Organizing for Synergies

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Abstract

Merging companies attempt to realize synergies by sharing resources to exploit scale economies in functional areas such as R&D, manufacturing, or sales. If it were possible to do everything else the same, such mergers would always be value creating. However, in order to exploit the synergy, the firm will typically need to centralize decision-making in the relevant function.

We develop a model of organizational structure in which the decision of what activities to group under a common manager determines the information available and the incentives of decision-makers. Incorporating a functional division manager with the authority to implement synergies into a decentralized product-based organization reduces product division coordination and reduces adaptation to local information. We also analyze an organizational structure in which conflicts between product division managers and the functional manager are resolved by senior management after costly communication. Although this structure allows more efficient decision making, it does so at the expense of excessive conflict. We characterize the optimal choice of organizational structures as a function of the value of synergies, coordination, and local adaptation.

Extensions of the basic model allow us to study: (1) organizational structures designed to realize several functional synergies, (2) investment choice by managers, (3) transfer prices, and (4) strategic communication of private information.

1 Introduction

Organizations exist to coordinate complementary activities in the presence of specialization. Different organizational structures, through their impact on the information available and the incentives of decision makers, involve tradeoffs in the type and level of synergies and coordination that can be achieved. We develop a model to capture the tradeoffs that guide organizational structure in the presence of coordination problems and potential synergies. The model allows us to explore the mechanisms by which these tradeoffs operate, develop predictions about when different organizational structures are optimal and provide a framework for thinking about other issues relating to organizational structure.

These tradeoffs can be critical in determining how an organization can realize synergies among different business units. There are countless examples of firms that fail to implement organizational strategies that allow them to realize the potential gains from a merger. Many of the most spectacular failed mergers involve the inability to achieve the synergies that motivated the deal. The recent merger between AOL and Time Warner is a particularly prominent example of what appears to be quite common.[1] The merging parties claimed an important source of increased value from the merger would be synergies from selling advertising packages that included all media encompassed by the merged company's divisions. However, centralized ad-selling was thwarted by divisional advertising executives who felt they could get better deals than the shared revenue from centralized sales. An outside advertising executive was quoted by the Wall Street Journal, stating, "[t]he individual operations at AOL Time Warner have no interest in working with each other and no one in management has the power to make them work with each other." AOL Time Warner could have chosen to provide more authority to the centralized advertising unit, but this too is not without cost and significant peril. Taking authority away from business units over such an important source of revenue could reduce the sensitivity of decisions, reduce the coordination among the different activities of a business unit and blunt incentives.[2]

The more general question is one that arises in any theoretical discussion of mergers. Typically, it is possible to identify some likely source of potential synergy in mergers of related

[1] See Rose, Angwin, and Peers (2002).

[2] The anecdotal evidence is also supported by the broader empirical literature on merger performance in corporate finance. See Andrade, Mitchell, and Stafford (2001).

companies by taking advantage of scale economies and sharing resources in some functional area, be it R&D, manufacturing, distribution, brand coverage, or sales. A simple (or simplistic) justification for the merger is that the two firms can do everything as before except the narrow combination of activities needed to exploit the synergy. The standard (economist's) response to this is that there are costs associated with expanding the scale of the firm and then there is some hand-waving about managerial diseconomies of scale that derive from increased bureaucracy and limited spans of control, and perhaps less financial market discipline if both merging companies are public. These answers are mostly imprecise and they are not very satisfying. They do not explain why bureaucracy increases if most everything is the way it was before the merger. Perhaps more important, they do not tell us when these costs are relatively important and when they are not. Thus, we cannot make predictions about when mergers will be efficiency-enhancing because we can only speak to the details of one side of the tradeoff.

This lack of specificity about the costs of organizational scale is also a problem in many discussions of the theory of the firm. An important strand of this literature focuses on the tradeoff between the contractual relationships and internal relationships. An enormous literature has explored the imperfections of contractual relationships; it provides us with predictions of when contractual mechanisms are likely to perform well and when they will not. Again, the internal side of the tradeoff is given less attention and the empirical implications derive from only one side of the tradeoff between the costs of contracts and the costs of internal organization.

The problem of organizing to achieve synergies is not unique to mergers; all companies with related lines of business must decide which activities to centralize, how to allocate control rights over complementary decisions, how to share relevant information, and how to create incentives for effective coordination and efficient operations. The example that motivated us to develop our model is a Harvard Business School case on Jacobs Suchard (Holland 1989). In the late 1980s, Jacobs Suchard was Swiss coffee and confectionery company with the leading EEC market share in confectionery products. It had a decentralized organizational structure with general managers for largely independent business units organized around products and countries, so for example, there would be a French confectionery business unit and a German beverage business unit. The general managers received compensation based on business unit and corporate profits. Each business unit had its own sales, marketing, and manufacturing divisions. There was a small corporate staff. The autonomy and incentives of the general

managers created an entrepreneurial environment that was able to attract and retain talented executives as general managers.

The tariff reductions, open borders, and standardization of regulation of the upcoming 1992 European integration created the opportunity for Jacobs Suchard to achieve cost savings by combining manufacturing plants across countries. The company planned to shift from 19 plants to six primary plants that would serve all of Europe. General managers were to lose responsibility for manufacturing, but maintain control of sales and marketing. The company would appoint a "manufacturing center sponsor" to oversee the plant managers and focus on economies of scale through, among other things, global product standardization. Profit measurements for business units would be based on transfer prices from the manufacturing plant. The changing European environment also created the opportunity to improve performance by consolidating products across countries and developing common marketing strategies. Therefore, the company appointed "global brand sponsors" for each of the five major confectionery brands. These were general managers given the additional responsibility, along with general managers, to promote their brands globally, develop new products, and standardize the brands across the world, including standardization of packaging across countries. There was a proposal by some executives, which was not accepted, to give the global brand sponsors control of marketing as well as profit and loss responsibility for their brands. This would leave the general managers and their units as mere sales centers.

Jacobs Suchard's experience with its new organizational structure demonstrates the tradeoffs that arise in attempts to organize to realize synergies. Business unit marketing managers were unable to make decisions because either the global brand sponsor or general manager would disagree. Conflicts were common over issues such as packaging, advertising, choice of factory, who would pay for product development, and international marketing efforts. The senior corporate manager responsible for all of confectionery would resolve disputes between general managers and global brand sponsors. General managers fought standardization in manufacturing that they believed would harm their unit's profits. The general managers no longer controlled their own business units having to rely on manufacturing, packaging, product selection, and marketing decisions made, in part, by others. The outcome was to reduce coordination within business units, increase time and effort to communicate, defend, and debate strategic choice, rely on decisions by poorly informed senior managers, threaten the firm's entrepreneurial culture, and blunt incentives for general managers.

It is difficult to determine if the organizational change was a good decision or not. It is clear, however, that the benefits from the attempt to create cross-border synergies did not come without costs. These costs include poorer coordination and incentives within business units, increased conflict and centralized decision-making, and the communication and influence costs that go with it.

We develop a model to capture the basic issues in the Suchard example and, more generally, the tradeoffs that guide organizational structure in the presence of local information, coordination problems, and potential synergies. In our model, an organization consists of a fixed number of discrete operating units that are organized in a matrix. Rows represent product divisions that can be defined by product, customer, or geography. Columns represent functions such as R&D, marketing, manufacturing, or sales. The organizational structure may include product division managers, functional managers, or both. We assume that the organizational structure determines the availability of information, so that managers are only able to obtain local knowledge from the operating units they oversee. This assumption captures the idea that managers are specialized in understanding the inner workings of these operating units. This allows them to understand detailed, verifiable information provided by lower level managers, and to induce credible revelation of information. Moreover, we assume managers only care about their own units rather than having the best interests of the organization in mind when they make their choices. This assumption naturally generates conflicts between managers when they have conflicting responsibilities, which we study.[3]

We could use our model to analyze the tradeoffs between an organization structure with product-based divisional authority (M-form) and a centralized functional organization (U-form), but the most significant advantage of our approach is that we can analyze the tradeoffs among more complex and more common organizational forms. We begin by studying the effectiveness of different organizational structures to realize a single potential functional synergy with minimum disruption. Starting from a baseline M-form organization that cannot realize functional synergies, we study the possibility of centralizing just one function. We thereby capture Jacobs Suchard structure with centralized manufacturing but business unit control over sales and marketing. We refer to this structure as a partial functional authority or E-form. Although the E-form allows the organization to exploit significant functional synergies,

[3] In an extension, we discuss the effects of incorporating incentives based on broader organizational performance.

it does so at a cost of decreased coordination within product divisions and decreased sensitivity of strategies to local information.

The presence of both functional and product division managers creates a potential role of senior management to resolve disputes and coordinate activities. The senior manager may be the CEO, but could also be an executive of lower rank. Thus, we also analyze a structure with centralized conflict resolution (partial matrix), in which disagreements can arise between the product division managers and the single functional manager. No divisional manager has the ability to impose a strategy on the other. If the managers are unable to agree on their choices, any can appeal to the senior manager who will obtain information at a cost to both division and senior managers. The senior manager will then choose strategies that maximize firm value given his information. We show that this structure allows the organization to use ex post information to make tradeoffs between synergies and business unit coordination. We show that there are too many disputes in equilibrium, so if communication is costly, centralized conflict resolution may perform poorly.

This organizational structure can often be made more attractive by increasing communication costs, in particular if time of senior management is costly. Indeed, by increasing the costs of appeal incurred by the division managers themselves - say by adding more red tape and bureaucracy - the latter will only appeal if functional standardization is very harmful. Valuable time of senior management is less likely to be wasted on borderline cases where decentralization and functional centralization tend to yield similar payoffs. This is most effective if the organization can identify the manager that is creating the conflict. Placing an additional cost on that manager rather than the entire organization reduces the likelihood of conflict while imposing lower costs on the organization when conflict does occur.

Centralized conflict resolution is valuable when choosing between synergies and coordination will be valuable ex post. This does not, however, imply that the organizational structure is optimal only when economics of scale and divisional coordination are more or less equally important. Even when functional synergies are much larger than the benefits of coordination, centralized conflict resolution will often be preferred to the E-form, even though in the great majority of cases, the outcome will be the same strategy as the E-form. The reason for this is that the equilibrium costs of communication are endogenous – a large functional synergy will dramatically decrease these communication costs, since product division managers know that

it will be extremely difficult to avoid functional standardization. Hence, large economics of scale disciplines the product division managers; they only appeal if economics of scale are very harmful. We also demonstrate that centralized conflict resolution is more attractive in smaller organizations (fewer product divisions) because each product division manager internalizes a larger fraction of the total communication cost.

We study four extensions of the model. First, we analyze two decentralized organizational structures designed to realize more than one functional synergy: (1) an extended E-form organization where there are two functional division managers as well as product division managers, and (2) a decentralized functional organization where there is a division manager for each function and no product division managers. Although these organizations realize additional functional synergies, they do so at a large loss of coordination within product divisions; it becomes more difficult for business unit managers to adjust to incompatible decisions of functional managers.

If one takes as a given that coordination of operating units within a product division is essential, attempts to standardize and realize synergies in several functions creates a need for a coordinating mechanism. Product division managers are insufficient because they do not control enough operating units. In our model, the only other possibility is senior management. Although we do not formally analyze a model with senior management, it would improve coordination but at a cost of increased communication costs and reductions in local adaptation. As the scale and scope of the firm increases, the burdens on the time and expertise of senior management would grow. This is the essence of Chandler's (1962) insight that the administrative demands of functional organizations are much greater than product-based organizations.

Second, we introduce investment choice into the model. Functional division managers' investment increases the size of available synergies and product division managers' investment increases the gains from product-based coordination. This feature reduces the relative attractiveness of the centralized dispute resolution organization. A division manager's incentive to invest depends on the probability that he will win. In an E-form, the functional division manager always gets to implement the functional synergy, so he has strong incentives to invest. In the M-form, the product division manager can always coordinate the operating units, so he has strong incentives to invest. If neither is in control, each has a reduced incentive to invest. This is because sometimes the division manager will lose and investment will be wasted. The

E-form and the M-form allows the organization to concentrate the investment in the division for which it will be valuable. In essence, the presence of ex ante investment makes allocation of ex ante control rights relatively more attractive than ex post determinations of who gets to decide.

Our third extension allows product division managers to share in the functional synergy. This can occur directly if incentive pay reflects the costs in the relevant function or indirectly if the cost savings from the synergy are reflected in the transfer price that a product division pays for the functional divisions services. This has no effect in the M-form or the E-form. In the M-form, the information necessary to implement a synergy simply does not exist. In the E-form, the synergy is always implemented. However, in the centralized conflict resolution organization, the sharing reduces the likelihood that a product division manager will appeal and this improves performance.

The final extension is to introduce private information that allows the possibility of strategic communication in the centralized conflict resolution organization. In particular, we allow the importance of local adaptation to be either high or low. There can be a pooling equilibrium in which both types of product division managers choose strategies to convince imperfectly informed senior managers that local adaptation is important. This demonstrates an additional cost of centralized conflict resolution. Influence costs work in the model, not by exerting effort to lobby senior management, but by choosing suboptimal strategies designed to convince senior management that it is important that one wins any dispute with other divisions. In addition to suboptimal strategies, senior management may end up less well informed.

Although all the extensions are not worked out completely, they demonstrate that our basic framework can be useful to study the interplay of the set of complex forces that drive the tradeoffs in organizational design. Furthermore, we think the framework will be useful to study question in the theory of the firm, resource allocation in organizations, and organizational responses to information and change.

2 Related Literature

Scholars have been aware of the importance of designing the organizational structure to solve coordination problems at least since Chandler's (1962) classic analysis of the impact of the

change from functional to multidivisional organizational forms on the performance of large corporations. Also seminal is Lawrence and Lorsch's (1967) study of the mechanisms organizations use to integrate its differentiated activities. The theoretical literature trying to understand these coordination problems originated with the theory of teams of Marshack and Radner (1972). This approach studies coordination among agents when information must be necessarily disperse, but purposely assumes away incentive issues to simplify the analysis.[4] Agents with common interests would choose to share their information if they could, so an additional necessary restriction is the existence of some communication costs that prevent agents from freely communicating.

Most studies of coordination in organizations sharing this (non-incentive based) methodology focus on situations where there exist no interdependencies among tasks.[5] We depart from this view, and assume instead that the organizational design must take into account the existence of interdependencies among tasks. Several antecedents for this view are particularly worth noting. Cremer (1980) studies the optimal grouping of subunits into units in a resource allocation problem. The existence of interdependencies among subunits means that any particular grouping creates externalities, as some interdependence must be ignored. The question he considers is how to group units in a way that internalizes as many of these externalities as possible, when agents ability to collect information is limited. The attractive generality of the approach limits, at the same time, its insights to the initial one that the organization should put together related units and segregate unrelated ones.[6]

Vayanos (2002) studies decentralized information processing when tasks are related. In his setting, when agents aggregate information to communicate it to a superior, some information is lost. Moreover, the decision of one agent impacts those of other agents. Under these circumstances, the problem is to determine how best to group units into subunits to minimize the information loss while taking into account the interdependencies. Rivkin and Siggelkow (2002) also develop a model with decentralized information processing and interdependent decisions. They analyze how the degree of centralization relates to other organizational variables. Most closely related to our model, Roland, Qian and Xu (1999) model the tradeoff involved in

[4] Team theory models assume that all players have the same payoffs for every state and action profile.

[5] See e.g. Keren and Levhari (1983), Radner, (1993), Van Zandt (1999), Bolton and Dewatripont, (1994), and Garicano (2000).

[6] Aoki (1986) and Genakoplos and Milgrom (1991) deepen and generalize the study of a resource allocation problem of this kind.

the organizational design choice as one between decentralizing and allowing multiple divisions to use their local knowledge versus losing standardization and economies of scale. Among other things, they show that the M-form improves coordination at the expense of economics of scale. While our approach coincides with theirs in modelling coordination as requiring the matching of the organizational design choices to each other under local knowledge, our model allows us to study the incentive conflicts that result from the reliance on this local knowledge. This allowance for conflicts (and conflict resolution) between synergies also allows us to study a broader set of organizational structure. Harris and Raviv (2002) study the organizational structure that best appropriates synergies when managers are expensive. Their model, however, abstracts from conflicts between synergies and from the use of local knowledge for local adaptation.

A recent literature has studied jointly the incentive problems and the coordination costs that follow from the design decision, focusing in particular on the M-form versus U-form choice. Holmstrom and Tirole (1991), analyze transfer pricing between different divisions under interdependencies. They associate the M-form with a decentralized organization in which division managers are free to both trade internally and with the external market. They show that, while the M-form tends to maximize incentives, it results in divisions being less well coordinated relative to more centralized organizational forms which do not allow external trade. The problem they study is a pure moral hazard problem; the informational consequences of the design play no role in it. Maskin, Qian and Xu (2001), in contrast, highlight the advantages of the M-form in providing incentives based on yardstick competition, but interdependencies between decisions play no role.

There is a large literature which investigates how the boundaries of the firm affect the ability of divisions or firms to coordinate. Gertner (2000) analyzes a model where conflicts over coordination problems are resolved by senior management if the combating units are both part of the same firm. In contrast, disputes are resolved through contractually allocated control rights if the units are part of separate firms. In both cases, the dispute resolution mechanism is used only if the parties fail to reach a negotiated agreement. Gertner studies how ownership structure affects the incentives for the units to share information. Hart and Holmstorm (2002) argues that whereas independent firms coordinate too little their activities, integrated firms have a tendency to realize too many synergies, neglecting private benefits of mangers and workers. While this paper shares our view that organizational structure affects incentives, in

it, unlike in ours, organizational form does not affect the use and availability of information.

More broadly, what distinguishes our approach from previous papers is the ability of our model to study organizational design issues when agents are self-interested and coordination among them is important. In our view, developing a framework that can deal both with the reasons the organization is actually set up as well as with the informational asymmetries and incentive conflicts that emerge as a result of the design decision is an essential step towards a deeper understanding of both organizations and incentives. Moreover, it allows us to illuminate an issue that is almost completely absent from all of these accounts, and that, on our view, is pervasive in organizations: the existence of conflict and the role of managers as conflict resolvers.

3 The Basic Model

The organization consists of a fixed $m \times n$ matrix. Each element of the matrix represents an operating unit that has both a functional and product definition. Each of the m rows represents a different product division. We use the term "product division" for convenience, but a row could represent a product, a geographical area, a customer segment, or some combination of all of these. So, a product division in a bank could be trust services for customers with accounts greater than £1,000,000 in Scotland. Each of the n columns represents a functional division such as R&D, marketing, manufacturing, or sales.

Each operating unit must choose a strategy, s_{ij}, a real number. Each operating unit receives a signal θ_{ij} that identifies its optimal strategy absent coordination and synergies. We assume that each θ_{ij} is i.i.d. with variance σ^2. For some of the organizational structures we study, we further assume that $\theta_{ij} \sim N(0, \sigma^2)$. Deviations from the locally optimal strategy leads the organization to incur incremental costs of:

$$\sum_{i=1}^{m} \sum_{j=1}^{n} \frac{\alpha}{2} \left(s_{ij} - \theta_{ij}\right)^2 .$$

Coordinating the functions within a product division is also valuable. We represent this by strategies that are identical or close. Again we assume quadratic costs of the form:

$$\sum_{i=1}^{m}\sum_{j=1}^{n}\frac{\beta}{2}\left(s_{ij}-\bar{s}_i\right)^2,$$

where $\bar{s}_i = \frac{1}{n}\sum_{j=1}^{n} s_{ij}$.This captures the notion that there is a tradeoff between choosing the strategy which is locally best and the strategies that most effectively coordinate the operating units with the product divisions. The value of β relative to α captures the importance of coordination among the functions within a product division.

There may also be synergies from coordinating the strategies within a function (column). We think of these synergies arising from economies of scale through standardization. For example, there may be cost-savings in manufacturing from producing the same product for all geographical operating units in a single plant. We model this by assuming that a functional manager, if there is one, receives a second i.i.d. random variable γ_{ij}, for each operating unit within his functional division. We assume γ_{ij} has variance σ^2, and, again, for some organizational structures, we assume that $\gamma_{ij} \sim N(0, \sigma^2)$. If all divisions within function j choose $s_{ij} = \gamma_{ij}$, there is an additional cost savings of κ_j to capture the standardization required to achieve economies of scale. The "all-or-nothing" aspect of functional synergies is designed to capture the idea that synergies require standardization, not near standardization. We assume an independent random variable for each product division rather than a single random variable for all product divisions because it simplifies some of our analysis and it reflects the idea that standardizing may imply different interactions within each product division. We do not think it is important for any of our results. In the next section, we analyze environments where the organization tries to exploit at most one functional synergy. In effect we assume that $\kappa_1 > 0$, and $\kappa_j = 0, \forall j \neq 1$. In section 5, we analyze organizational structures that can exploit more than one functional synergy.

An organizational structure is a grouping of operating units into divisions with divisional managers, and an allocation of control rights to divisional managers, operating unit managers, and senior management. We allow operating units to be part of more than one division, so an organization may have both functional divisions and product divisions. If an operating unit is not part of a division, the operating unit manager can choose its own strategy. Divisional managers may be given the authority to make strategic choices for the operating units they oversee. If an operating unit is part of both a functional and product division, either manager

may be given control rights over the operating unit or the rights could be shared. If they are shared and the divisional managers do not agree on the operating unit's strategy, we assume that the dispute will be resolved by senior management. We discuss the details of this costly mechanism when we analyze the centralized conflict resolution structure below. We also allow for the possibility that senior management will maintain control rights absent a dispute among divisional managers. This only becomes relevant when senior management attempts to coordinate among more than one functional division.

We assume a close link between the organizational and information structure of the firm. The basic philosophy that underlies the specific information assumptions is that local information is costly to communicate and expertise is needed to understand the implications of local information. Thus, we assume that all direct, verifiable communication is hierarchical, i.e., operating unit managers can only share their information with division managers, not each other, and division managers can only share their information with senior management, and not each other. Signaling and cheap talk may still be possible, but our assumptions about incentives and the extensive form rule them out. We do this to improve tractability and focus attention on the communication of verifiable information.

There are several reasons for our restriction to hierarchical communication. First, we believe it captures the baseline reality of most organizations. Managers devote a great deal of time to understand the inner workings of the divisions they oversee. This allows them to understand detailed, verifiable information provided by their operating unit managers. They are able to induce credible revelation of information because they are better able to identify misleading communication, they have a long-term relationship with their employees, and they have the power to affect wages, promotion, and future employment. Communication does not just depend on the incentives for the sender to provide the information, but also on the ability of the recipient to interpret it and senior managers have the incentive to invest in this expertise for the units they oversee. For mathematical simplicity, we model the information as a single-valued random variable, but information on the returns from any strategic choice is complex and the set of choices cannot be easily mapped into the real line. Managerial expertise is needed to aggregate the information and identify what set of choices among operating units provide the most effective coordination. Although our assumptions are surely a little extreme, since institutions like cross-functional teams, reputational concerns, and commonalities in the expertise needed across the organization may allow for some effective communication across hi-

erarchical lines, our approach allows us to focus attention on the most important organizational tool for coordination – management.

An implication of these assumptions is that the only way to achieve functional synergies is with functional managers and the only way to achieve product-based coordination is with product division managers. This provides the basic link between organizational structure, strategy, and efficiency.

We make several other informational assumptions to simplify the analysis. First, we assume that managers do not know if their signals are near or far from the mean. This would be the case if each division has a disperse prior over the mean of the random variables. Second, we assume that functional managers do not observe the $\theta_{ij}s$ for the operating units in their divisions. Functional managers are less likely than product managers to use this local information because of our assumption that functional synergies require s_{ij} exactly equal to γ_{ij}. This is in contrast to a product manager's strategic choice, where there is a continuous tradeoff between local information and coordination. Thus, functional division managers may decide to not develop the expertise necessary to acquire this information. Neither of these assumptions affects our results in an important way. They simplify our analysis of centralized conflict resolution by eliminating complex inferences about the outcome of the dispute resolution mechanism.

The organizational structures we study vary in the number of division managers. We do not explicitly model the direct cost to the organization of employing them. Even if they are costless, the tradeoffs among organizational structures that we wish to focus on exist. Although it would be trivial to add such costs, we do not because the reader can still easily see the differences in managerial density across organizational forms and we avoid carrying around additional parameters.

We assume that division managers have local incentives, i.e., each minimizes costs in the division that he oversees. In most of the organizational structures we study, this assumption has no effect because managers do not have any information about the costs they impose on the rest of the organization when they make decisions. Thus, the parochial behavior is largely derived from the information assumptions of the model, not the incentive assumptions. In the extension section, we discuss the effects of alternative assumptions in the organizational structures where it can matter.

3.1 Operating Unit Autonomy

We begin our analysis with a base case in which there are no functional or product division managers. Each operating unit manager chooses $s_{ij} = \theta_{ij}$ because he does not know how to coordinate and achieve synergies. Total costs are:

$$\begin{aligned} C_A &= \sum_{i=1}^{m}\sum_{j=1}^{n}\frac{\alpha}{2}\left(s_{ij}-\theta_{ij}\right)^2+\sum_{i=1}^{m}\sum_{j=1}^{n}\frac{\beta}{2}\left(s_{ij}-\bar{s}_j\right)^2 \\ &= \sum_{i=1}^{m}\sum_{j=1}^{n}\frac{\beta}{2}\left(\theta_{ij}-\bar{\theta}_j\right)^2. \end{aligned}$$

The expected costs are:

$$\bar{C}_A = E_\theta\left[\sum_{i=1}^{m}\sum_{j=1}^{n}\frac{\beta}{2}\left(\theta_{ij}-\bar{\theta}_j\right)^2\right] = \frac{\beta\left(n-1\right)}{2}m\sigma^2.$$

This organization does a perfect job of responding to local information but fails to coordinate with product divisions and realizes no synergies.

4 Organizational Structure Choice With One Functional Synergy

In this section we analyze and compare three organizational structures. They are designed to illustrate the costs in reduced coordination and use of local information in organizing to realize a single functional synergy, so we assume that $\kappa_1 > 0$, and $\kappa_j = 0, \forall j \neq 1$.We begin with a decentralized product-based organization that cannot identify the functional synergy because it lacks a functional manager. This serves as a basis of comparison between the next two organizational structures. In the first, the functional manager has control rights over the operating units within his function while in the second the product division manager and the functional division manager share control rights. Disputes are resolved by senior managers.

4.1 Product Division Authority (M-Form)

In the organizational form with product division authority, each product division manager tries to minimize costs in his division. Each manager is able to learn each of his operating units' θ_{ij}s, and choose strategies that optimally trade off local optimization and coordination within the division. The product division managers are unable to coordinate within functions across product divisions to obtain functional synergies. Suppressing the row subscript, a given product division manager's problem is:

$$c_M = \min_{s_1,\ldots,s_n} \sum_{j=1}^{n} \frac{\alpha}{2} (s_j - \theta_j)^2 + \sum_{j=1}^{n} \frac{\beta}{2} (s_j - \bar{s})^2 .$$

The first-order condition is:

$$s_j = \frac{\alpha\theta_j + \beta\bar{s}}{\alpha + \beta}.$$

Summing the first-order conditions over all n choices and dividing by n gives:

$$\begin{aligned} \bar{s} &= \bar{\theta}, \\ s_j &= \frac{\alpha\theta_j + \beta\bar{\theta}}{\alpha + \beta}. \end{aligned}$$

Substituting back into the objective function, gives a cost per row of

$$\begin{aligned} c_M &= \sum_{j=1}^{n} \left\{ \frac{\alpha}{2} \left[\frac{\beta \left(\bar{\theta} - \theta_j\right)}{\alpha + \beta} \right]^2 + \frac{\beta}{2} \left[\frac{\alpha \left(\bar{\theta} - \theta_j\right)}{\alpha + \beta} \right]^2 \right\} \\ &= \frac{\alpha\beta}{2(\alpha + \beta)} \sum_{j=1}^{n} \left(\bar{\theta} - \theta_j\right)^2 . \end{aligned}$$

The expected total costs from the decentralized business unit organization are

$$\bar{C}_M = \frac{m\alpha\beta}{2(\alpha + \beta)} E_\theta \left[\sum_{j=1}^{n} \left(\bar{\theta} - \theta_j\right)^2 \right] = \frac{\alpha\beta(n-1)}{2(\alpha + \beta)} m\sigma^2.$$

The comparison with complete divisional autonomy is simple and intuitive.

$$\frac{\bar{C}_M}{\bar{C}_A} = \frac{\alpha}{\alpha + \beta}.$$

The more important coordination between divisions within a business unit, the greater are the benefits from adding business unit managers. Although we do not explicitly model the costs of adding managers, it is clear that it will pay to hire such managers if β is sufficiently large.

4.2 Partial Functional Authority (E-Form)

Many organizations are basically organized by product-based divisions but still decide to centralize one or more functions. In this section we analyze a structure with m product division managers and a single functional division manager. He is the manager of column 1 and has control rights over all s_{1j}s. His incentives are to minimize the costs in column 1. Since he does not observe the θs, he will simply choose to set $s_{1j} = \gamma_{1j}$ in order to obtain the functional synergy. We assume the product division managers can adjust their choices for all other operating units in their divisions based on the functional manager's choice. Product division manager i's decision is:

$$c_E = \min_{s_2,\ldots,s_n} \sum_{j=1}^{n} \frac{\alpha}{2} (s_j - \theta_j)^2 + \sum_{j=1}^{n} \frac{\beta}{2} (s_j - \bar{s})^2 .$$

The first-order conditions are:

$$s_j = \frac{\alpha\theta_j + \beta\bar{s}}{\alpha + \beta}.$$

Summing over all n-1 first-order conditions gives:

$$\bar{s} = \frac{(\alpha + \beta)s_1 + \alpha \sum_{j=2}^{n} \theta_j}{\alpha n + \beta}.$$

Substituting:

$$
\begin{aligned}
c_E &= \sum_{j=2}^{n} \frac{1}{2}\left[\alpha(\frac{\alpha\theta_j+\beta\bar{s}}{\alpha+\beta}-\theta_i)^2+\beta(\frac{\alpha\theta_j+\beta\bar{s}}{\alpha+\beta}-\bar{s})^2\right]+\frac{1}{2}\left[\alpha(s_1-\theta_1)^2+\beta(s_1-\bar{s})^2\right] \\
&= \sum_{j=2}^{n} \frac{1}{2}\left[\alpha(\frac{\beta(\bar{s}-\theta_j)}{\alpha+\beta})^2+\beta(\frac{\alpha(\theta_j-\bar{s})}{\alpha+\beta})^2\right]+\frac{1}{2}\left[\alpha(s_1-\theta_1)^2+\beta(s_1-\bar{s})^2\right] \\
&= \sum_{j=2}^{n} \frac{1}{2}\frac{\alpha\beta(\bar{s}-\theta_j)^2}{(\alpha+\beta)}+\frac{1}{2}\left[\alpha(s_1-\theta_1)^2+\beta(s_1-\bar{s})^2\right].
\end{aligned}
$$

The expected payoffs in the e-form organization are given by:

$$
\bar{C}_E = \frac{\alpha\left[2\alpha^2 n+2\beta^2 n+\alpha\beta\left(n^2+n+2\right)\right]}{2\left(\alpha+\beta\right)\left(\alpha n+\beta\right)} m\sigma^2-\kappa_1.
$$

Although we reserve until later a more complete comparison of organizational forms, we note here several aspects of a comparison between the E-form and M-form. The E-form allows the organization to realize synergies within a function, but with two types of cost. First, and most directly, the synergies are attained by ignoring local information in the operating units. This arises directly from our assumptions that γ_{ij} and θ_{ij} are independent and that the synergy can only be realized if s_{ij} is exactly equal to γ_{ij}. The second cost of the E-form relative to the M-form is that it decreases the effective coordination among operating units within a product division. The operating unit that is part of the functional division does not adjust its strategy for the local information of the other operating units in its product division and the these other product divisions are thereby likely to have to adjust their strategies farther away from their local optimal to mitigate this effect.

If the synergy is sufficiently large (κ) relative to the importance of local adaptation (α) and product coordination (β), the E-form is preferable to the M-form. For any firm making organizational structure choices, it is essential that the costs of centralizing a function are incorporated in the calculus. In our model, it is not possible to merge related businesses, centralize manufacturing to save costs, and keep everything else the same. Everything else becomes less efficient.

Note that $\bar{C}_E \to \infty$ as $\alpha \to \infty$, but approaches a finite limit as $\beta \to \infty$. (This limit is increasing if $\alpha > \frac{1}{n}$.) As the importance of local information increases, it is inefficient to try

to take advantage of any column synergies. However, if coordination with a product division is extremely important, the product division can adjust all of its other functions to coordinate with the functional division's strategy.

4.3 Centralized Conflict Resolution (Partial matrix)

Neither the E-form nor the M-form allows choice between the functional synergy and product division coordination on the basis of the realizations of the ex ante uncertainty. There is no mechanism in either organizational structure for use all of the relevant information in making this decision. The E-form always imposes the synergy and the M-form never does.

An omniscient decision-maker would observe the realization of all relevant information in the organization and then decide whether or not to standardize to realize the synergy or ignore it. Given that the relevant information is disperse in the organization, communication is needed to make decisions that trade off the ex post costs of implementing the synergy.

In this section we analyze an organizational structure where, like in the E-form, there is a single functional division manager (for column 1) and m product division managers. However, unlike the E-form we assume that none of these managers, by himself, has control over the operating units. Agreed upon strategies are implemented; if they fail to agree, senior management chooses. We assume that reliance on senior management results in incremental costs to the division managers and to senior management. This captures the time and cost of preparing information for senior management, senior management's time to meet and process the information, and the costs to the organization from delaying decisions.

We analyze a simple extensive form. The functional division manager proposes strategies for each operating unit in his division. Each product division manager observes the proposal and simultaneously decides whether to appeal the proposal or not. If any product division manager appeals, it goes to senior management. We assume, for the moment, that the product division manager does not share in the functional synergy. It is a simple extension, which we discuss below, to have each product division manager care about product division costs less $\frac{1}{m}$ of the synergy. Each product division manager incurs a cost c_L if there is an appeal. There is an additional cost c_H if there is an appeal. This cost could be incurred by any combination of

the product division manager, senior management, and the organization as a whole. If there is an appeal, senior management observes all random variables and decides whether or not to impose the synergy, i.e., he chooses either the M-form or E-form outcome efficiently.

This extensive form allows us to avoid complex inference problems or signaling in the proposal and appeal stages, thereby greatly simplifying the analysis. A richer bargaining game among the division managers might improve matters by allowing more efficient outcomes without appeal, but also introduces the possibility of proposing strategies that are not optimal in order to signal private information. In the extension section, we discuss a variant of the model that has this feature.

In our game, the functional unit manager always proposes the strategies that implement the functional synergy. Since we assume that he does not know whether the γ_{1j}s are close or far from the mean, his proposal provides a product division no information about the expected costs of implementing the synergy for other product division managers or the likelihood they will appeal. A product division manager's decision to appeal or not is more complex. We will denote by Δ_i, the difference between a product division's costs with the synergy imposed and without it. Dropping, the row subscript,

$$\Delta = \frac{1}{2}\left\{\sum_{j=2}^{n}\frac{\alpha\beta(\bar{s}-\theta_j)^2}{(\alpha+\beta)} + \left[\alpha(s_1-\theta_1)^2+\beta(s_1-\bar{s})^2\right] - \frac{\alpha\beta}{(\alpha+\beta)}\sum_{j=1}^{n}\left(\bar{\theta}-\theta_j\right)^2\right\},$$

where

$$\bar{s} = \frac{(\alpha+\beta)s_1 + \alpha\sum_{j=2}^{n}\theta_j}{\alpha n+\beta}.$$

If $\theta_{ij}, \gamma_{ij} \sim N\left(0,\sigma^2\right)$, it turns out (the proof is in the appendix) that $\hat{\Delta} \sim \chi_1^2$, where $\hat{\Delta} \equiv \Delta/\lambda_1$, and λ_1 is a constant defined by:

$$\lambda_1 \equiv \frac{\alpha\left[2\alpha^2 n + 4(n+1)\alpha\beta + (n+1)\beta^2\right]}{2\left(\alpha+\beta\right)\left(\alpha n+\beta\right)}\sigma^2.$$

The cost of an appeal to a product manager is c_L. The benefits are Δ multiplied by the probability the appeal is successful. The equilibrium decision to appeal will depend on

the probability of success conditional on the product division manager being pivotal, i.e., the other product division managers do not appeal. Row i will be indifferent being appealing or not if $\Delta_i = \Delta^*$, where Δ^* is given implicitly by the following equation:

$$c_L = \Delta^* * prob\left(\sum_{k \neq i} \Delta_k + \Delta^* > \kappa \mid \Delta_k < \Delta^*, \forall k \neq i\right).$$

We compare the three organizational forms numerically. For all the calculations, we assume that $\theta_{ij}, \gamma_{ij} \sim N\left(0, \sigma^2\right)$, and $m = n = 3$.

A first important feature of the centralized conflict resolution structure is that excessive appeals take place in equilibrium, since agents do not internalize their impact on the rest of the organization. Figure 1 shows the probability of conflict as a function of the level of synergies both in the first best (the level of Δ^* that minimizes expected organizational costs) and the actual probability that is realized in equilibrium. Two interesting observations can be made. First, the appeal threshold in the first best is higher than the one that an individual manager would choose. As a result, as the figure shows, the probability of conflict is always lower in the first best than when division managers only care about their units. There are two forms of externalities. First, an individual managers does not internalize the delay and communication costs of other divisional managers and senior management from conflict. Second, an individual manager does not internalize the effects of a change in strategy on other parts of the organization. This includes the gains to other product divisions and costs to functional divisions.

Note that, in Figure 1, the gap between the first best threshold for appealing and the threshold managers choose narrows with the level of synergies. As synergies increase, we observe two effects. The first effect, which is observed in both the first best and the equilibrium of the game, has product division managers appealing less, as the relative value of local adaptation and coordination declines. Second, and less obviously, as synergies increase, the product division managers are disciplined by the higher risk of losing the appeal. This leads to a convergence of the centralized conflict resolution level of conflict to the one in the first best.

The excessive level of appeals in the centralized conflict resolution structure may create an incentive for the organization to increase managerial communication costs to decrease the

likelihood of appeals. Table 1 illustrates this effect. There we see that, by placing obstacles in the path of those managers who want to appeal, the organization can improve its cost position; this is true even though the higher communication costs are also borne by the organization. When the communication costs are very low, as cost increases, the decrease in the probability of conflict more than compensates for the higher communication costs. This is not the case when the communication cost is higher. Note also that the higher the cost of the CEO, the higher the increase in the communication cost that the organization is willing to impose on lower level managers.

Figure 2 compares centralized conflict resolution to the other two organizational forms as a function of the value of the functional synergies available and of the coordination between products. One might conjecture that, for a given level of communication costs, centralized conflict resolution will be optimal when economics of scale and divisional coordination are more or less equally important. In contrast, one could expect the E-form or M-form to prevail if either economics of scale or coordination dominates. However, our model shows a somewhat different picture. First, if economies of scale and the benefits of divisional coordination are small, the communication costs associated with centralized conflict resolution often outweigh its benefits, and it will be optimal to choose either the M-form or the E-form. If both are small, the M-form is preferred in these cases because it allows for local adaptation. Second, even when functional synergies are much larger than the benefits of coordination, joint control will often be preferred to the E-form, even though in the great majority of cases, the outcome will be the same strategy as the E-form. The reason for this is that the equilibrium costs of communication are endogenous – a large functional synergy will dramatically decrease these communication costs, since product division managers know that it will be extremely difficult to avoid functional standardization. Hence, large economics of scale disciplines the product division managers; they only appeal if economics of scale are very harmful.

A similar results hold with respect to the importance of coordination. Even if coordination becomes very important relative to economics of scale, centralized conflict resolution often remains optimal, since product division managers can easily achieve good coordination at the expense of local adaptation. Depending on the particular situation, under centralized conflict resolution, if coordination is very important, senior management then decides whether or not it will obtain coordination at the expense of local adaptation (that is by choosing the E-form) or at the expense of economics of scale (that is by choosing the M-form).

The latter observation points to a very important difference between the importance of local adaptation and coordination. In contrast to the importance of coordination, if local adaptation becomes very important, then this will necessarily imply that a divisional organization is optimal. Indeed, economics of scale always come at the expense of local adaptation. Hence, if local adaptation is very important, the E-form is rarely optimal.

An interesting question is whether the way in which synergies are realized is different in large organizations – with many product divisions – as opposed to smaller organizations. Intuitively, one may expect conflict resolution mechanisms to play a smaller role in larger organizations for two reasons. First, as the number of divisions increases, the ex post uncertainty as to whether a functional synergy will be worth implementing becomes smaller. Given that conflict resolution is costly, the organization is then more likely to choose for a simple organizational form which delegates authority to either the functional division manager or the product division managers, depending on whether or not the functional synergy is valuable in expectations. Second, as the number of divisions increases, each product division bears a smaller part of the overall cost of the appeal procedure. Hence, the difference between the private incentives of division managers to appeal and what is optimal from an organizational perspective, is likely to become larger as organizations add more product divisions.

Figure 3 illustrates these intuitions by comparing the E-form, the M-form and centralized conflict resolution for two product divisions, as opposed to the three product divisions in Figure 2. In order not to bias this comparison, we compare functional synergies that are directly proportional to the number of divisions. A total synergy of value 1.5 in Figure 2 is thus equivalent to a total synergy of value 1 in Figure 3. (We take this into account graphically by reducing the scale of the y-axis by 1/3 in Figure 3.) Similarly, we have assumed that the communication cost incurred by senior management is proportional to the number of divisions - all other parameters are identical. As can be seen, reducing the number of divisions dramatically increases the optimality of centralized conflict resolution at the expense of both the E-form and the M-form.

5 Extensions

In this section, we develop four extensions of the basic model. First, we analyze organizational structures designed to exploit more than one functional synergy. Second, we add effort incentives into the model. Third, we study the effect of allowing product division managers to share in the functional synergies. This could be achieved with changes in incentive pay or transfer pricing rules. Finally, we discuss an extension of the model in which product division managers have private information about the importance of local adaptation.

5.1 Multiple Functional Synergies

We now extend the model to allow attempts to exploit more than one functional synergy. We assume that the functions are ordered such that $\kappa_1 \geq \kappa_2 \geq ... \geq \kappa_n$. There are two types of decentralized organizations that can be used to exploit several functional synergies. First, there are variants of the E-form where there are more than one functional manager. In such an organization, the role of the product division manager declines as he has fewer operating units under his control. Alternatively, one could envision an organization with functional division managers and no product division managers. Either there is a functional division manager for each division or some operating units make decisions on their own.

We can illustrate the important issues effectively by extending the E-form to two functional managers (extended E-form). There are few additional insights but a great deal of additional algebra by extending the analysis to an arbitrary number of functional divisions. We assume that there are functional division managers for the columns with the two highest synergies (columns 1 and 2). The two functional division managers choose strategies to generate functional synergies and product division managers minimize costs taking s_1 and s_2 as given. A product division manager's objective function is to:

$$\min_{s_3,..s_n} \sum_{j=1}^{n} \left[\frac{\alpha}{2} (s_j - \theta_j)^2 + \frac{\beta}{2} (s_j - \bar{s})^2 \right].$$

The optimal solution is given by

$$
\begin{aligned}
s_j &= \frac{\alpha\theta_j + \beta\bar{s}}{\alpha+\beta}, \text{ where} \\
\bar{s} &= \frac{\alpha \sum_{j=3}^{n} \theta j + (\alpha+\beta)(s_1+s_2)}{\alpha n + 2\beta}.
\end{aligned}
$$

Substituting into the objective function, expected costs for one row are:

$$
\bar{c}_{EE} = E_\theta \left\{ \frac{1}{2} \sum_{i=3}^{n} \frac{\alpha\beta(\bar{s}-\theta j)^2}{\alpha+\beta} + \frac{1}{2} \sum_{j=1}^{2} \left[\alpha(s_j-\theta_j)^2 + \beta(s_j-\bar{s})^2 \right] \right\}.
$$

After much algebra

$$
\bar{c}_{EE} = \frac{2\beta^3 + 4\alpha^3 n + 4\alpha\beta^2(n+1) + \alpha^2\beta\left(8+3n+n^2\right)}{2(\alpha+\beta)(\alpha n+2\beta)}\sigma^2.
$$

Total expected costs of the extended E-form are then:

$$
\bar{C}_{EE} = \frac{2\beta^3 + 4\alpha^3 n + 4\alpha\beta^2(n+1) + \alpha^2\beta\left(8+3n+n^2\right)}{2(\alpha+\beta)(\alpha n+2\beta)}\sigma^2 m - \kappa_1 - \kappa_2.
$$

Note that $\bar{C}_{EE} \to \infty$ as $\beta \to \infty$, unlike either the E-form or the M-form. In the E-form, a product division can adjust for the strategy of the operating unit that is part of the functional division. However, with two functional divisions, each may choose strategies that are far apart; if coordination is sufficiently important, there is little the product division can do to adjust.

In the model, the incremental cost of implementing a second synergy is, in a sense that we make precise, higher than the cost of exploiting the first synergy. Consider an environment where $\kappa_2 = \kappa_1 = \kappa$. If κ is low, the M-form is optimal. As κ increases, we can show (we omit the unilluminating algebra) that the optimal organization never goes directly from an M-form to the extended E-form, without first switching to the simple E-form. In other words, the incremental benefit from exploiting the first synergy is greater than the incremental benefit from exploiting the second, even if the $\kappa_1 = \kappa_2$.

The same basic can be illustrated in a decentralized functional organization. Here there are no product division managers; all synergies are realized but there is no local adaptation or

product-based coordination. The functional managers simply set $s_{ij} = \gamma_{ij}$. This implies that the costs of this organizational form are:

$$C_F = \sum_{i=1}^{m}\sum_{j=1}^{n}\frac{\alpha}{2}\left(\gamma_{ij} - \theta_{ij}\right)^2 + \sum_{i=1}^{m}\sum_{j=1}^{n}\frac{\beta}{2}\left(\gamma_{ij} - \bar{\gamma}_i\right)^2 - \sum_{j=1}^{n}\kappa_j.$$

Taking expectations, gives

$$\bar{C}_F = \frac{1}{2}\left[2\alpha n + \beta\left(n-1\right)\right]m\sigma^2 - \sum_{j=1}^{n}\kappa_j.$$

Again, functional synergies are realized, but at the cost of complete lack of local adaptation and coordination. It is again straightforward to show that if $\kappa_i = \kappa$, for all $i = 1, ..., n$, then if we increase κ, we never go directly from an M-form to a decentralized functional organization, without first switching to the E-form.

These two versions of our model capture what we believe is an important idea about functional organizations. In most companies, coordination of activities to support a product or line of business is essential. It is unimaginable that independent manufacturing, marketing, sales, and R&D would be able to survive without some method to coordinate their activities in support of particular products or groups of customers. In our model, this is equivalent to saying that β is large and the decentralized organizations we have just analyzed cannot be optimal.

The only alternative to abandoning the functional synergies by organizing exclusively by product-based divisions is to use senior management to coordinate among the functional divisions. It is possible to add senior management coordination into these models. We do not analyze these models explicitly here, but we have worked some of them out , so we comment on some of the results. Senior management will regularly be needed to mediate the conflicting desires of functional division managers. Communication costs will be high and, if communication to senior management involves loss of local information, local adaptation will decline. As the organization grows, the demands on senior management will likely grow more than proportionately. This reflects Chandler's (1962) classic argument that the overwhelming demands on senior management in growing centralized organizations was overcome by the innovation of product-based divisional organizations.

5.2 Effort Incentives and Endogenous Synergies

Until now, we have focused on the impact of local incentives on decision making. Managerial incentives may not only matter for which strategies are implemented; they may also affect the quality of the available synergies. Intuitively, one may expect managers to spend more energy in developing synergies if there is a decent probability that their proposals will be implemented. Hence, how devoted managers are in creating synergies is likely to depend on the organizational structure. If the level of synergies is endogenous and depends on the organizational form, how does this affect our previous analysis?

To analyze this question, we assume that the level of functional synergies depends on the effort provided by the functional division manager. In particular, we assume that value of a functional synergy is given by

$$\kappa = \kappa(e) \equiv e * \tilde{\kappa},$$

where e is the effort provided by the functional division manager. For concreteness, we assume that the functional division manager incurs a cost $g(e) = e^2/2$ in providing effort e. Obviously, the payoff in the M-form organization is not affected by this specification, as a functional synergy is then never implemented (as a result, a functional column manager - if there were to be one - would provide zero effort). The payoffs under the E-form, in contrast, are now given by

$$-\frac{\alpha\left[2\alpha^2 n + 2\beta^2 n + \alpha\beta\left(n^2+n+2\right)\right]}{2\left(\alpha+\beta\right)\left(\alpha n+\beta\right)} m\sigma_\theta^2 + \tilde{\kappa}^2.$$

Indeed, as the functional division manager knows that his synergy will always be implemented, he chooses e in order to maximize

$$e * \tilde{\kappa} - e^2/2,$$

which yields $e^* = \tilde{\kappa}$ and $\kappa(e) = \tilde{\kappa}^2$.

It follows that the output under the E-form and M-form are as if there was an exogenous functional synergy with value $\kappa = \tilde{\kappa}^2$. In contrast, we now show that the payoff under centralized conflict resolution is smaller compared to a setting in which there is an exogenous functional synergy of value $\kappa = \tilde{\kappa}^2$. In other words, centralized conflict resolution becomes less attractive relative to the E-form or the M-form, if one endogenizes the value of synergies by introducing effort incentives.

Indeed, under joint control, the product division manager of row i, will appeal if and only if $\Delta_i \geq \Delta^*$ where Δ^* is determined by

$$c = \Delta^* * prob(\Delta_2 + \Delta_3 > \kappa(e^*) - \Delta^* | \Delta_2 < \Delta^*, \Delta_3 < \Delta^*).$$

If we make the natural assumption that the CEO does not observe e^*, but forms rational expectations about e_c^*, then the functional division manager will choose e in order to maximize

$$p_c^* * e * \tilde{\kappa} - e^2/2,$$

which yields $e^* = p_c^* * \tilde{\kappa}$ and $\kappa(e^*) = p_c^* * \tilde{\kappa}^2$, where p_C^* is that the probability there is no appeal, or there is an appeal but the CEO sides with the functional division manager. Thus, whereas under the E-form (and the M-form), organizational profits are as if there was an exogenous column synergy of value $\kappa = \tilde{\kappa}^2$, under centralized conflict resolution, profits are as if there was only a column synergy of value $\kappa = p_c^* * \tilde{\kappa}^2$, where $p_c^* < 1$ unless $\tilde{\kappa}$ is extremely large. Since under centralized conflict resolution, profits are decreasing in κ, this implies that relative to a case in which functional synergies are exogenous, centralized conflict resolution is less prevalent if the quality of functional synergies endogenously depends on effort incentives.

Note that under centralized conflict resolution, there will typically be multiple equilibria, as the expectations of the CEO with respect to the quality of functional synergy, directly affects the value of this synergy through its impact on effort provision. For example, as long as c is not too large, there always exists an equilibrium in which the functional division manager provides no effort, product division managers always appeal, and the CEO always decides in favor of the product division manager. The functional division manager, being completely demotivated, then provides no effort such that it was indeed optimal for the CEO to allows follow the product division. One can show, however, that in many cases there will be positive effort in equilibrium.

Our result that endogenizing the level of synergies tends to make centralized conflict resolution less attractive, points to what we believe is a more general insight about a default of any contingent control mechanism. Intuitively, if the quality of proposed decisions is increasing in effort, and effort provision is positively correlated with decision rights, this makes it very attractive for the organization to concentrate effort in one manager. Indeed, relative to a case of centralized dispute resolution – in which all proposed decisions are from intermediate quality

— by concentrating the effort in one person, the organization increases the quality of proposals/synergies which are most likely to be implemented at the expense of decisions/synergies which are unlikely to be realized.

The latter discussion suggests that a similar result would obtain if one would also endogenize the incentives of the product division managers to coordinate their units. For example, one could posit that the payoff of a product division is given by

$$e_r \left[A - \frac{\alpha}{2} (s_j - \theta_j)^2 + \sum_{j=1}^{n} \frac{\beta}{2} (s_j - \bar{s})^2 \right],$$

with the cost to the product division manager of providing effort e_r given by $g(e_r)$. Again, the above specification has the characteristic that effort by the product division manager will be increasing in his authority. Thus, effort will be maximized in an M-form organization, which is exactly the organizational form in which effort by product division managers is most productive. In contrast, product division effort will be minimal (and functional division effort will be maximal), in the E-form, which is precisely the organizational form where effort by product division managers is least productive (and effort by functional division managers is most productive). Finally, effort will be intermediate for both the functional and the product division managers in an organization with contingent control. Interestingly, this implies that under centralized dispute resolution, if the CEO decides to rule in favor of a product division manager, profits will still fall short of would have been achieved in an M-form organization. Similarly, if it is optimal ex post to realize functional synergies, the CEO never is able to obtain the E-form outcome. In contrast, if synergies are exogenous, the CEO does exactly mimic the outcome of the M-form or E-form. The only cost of centralized dispute resolution are then the communication and investigation costs c_L and c_H. Hence, endogenizing both the functional synergies and the product coordination benefits is likely to reduce the attractiveness of centralized dispute resolution. In essence, there is a cost of using ex post control allocation in an organization with ex ante investment.

While the outcome of the M-form and E-form with endogenous effort is easy to calculate, solving the centralized conflict resolution case turns out to be much more difficult if both product managers and functional managers exert effort. The reason is that rational expectations again play an important role, where effort provision is a function of equilibrium expectations about effort provision. Adding to the complications, these rational expectations lead to the

possibility of multiple equilibria. Indeed, if the CEO tends to favor functional managers, then in equilibrium, functional managers work harder, but product managers are discouraged, which makes it optimal to the CEO to favor functional managers. Another equilibrium may exist, however, in which CEO tends to favor product managers, which motivates the latter but blunts the incentives of the functional managers.

5.3 Profit Sharing (Transfer Pricing)

So far, we have assumed that row managers have local or parochial incentives, that is they do not care at all about potential functional synergies. We have motivated this assumption by referring to career concerns and the need to reward managers based on divisional performance in order to induce effort. In practice, however, business units are often imputed a fraction of the cost of centralized functions through transfer pricing rules or explicit incentive pay schemes, and hence, benefit at least partially from realized synergies and economics of scale. More generally, the organization can try to reduce conflicts of interest by rewarding managers at least partially on overall company performance. To see the impact of such transfer pricing or profit sharing, consider the following extension of our basic model, in which the payoff of a product division manager is given by

$$-\sum_{j=1}^{n}\left[\frac{\alpha}{2}\left(s_j-\theta_j\right)^2+\sum_{j=1}^{n}\frac{\beta}{2}\left(s_j-\bar{s}\right)^2\right]+\phi x\kappa,$$

where $x = 1$ if functional synergies are realized and $x = 0$ otherwise. For example, if each product division is imputed its'fair' share of the realized synergies, this would imply that $\phi = 1/m$.

It is easy to see that given our restrictions on horizontal communication, profit sharing has no impact on the payoffs in the M-form or the E-form. In contrast, profit sharing makes centralized conflict resolution more attractive, as a manager in control of row 1, will appeal if and only if $\Delta_1 > \Delta^*(\phi)$ where $\Delta^*(\phi)$ is given by

$$c = [\Delta^* - \phi\kappa] * prob(\Delta_2 + \Delta_3 > \kappa - \Delta^* | \Delta_2 < \Delta^*, \Delta_3 < \Delta^*).$$

Thus, profit sharing or effective transfer pricing reduces the excessive incentives of product division managers to appeal. Indeed, it is straightforward to see from the previous equation that $\Delta^*(\phi)$ is increasing in ϕ.

5.4 Strategic Communication of Private Information

So far, we have assumed that if there is an appeal, senior management observes all random variables and chooses either the M-form or E-form outcome efficiently. While greatly simplifying the analysis, the latter assumption implies that the only cost of centralized conflict resolution is the communication costs and the delay in decision making. If, in contrast, the information of senior management was less than perfect, not only would senior management sometimes side with the wrong division, but divisional managers might also distort their private information in order to influence senior management's decision. Importantly, such information distortions not only increase the likelihood of mistakes by senior management in terms of whether or not functional synergies should be implemented, but also imply that senior management lacks the correct local information to mimic ex post the (efficient) outcome of a product based organization. In other words, relative to a conflict resolution mechanism in which senior management is very involved, a simple organizational form which delegates full decision-making authority to, say, product division managers, has the advantage that it avoids the distortion of the local information of these division managers.[7]

In order to formalize the above ideas, assume that whereas senior management may learn the values of all $\theta_{ij}s$, only the product division manager of division i knows how important the adaptation to local information of the decisions is. In particular, we assume that with probability μ, $\alpha_i = \alpha_L$ whereas with probability $1-\mu$, $\alpha_i = \alpha_H > \alpha_L$, where α_i is private information of the division manager of product i.

Importantly, even after senior management has incurred the cost c_H, she must rely on a cheap talk statement of division manager i about α_i in order to decide whether or not to implement the functional synergy. Once there is an appeal to overturn the functional synergy, each division manager has an incentive to exaggerate the importance of local adaptation and how this is made very difficult by the imposed synergy. Thus, conditional upon an appeal, in order to influence senior management's decision to abolish the functional synergy, all product division managers have an incentive to claim that $\alpha_i = \alpha_H$, unless $\alpha_H - \alpha_L$ is very large.

Moreover it is natural assumption that senior management can always revise its decision

[7]The insight that under centralization, privately informed agents are likely to distort their private information and, as a reponse to this, delegation of authority to these agents is often preferred over hierarchical communication, was first highlighted by Dessein (2002) in the context of a simple principal-agent relationship.

whether or not to implement a functional synergy. Hence if senior management decides not to implement the functional synergy, a manager of type α_L will need to mimic the behavior of a manager of type α_H in deciding on s_{ij} if it does not wants to be revealed as a low type ex post.

Thus, the information distortion by divisional managers makes joint control less attractive in two ways. First, the fact that senior management must make a decision based on incomplete information results in organizational mistakes: sometimes the functional synergy will be implemented when it should not, on other occasions product divisions will be given autonomy whereas the functional synergy is wealth increasing. This result provides and incentive-based underpinning of our informational assumptions: communication of information is limited or costly not for some technological reasons - as necessarily assumed in the team-theoretic literature - but *because of the presence of incentive conflicts and parochial preferences.* In particular, division managers cannot be trusted to truthfully reveal their private information to senior management. Second, the distortion of local information implies that centralized conflict resolution cannot implement the outcome of the M-form ex post. Indeed, in many instances, the choices of s_{ij} will be distorted, that is they will reflect too much adaptation to local circumstances. Thus, even if senior management decides against the implementation of functional synergies, organizational payoffs will tend to fall short of what could have been obtained by giving product division managers decision-making authority straight away.

APPENDIX

This appendix shows that, when $\theta_{ij}, \gamma_{ij} \sim N\left(0, \sigma^2\right)$ $\hat{\Delta} \sim \chi^2_1$, where $\hat{\Delta} \equiv \Delta/\lambda_1$, and λ_1 a constant.

Proof. Recall the definition of Δ :

$$\Delta = \frac{1}{2}\left\{\sum_{j=2}^{n} \frac{\alpha\beta(\bar{s}-\theta_j)^2}{(\alpha+\beta)} + \left[\alpha(s_1-\theta_1)^2 + \beta(s_1-\bar{s})^2\right] - \frac{\alpha\beta}{(\alpha+\beta)}\sum_{j=1}^{n}\left(\bar{\theta}-\theta_j\right)^2\right\}.$$

We want to convert this expression into a simple quadratic form. To do this, consider the change of variables: $x_1 = \bar{\theta} - \theta_1$; $x_2 = \bar{\theta} - \theta_2$; $x_3 = s_1 - \bar{s}$; and $x_4 = \theta_2 - \bar{s}$.

Given this change,$\bar{\theta} - \theta_3 = -x_1 - x_2$, $\alpha(s_1 - \theta_1 = (x_4 - x_3) - (x_2 - x_1)$, and $\theta_2 - \bar{s} = -x_4 - \frac{\alpha+\beta}{\alpha}x_3$. Since the θ_i random variables are normal, so are x_i, which are simply linear transformations of normals. Since θ_i is mean 0, so is x_i The variance covariance matrix of $X = (x_1, x_2, x_3, x_4)$ can be readily calculated and is:

$$\Omega_x = \begin{bmatrix} \frac{2\,\sigma^2}{3} & \frac{-\sigma^2}{3} & \frac{2\,\alpha\,\sigma^2}{3\,(3\,\alpha+\beta)} & \frac{-\left((\alpha+\beta)\,\sigma^2\right)}{3\,(3\,\alpha+\beta)} \\ \frac{-\sigma^2}{3} & \frac{2\,\sigma^2}{3} & \frac{-\left(\alpha\,\sigma^2\right)}{3\,(3\,\alpha+\beta)} & \frac{(5\,\alpha+2\,\beta)\,\sigma^2}{3\,(3\,\alpha+\beta)} \\ \frac{2\,\alpha\,\sigma^2}{3\,(3\,\alpha+\beta)} & \frac{-\left(\alpha\,\sigma^2\right)}{3\,(3\,\alpha+\beta)} & \frac{6\,\alpha^2\,\sigma^2}{(3\,\alpha+\beta)^2} & \frac{-3\,\alpha\,(\alpha+\beta)\,\sigma^2}{(3\,\alpha+\beta)^2} \\ \frac{-\left((\alpha+\beta)\,\sigma^2\right)}{3\,(3\,\alpha+\beta)} & \frac{(5\,\alpha+2\,\beta)\,\sigma^2}{3\,(3\,\alpha+\beta)} & \frac{-3\,\alpha\,(\alpha+\beta)\,\sigma^2}{(3\,\alpha+\beta)^2} & \frac{2\left(3\,\alpha^2+3\,\alpha\,\beta+\beta^2\right)\sigma^2}{(3\,\alpha+\beta)^2} \end{bmatrix}$$

Given this change of variable, we can write Δ as the quadratic form:

$\Delta = X\Gamma X$

where $X = (x_1, x_2, x_3, x_4)$ and:

$$\Gamma = \frac{1}{2}\begin{bmatrix} -\alpha + \frac{2\,\alpha\,\beta}{\alpha+\beta} & \alpha + \frac{\alpha\,\beta}{\alpha+\beta} & \alpha & -\alpha \\ \alpha + \frac{\alpha\,\beta}{\alpha+\beta} & -\alpha + \frac{2\,\alpha\,\beta}{\alpha+\beta} & -\alpha & \alpha \\ \alpha & -\alpha & -\alpha - \beta - \frac{\beta\,(\alpha+\beta)}{\alpha} & \alpha - \beta \\ -\alpha & \alpha & \alpha - \beta & -\alpha - \frac{2\,\alpha\,\beta}{\alpha+\beta} \end{bmatrix}$$

We now seek the distribution of Δ, given our knowledge of the distribution of x_i, i.e. the object of interest is:

$$P[\Delta < y] = P[X'\Gamma X < y] = \int_{X'\Gamma X} f(Z)dZ.$$

To characterize this distribution we proceed in three steps, by successive changes of variables.

First, since Ω is a symmetric positive definite matix, we can apply the Cholesky decomposition to convert it into a lower triangular matrix, i.e. $\Omega = PP'$, with P non-singular and lower triangular matrix. We can then write:

$$\Delta = X'\Gamma X = X'P_1'P'\Gamma PP^{-1}X = X^{*'}P'\Gamma PX^*$$

where it is easy to see that given this linear transformation $X^* = P^{-1}X$ is a $N(O, I)$.

Second, to decompose further the matrix $P'\Gamma P$, note that it is symmetric, so calling Λ its matrix of eigenvalues and R the eigenvectors associated with it, we have its spectral decomposition:

$R'P'\Gamma PR = \Lambda$,

where Λ, the matrix of eigenvalues of $P'\Gamma P$ or, alternatively, of $\Gamma\Omega$ has the four eigenvalues in the diagonal, $\lambda_2 = \lambda_3 = \lambda_4 = 0$ and

$$\lambda_1 = \frac{\alpha\ \left(3\,\alpha^2 + 4\,\alpha\,\beta + 2\,\beta^2\right)\ \sigma^2}{(\alpha + \beta)\ (3\,\alpha + \beta)}.$$

Third, we can now make a new linear transformation: $Z = RX^*$,so that:

$$\Delta = X^{*'}\Gamma X^* = Z\Lambda Z'$$

where Z is also a $N(O, I)$. Since the Z's are independent random variables, we can rewrite Δ as:

$$\Delta = \sum_{i=1}^{n} \lambda_i^2 z_i^2 = \lambda_1 z_1^2.$$

Given that z_i is a unit normal variable, we have that Δ is distributed as a constant λ_1 times a chi square, as we wanted to show. ■

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Figure 1
Excessive Communication and Conflict

Probability of Conflict: First Best and Equilibrium Probability Given Individual Choice
As a function of k

The figure presents the probability of conflict in the centralized conflict resolution organization as a function of the level of synergies. The lower line (red) is the first best probability of conflict. The upper line (green) is the actual equilibrium probability of conflict.

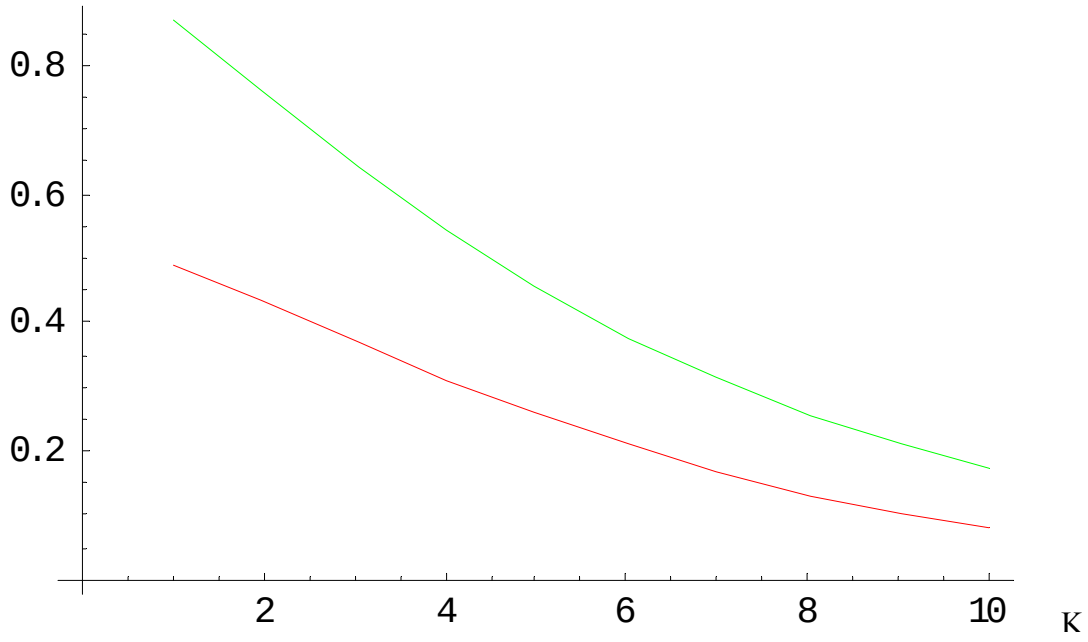

Figure 2
Organizational Choice
As a function of k and β

The figure presents the regions where each one of the three possible organizations (M-form, E-form, or centralized conflict resolution) are chosen as a function of the value of functional coordination (k) and level of within organization synergies (β)

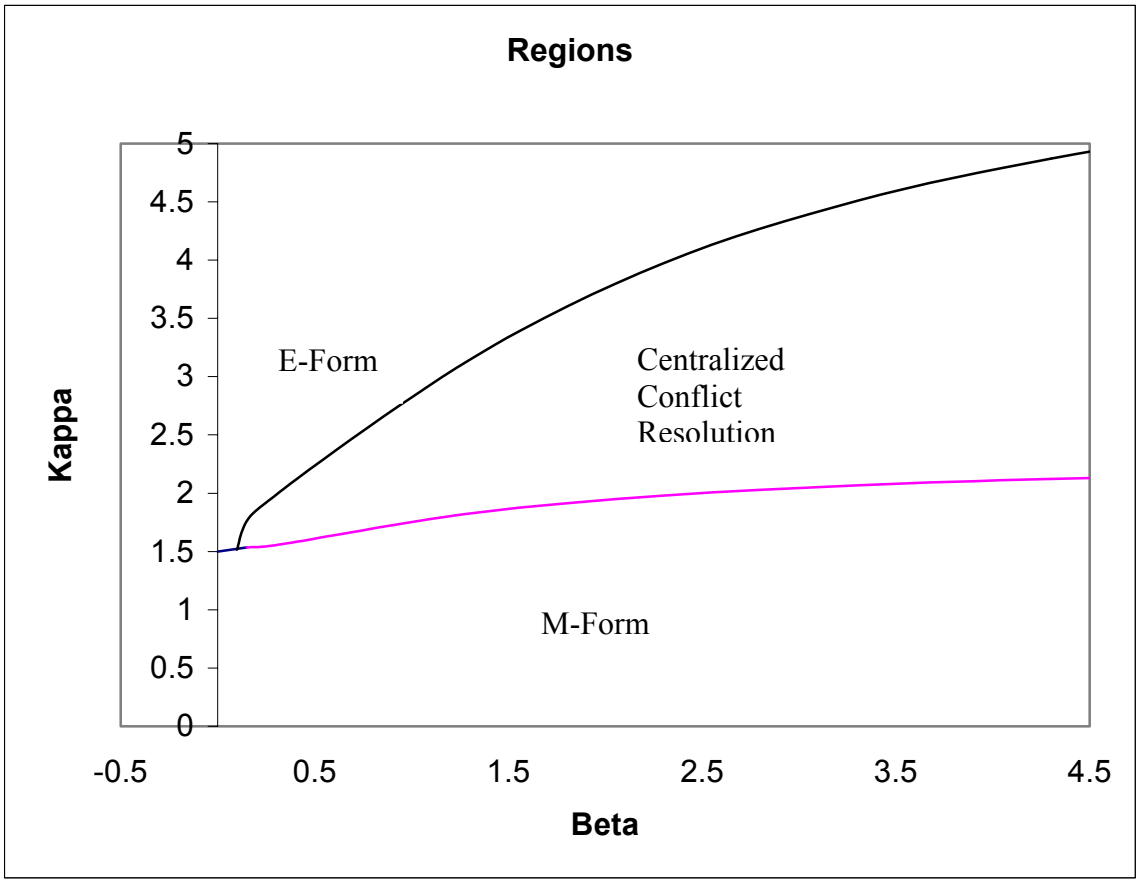

Figure 3
Organizational Choice: Effect of a Decrease in the Number of Product Divisions
As a function of k and β

This figure presents a configuration with the same parameters as the figure before, but with one row less.

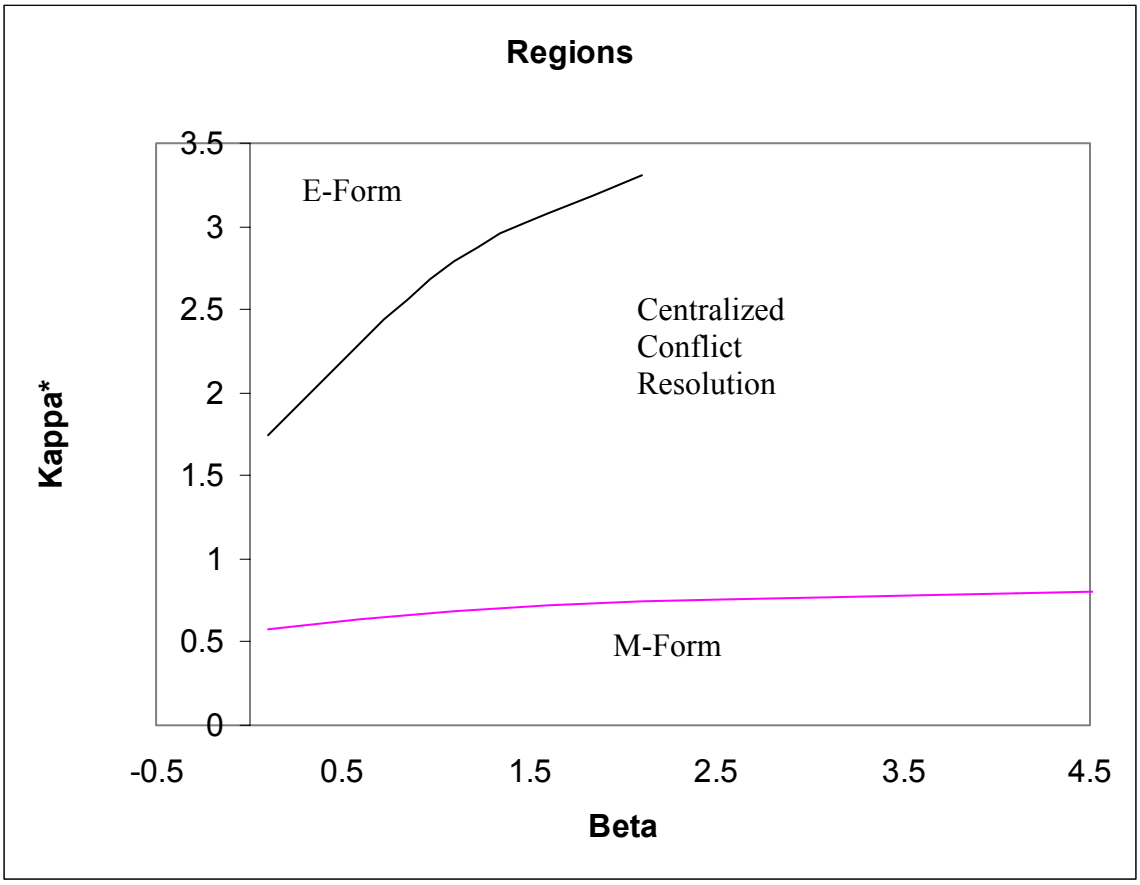

Table 1
Endogenous Choice of Cost of Appeal
The table shows the impact of an increase in the CEO cost when communication costs for managers are exogenously given (upper row), and when the organization can impose extra costs on managers.

	Cost of Appeal		Organizational Cost of Centralized Conflict Resolution	Probability of Conflict
Exogenous Appeal Cost for Manager	**Cost CEO**	**Cost Manager**	**Cost**	**Probability**
	2	.05	1.08	.47
	2.5	.05	1.34	.47
	3	.05	1.55	.47
Optimal Appeal Cost for Manager	**Cost CEO**	**Cost Manager**	**Cost**	**Probability**
	2	**.09**	1.06	.43
	2.5	**.13**	1.31	.41
	3	**.16**	1.51	.405