mi1$ is either very low or very high, only the second effect is relevant so that V is increasing in $se1$. When instead HQ is moderately good at discovery both effects are operative and, as shown in figure 2, the first one dominates so that V is decreasing in $se1$.

Property 6. When HQ is neither poor nor great at discovery, the relative attractiveness of the centralized organization increases in the evaluative skills of HQ. When HQ is poor or great at discovery, the relative attractiveness of the centralized organization decreases in the evaluative skills of HQ.

By this logic, V would be more likely to be increasing in $se1$ as the amount of R&D conducted by HQ falls. This would occur as the cost of an R&D draw, as parameterized by θ, rises. Additional simulations not reported here confirm that conjecture. When $\theta = 1$, we found that V is roughly non-decreasing in $se1$ for all $mi1$ while, when $\theta = 10$, it is strongly increasing in $se1$ for all $mi1$.

4. The Effect of the Environment on the Rate of Innovation

The appropriate organizational form is apt to vary across industries and within an industry across time. Two industry characteristics relevant to this issue are the extent of opportunities for generating new ideas and the complexity of those ideas. In summarizing the findings of this section, the centralized organization is preferred when innovative opportunities are moderate while the decentralized organization is preferred when innovative opportunities are rich. In industries with more complex ideas, centralization is found to perform relatively better.

4.1. Variation in Innovative Opportunities

An important characteristic of a firm's environment is the potential for making innovations. Vast opportunities for new innovations are apt to be present when there has been a major technological change like the advent and integration of computers or the development of a new store format (e.g., superstores or supercenters). In this section, we address how the opportunities for innovation affects the relative performance of different organizational forms.

Broad-based changes such as those mentioned above should affect the productivity of discovery at both HQ and the stores. Without a more primitive model to tell us how a change in the external environment influences their discovery distributions, our approach to this problem is to assume that HQ and stores have identical discovery distributions: $mi1 = mi2 = mi$ and $si1 = si2 = si$; and to assume that greater innovative opportunities is associated with a better draw on average (higher value of mi).

Turning to our simulations, figure 3 shows V as a function of both mi and si. Fixing si, we find that centralization is preferred ($V > 0$) for industries with moderate innovative opportunities while decentralization is preferred ($V < 0$) for industries with strong innovative

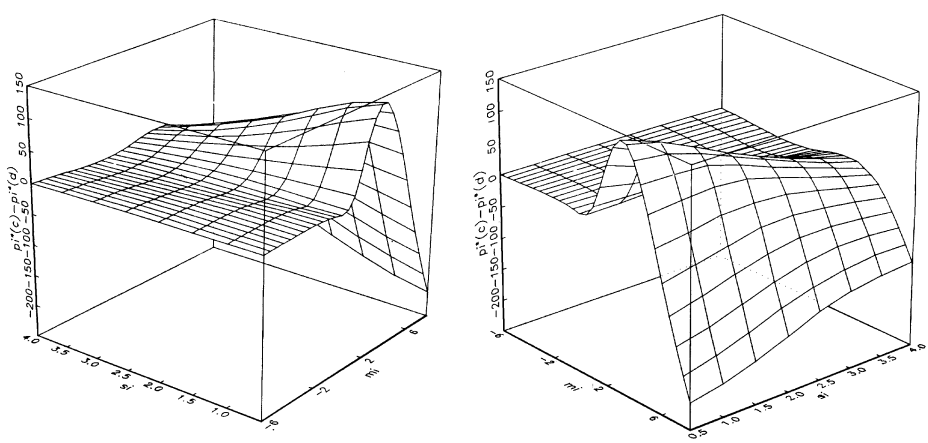

Figure 3. $V(mi, si)$ for $me2 = 0$ and $se2 = 3$.

opportunities. When *mi* is sufficiently negative, HQ does not engage in R&D and even though the stores do (by assumption), those ideas are so bad that almost all are rejected. V is then zero and thus independent of *mi*. When *mi* is around zero, HQ invests in R&D and some HQ and store innovations are adopted. At that point, V is increasing in innovative opportunities so that centralization is increasingly preferred. However, when innovative opportunities become sufficiently great, V is decreasing in *mi* and eventually decentralization is preferred.

Property 7. The centralized organization is preferred for environments with moderate innovative opportunities while the decentralized organization is preferred for environments with large innovative opportunities.

Figure 3 assumes that store managers are unbiased ($me2 = 0$) and relatively poor evaluators ($se2 = 0$). Further simulations not reported here show that this relationship is robust. When innovative opportunities are moderate, the centralized structure is strongly preferred when store managers are quite conservative ($me2 < 0$) though is only mildly preferred when store managers are liberal ($me2 > 0$). Property 7 becomes more pronounced, the less skilled are store managers. When innovative opportunities are moderate, the major disadvantage of the decentralized structure is the associated conservatism of having two screens. This results in too many good ideas being rejected. This detrimental effect is compounded when store managers are also very noisy evaluators. Indeed, when $se2$ is relatively high, the ideas accepted by store managers are close to being a random selection. However, when innovative opportunities are great, store managers will not do too poorly even if they are noisy evaluators given the high quality of the draws. The advantage of having store managers engaged in innovation then makes decentralization preferable when innovative opportunities are strong.

4.2. Variation in the Complexity of Ideas

In recent years, many new ideas in retail trade have involved the collecting, managing, and utilizing of information. This is involved, for instance, with many advances in point-of-sale technologies. Such ideas are relatively complex in the sense that their value is intricately related to other store functions. If a new idea generates more information, its contribution to profit depends on how that information will be used which depends on other policies as regards, for example, pricing and inventories. One must then project how these new ideas, if implemented, would fit within the structure of operations and how one would appropriately modify that structure. Contrast these new ideas relating to information technology with the more traditional one of, say, changing a product line. The value of that idea can reasonably be evaluated independently of other store functions. In this sense, the idea is less complex. Ideas that largely work to increase floor traffic would also seem to be relatively simple to evaluate. Recent examples might include the introduction of a co-branded credit card or establishing a licensed department (as Toys' R Us did with Warner Brothers; Liebeck 1995).

Let us then consider how the performance of an organizational structure depends on the complexity of new practices. For our purposes, the notable feature of a new practice being

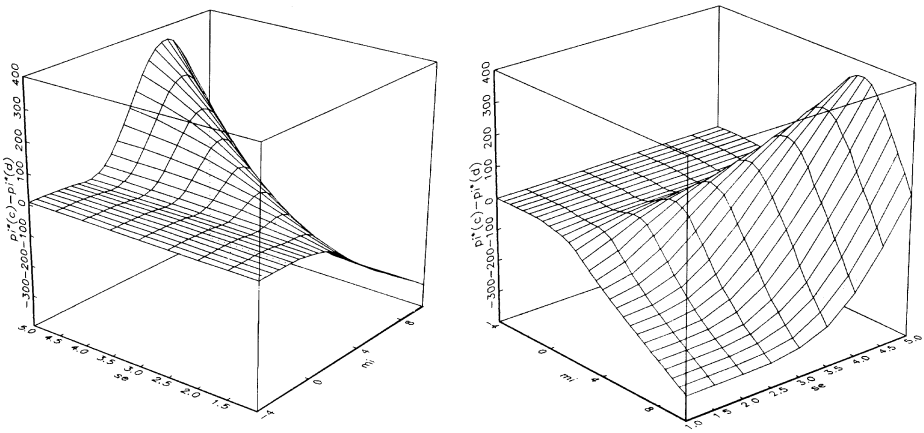

Figure 4. $V(mi, se)$ for $me2 = 0$.

more complex is that it is more difficult to evaluate. The natural measure of complexity is then se ($= se1 = se2$) which is the common standard deviation of evaluation errors for HQ and store managers. Higher values of se are associated with more complex ideas. A higher se may also be associated with a more rapidly changing environment. If a retail chain's environment is rapidly changing, evaluating the value of an idea would seem inherently more difficult than when the environment is stable and thus more predictable. Computer retail chains like CompUSA and Computer City may find it more difficult to evaluate new practices—due to rapid technological advances in products and evolving consumer demand—than general merchandise companies like Wal-Mart and Kmart.

Figure 4 shows the effect of complexity, as measured by se, on the relative attractiveness of the centralized structure, V, for various levels of innovative opportunities, as measured by mi ($= mi1 = mi2$). When innovative opportunities are relatively mild, V is relatively insensitive to se. However, when innovative opportunities are sufficiently great, V is increasing in se and this relationship is stronger when there are richer opportunities for innovation.

Property 8. When innovative opportunities are not poor, the relative attractiveness of the centralized organization is increasing in the complexity of practices and this relationship is more pronounced when innovative opportunities are greater.

Raising the size of evaluation errors reduces the expected profit of new ideas since then a larger proportion of bad ideas are adopted and a larger proportion of good ideas are not. While this reduces the expected profit generated by store managers under decentralization, we believe Property 8 is actually driven by what is happening with the rate of R&D investment and innovation at HQ. When $mi > 0$, the average idea, if implemented, is profitable. As se rises, what gets adopted is increasingly arbitrary since it is determined more by evaluation noise as opposed to the underlying value of the idea. In anticipation of more of their ideas being arbitrarily dismissed by store managers, HQ performs less investment in

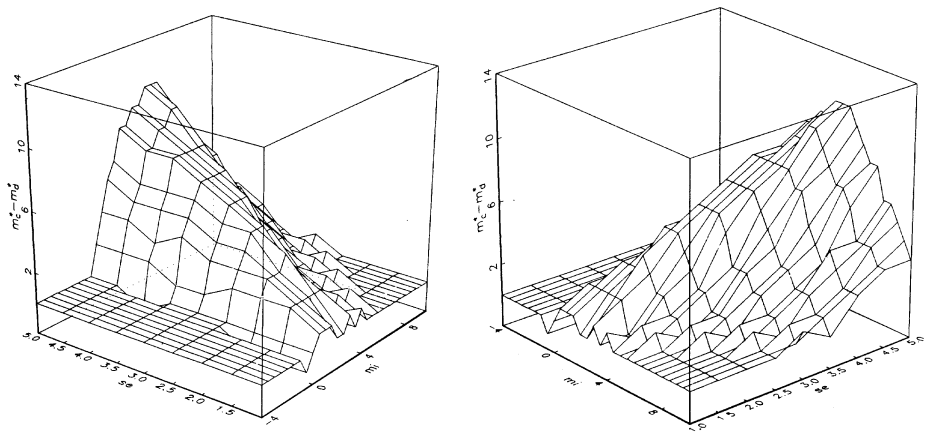

Figure 5. $(m_c^* - m_d^*)$, the difference between the number of HQ draws under centralization and decentralization as a function of (*mi*, *se*).

R&D under the decentralized structure relative to the centralized structure. This is shown in figure 5 where the difference between the number of HQ draws under centralization and decentralization is increasing in *se*. A higher value of *se* then implies a greater disparity between expected profit generated by HQ innovation under centralization relative to decentralization. Centralization then becomes increasingly more attractive as *se* rises. In essence, the more arbitrary is the evaluation of new ideas, the better it is to have ideas evaluated by fewer levels when, on average, ideas are profitable. Thus, centralization—with ideas being mandated from above—becomes increasingly attractive relative to decentralization—where HQ ideas are judged at both the corporate and store level. Since this differential between HQ innovation under the two organizational forms is more significant when HQ is a more valuable source of innovation, the sensitivity of V to *se* is greater when innovative opportunities are richer. Of course, all of this logic is reversed when $mi < 0$ so that the average profit of an idea is negative. Then, as *se* rises one increasingly worries about implementing too many of these ideas as opposed to arbitrarily dismissing too many of them. Of course, when *mi* is low, HQ innovation is relatively unimportant and indeed becomes trivial or non-existent when *se* is sufficiently large. As a result, we do not find V being decreasing in *se* when innovative opportunities are poor but rather V being insensitive to *se*.

In conclusion, when ideas tend to be more complex—so that they have the implication that members of corporate headquarters and store managers find them more difficult to evaluate—the centralized organization becomes relatively more attractive and this is more significant in environments with richer opportunities for innovation.

5. Sub-Optimality of the Mixed Organizational Form

In comparing two extreme organizational forms, centralized and decentralized, our model has abstracted away from an intermediate possibility that a chain may prefer to have a mixture of both forms. One generalization is to allow HQ to control a subset of stores, h

out of n: HQ exercises full control over h stores by dictating what ideas to adopt, while it gives the remaining $(n - h)$ stores full freedom to make their own adoption decisions. One might think of the latter as experimental stores. Ideas are then generated only by HQ and experimental stores. The two cases considered previously correspond to $h = n$ (full centralization) and $h = 0$ (full decentralization). A computational experiment was conducted to determine the optimal value of h. It was found that the optimal structure is always a corner solution in that the chain either prefers to control all stores or none at all. In fact, we do observe chains with mixed structures—whether in the form of experimental and non-experimental stores or franchised and company-owned stores—but, unfortunately, our model does not appear to encompass the factors that underlie such a phenomenon.

6. Concluding Remarks

The problem we are tackling—how organizational structure influences the rate of firm innovation—is a complex one and our model has thus far encompassed a very limited number of relevant factors. Still, several pieces of insight have been generated. First, while having more innovative store managers makes decentralization more attractive, the effect of the innovativeness of HQ is considerably more complex. Though HQ can engage in discovery regardless of the organizational form, its productivity is not neutral in determining the optimal organizational form because the form influences how effectively HQ innovations are adopted. Under centralization, all ideas that HQ finds worthy are implemented at the store level while under decentralization their adoption is left to the discretion of store managers. The end result is that we find centralization is more likely to be preferable when innovative opportunities in the industry are moderate. The main reason is that decentralization results in too many moderately good HQ ideas not being implemented by store managers. When instead innovative opportunities are sufficiently rich then decentralization is more likely to be preferred. The higher quality of HQ's ideas means it is more likely that store managers will adopt them and, furthermore, decentralization offers the benefit of being able to draw upon the ideas of store managers.

The optimal organizational form was also found to be quite sensitive to the evaluative skills of those involved and in non-obvious ways. In particular, the qualitative effect of HQ evaluative skills on the optimal organizational form depends on how effective HQ is at discovery. Under decentralization, HQ serves two roles: discovering new ideas and disseminating innovations made by store managers. When HQ is relatively ineffective at discovery then, under decentralization, the latter is its primary role. In that case, poorer evaluative skills means that HQ is less effective at dissemination and this makes decentralization less attractive. When instead HQ is productive in discovery then both roles are relevant. In that case, if HQ is less capable at evaluating its own ideas, it is then more useful to have store managers evaluate them as well. This serves to enhance the attractiveness of decentralization and can make decentralization more attractive when HQ is less skilled at evaluation.

Finally, we found that more complex ideas—as reflected in greater difficulty in evaluating their contribution to store profit—tend to favor centralization and this is more pronounced when innovative opportunities are richer. The intuition is that when ideas are more complex, evaluation tends to be noisier and this results in more arbitrary adoption decisions. Giving

autonomy to store managers results in many good HQ ideas being arbitrarily dismissed. Presuming that HQ ideas are, on average, good, centralization results in more HQ ideas being implemented and this induces HQ to engage in more R&D investment. The greater profit coming out of HQ under centralization makes it the more appropriate organizational form.

Appendix

Proof of Proposition 1: The expression for expected profit under decentralization is:

$$E[\pi_d(m)] = m\int x[1-K(-x)]\sum_{i=1}^{n}[1-G_i(-x)]\,dH(x) - f(m) + \sum_{i=1}^{n}\int x[1-G_i(-x)]\left\{1+p[1-K(-x)]\left[\sum_{j\neq i}^{n}[1-G_j(-x)]\right]\right\}dF_i(x). \tag{A.1}$$

Since the expected profit prior to netting out the cost of HQ discovery is linear in m and $f(m)$ increases at an increasing rate then the optimal value for m is defined by

$$f(m_d^*+1) - f(m_d^*) \geq \int_{-\infty}^{+\infty} x[1-K(-x)]\sum_i[1-G_i(x)]dH(x) \geq f(m_d^*) - f(m_d^*-1). \tag{A.2}$$

The middle expression is the change in expected gross profit from one more HQ draw while the lhs and rhs expressions are the incremental cost of one more draw given m_d^* and m_d^*-1 draws, respectively. Since these latter two expressions are independent of $G_h(\cdot)$, it is straightforward that $m_d^*(G_h(\cdot)) \geq m_d^*(G_h^0(\cdot))$ iff:

$$\int_{-\infty}^{+\infty} x[1-K(-x)]\left[\left(1-G_h(-x)+\sum_{i\neq h}(1-G_i(x)\right)\right]dH(x) \geq \int_{-\infty}^{+\infty} x[1-K(-x)]\left[\left(1-G_h^0(-x)\right)+\sum_{i\neq h}(1-G_i(x))\right]dH(x); \tag{A.3}$$

which just says that the marginal gross profit from one more draw is higher with $G_h(\cdot)$ than with $G_h^0(\cdot)$. The following steps are performed on (A.3):

$$\int_{-\infty}^{+\infty} x[1-K(-x)][1-G_h(-x)]\,dH(x) \geq \int_{-\infty}^{+\infty} x[1-K(-x)]\left[1-G_h^0(-x)\right]dH(x) \tag{A.4}$$

$$\int_{-\infty}^{+\infty} x[1-K(-x)]\left[G_h^0(-x)-G_h(-x)\right]dH(x) \geq 0. \tag{A.5}$$

$$\int_{-\infty}^{0} x[1-K(-x)]\left[G_h^0(-x)-G_h(-x)\right]dH(x)$$
$$+\int_{0}^{+\infty} x[1-K(-x)]\left[G_h^0(-x)-G_h(-x)\right]dH(x)\geq 0. \tag{A.6}$$

If $G_h^0(\cdot)$ is derived by performing a mean-preserving spread on $G_h(\cdot)$ then there exists x^0 such that $G_h^0(x) \gtreqless G_h(x)$ as $x \lesseqgtr x^0$ (see Rothschild and Stiglitz 1970: 230). Since $G_h^0(\cdot)$ and $G_h(\cdot)$ have density functions that are symmetric around zero then $G_h^0(0) = 1/2 = G_h(0)$ which implies that $G_h^0(x) \gtreqless G_h(x)$ as $x \lesseqgtr 0$.

In the first term in (A.6), $[G_h^0(-x) - G_h(-x)] < 0$ for all $x < 0$ which implies that the first term is positive. In the second term, $[G_h^0(-x) - G_h(-x)] > 0$ for all $x > 0$ which implies that the second term is positive. This proves (A.6) holds and thus Proposition 1 is true. □

Proof of Proposition 2: Since $G_i(\cdot)$ only affects $E[\pi_d^*]$, $V(G_h^0(\cdot)) > V(G_h(\cdot))$ iff $E[\pi_d^*(G_h(\cdot))] > E[\pi_d^*(G_h^0(\cdot))]$. The latter we will prove by showing that $E[\pi_d(G_h(\cdot), m)] > E[\pi_d(G_h^0(\cdot), m)]$ for all m.

Since $G_h'(\cdot)$ is symmetric around zero then $G_h(-x) = 1 - G_h(x)$. Making this substitution, we have

$$E[\pi_d(m)] = m\int x[1-K(-x)]\left[G_h(x)+\sum_{i\neq h}^{n} G_i(x)\right]dH(x) - f(m)$$
$$+\int xG_h(x)\left\{1+p[1-K(-x)]\sum_{j\neq h}^{n} G_j(x)\right\}dF_h(x)$$
$$+\sum_{i\neq h}^{n}\int xG_i(x)\left\{1+p[1-K(-x)]\left[G_h(x)+\sum_{j\neq i,h}^{n} G_j(x)\right]\right\}dF_i(x). \tag{A.7}$$

We can alternatively present (A.7) by

$$m\int_{-\infty}^{0} x[1-K(-x)]\left[G_h(x)+\sum_{i\neq h}^{n} G_i(x)\right]dH(x)$$
$$+m\int_{0}^{+\infty} x[1-K(-x)]\left[G_h(x)+\sum_{i\neq h}^{n} G_i(x)\right]dH(x) - f(m)$$
$$+\int_{-\infty}^{0} xG_h(x)\left\{1+p[1-K(-x)]\sum_{j\neq h}^{n} G_j(x)\right\}dF_h(x)$$

$$+\int_0^{+\infty} xG_h(x)\left\{1+p[1-K(-x)]\sum_{j\neq h}^{n}G_j(x)\right\}dF_h(x)$$
$$+\sum_{i\neq h}^{n}\int_{-\infty}^{0} xG_i(x)\left\{1+p[1-K(-x)]\left[G_h(x)+\sum_{j\neq i,h}^{n}G_j(x)\right]\right\}dF_i(x)$$
$$+\sum_{i\neq h}^{n}\int_{0}^{+\infty} xG_i(x)\left\{1+p[1-K(-x)]\left[G_h(x)+\sum_{j\neq i,h}^{n}G_j(x)\right]\right\}dF_i(x). \tag{A.8}$$

Recall from the proof of Proposition 1 that $G_h^0(x) \gtreqless G_h(x)$ as $x \lesseqgtr 0$. Since $G_h^0(x) > G_h(x)\,\forall x < 0$ then the first, third, and fifth terms are smaller (more negative) with $G_h^0(\cdot)$ than with $G_h(\cdot)$. Since $G_h^0(x) < G_h(x)\,\forall x > 0$ then the second, fourth, and sixth terms are smaller (less positive) with $G_h^0(\cdot)$ than with $G_h(\cdot)$. Thus, $E[\pi_d(G_h^0(\cdot), m)] > E[\pi_d(G_h(\cdot), m)]$ for all m which implies that $E[\pi_d(G_h^0(\cdot), m_d^*(G_h^0(\cdot))] > E[\pi_d(G_h(\cdot), m_d^*(G_h(\cdot)))]$ and thus $V(G_h^0(\cdot)) > V(G_h(\cdot))$. □

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Notes

1. It is reasonable to presume that the amount of effort a store manager puts into discovering, evaluating, and adopting new ideas will depend on his compensation scheme. Implicit in our analysis is that there is some incentive contract associated with each organizational structure and the form of that contract does not depend on other parameters in the model. The issue of how the incentive contracts may depend on characteristics of the environment is left for future research.
2. Following the suggestion of an anonymous referee, we do briefly consider in Section 5 the possibility of intermediate forms which mix HQ control and store discretion to varying degrees. Surprisingly, our simulations reveal that the optimal structures are, in fact, the extreme forms; full centralization or full decentralization.
3. While, in reality, there would be ideas originating from store managers even under centralization, it is likely that the number of such ideas would be much smaller than that under decentralization for the reasons discussed above. What is important in determining the relative attractiveness of an organizational structure is then simply the existence of this differential. For concreteness, we assume that each store manager gets one idea under decentralization and no idea under centralization.
4. For analytical simplicity, we rule out the possibility of direct inter-store learning, where the stores may learn from one another through direct observations without the HQ as a filter. While we acknowledge the existence of

such a channel for diffusion of ideas (See Darr et al. 1995 for an in-depth study of such learning in the context of a franchise), we believe that its impact on the optimal organizational form in our framework depends on the evaluation skills of the store managers relative to those of HQ in a rather straightforward manner: superior evaluation skills of the store managers will enlarge the benefits of such inter-store learning, since the stores would then be able to correctly adopt those additional ideas that may be ignored mistakenly by the HQ—this would improve the benefits of decentralization. On the other hand, the reverse will be true, if the store managers have inferior evaluation skills relative to HQ. The general relationship derived here between the evaluation skills and the optimal organizational structure is, hence, unlikely to be affected by the inclusion of this channel.

5. Also along this line of work is Sah and Stiglitz (1988, 1991), Koh (1992), Gehrig et al. (1995). Sah (1991) provides an overview of some of this research.
6. The simulation source code is written in GAUSS-386*i* version 3.2 (Aptech Systems, Inc.) and is available upon request from Chang.

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