

Organizing For Synergies

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Abstract

Multi-product firms create value by sharing resources to exploit scale economies in functional areas (e.g. manufacturing). We study the organizational barriers that thwart attempts to capture these synergies by integrating related business units. This integration often requires that the relevant functional area be reassigned from business unit managers to functional managers, who are then responsible for implementing or proposing standardization across units. Given this division of labor, realizing value-increasing synergies involves a trade-off between motivation and coordination. The reason is that motivating managers requires that incentives be narrowly focused around managers' area of responsibility, resulting in functional managers who are endogenously biased toward excessive standardization, and, in turn, in business unit managers who misrepresent local market information to limit standardization. As a result, integration may be value-destroying when motivation is sufficiently important. Attempts to soften this tradeoff by providing functional managers only with "dotted-line control" (where they need the cooperation from the business unit managers to undertake standardization moves), are unlikely to be successful. Providing those in charge of synergies with unrestricted control over standardization is typically preferred.

1 Introduction

Many mergers are motivated by potential synergies that may be realized by combining or standardizing activities such as R&D, manufacturing, purchasing or distribution. A simple (or simplistic) justification for such a merger is that two firms can do everything as before except the narrow combination of activities needed to exploit a synergy. However, there are countless examples of firms that fail to achieve the synergies that motivated the deal. Many of the most spectacular failed mergers involve failures to implement the organizational strategies required to realize the potential gains from the merger.¹

¹The anecdotal evidence of failed synergy implementation is also supported by the broader empirical literature on merger performance in corporate finance. See Andrade, Mitchell, and Stafford (2001).

The recent merger between AOL and Time Warner is a particularly prominent example of what appears to be quite common.² 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 to local information, reduce the coordination among the different activities of a business unit, and blunt incentives.

The standard (economist's) explanation of why all mergers with potential synergies do not enhance value is that there are costs associated with expanding the scale of the firm; 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. They do not tell us when these costs are relatively important and when they are not. They cannot make predictions about when mergers will be efficiency-enhancing because they can only speak to the details of one side of the tradeoff.

We attempt to explain the organizational cost of exploiting such synergies. Realizing cost savings through standardization or the sharing of resources often requires some task reallocation or centralization. For example, to realize production economies, all manufacturing facilities may need to be consolidated in one location with common control. One cost of standardization is that, although less costly to produce, the products may be less ideally suited for local market conditions. In addition, the organization now requires coordination between product divisions and manufacturing which is costly. Whereas independent business unit managers can be given high-powered incentives, coordination among managers requires the muting of incentives in order to induce efficient communication and decision-making. Hence, even when substantial synergies are likely to exist, the organizational cost of capturing them may then be so high that organizations may strictly prefer to run business units on a stand-alone basis.

Our model captures the tradeoffs that guide organizational structure in the presence of local information, coordination problems, effort choice, and potential synergies.³ We consider

²See Rose, Angwin, and Peers (2002).

³We thus build on a previous literature on multitask incentives (Holmstrom and Milgrom (1991, 1994), Holmstrom (1999)). This literature models the tradeoff among multiple tasks, some of which cannot be affected by incentives directly, in a reduced form setting. Our model provides content to this broad multitasking

a firm organized around two product units – one can think of two distinct products or two distinct locations. Each product requires two activities such as manufacturing and marketing. We assume that optimal organizational structure requires that the “local” activity be organized by products as management must make decisions based on local information. But there may be benefits from standardizing the second “synergistic” activity across products. Synergies can only be realized if the synergistic activities for each product are centralized (e.g. a single manufacturing plant be created), and new manager, specialized in that activity, is put in charge. This manager obtains information about the cost savings that may be attained through standardization. Standardization, however, has a cost in that a standard product is less adapted to the needs of the individual markets. Both the local information (the value of adaptation) and the information about cost savings are private information known only to the corresponding manager. An efficient decision on whether or not to implement standardization requires that such information be aggregated.

Furthermore, managers need to be motivated to carry out the activity assigned to them, and thus their compensation must be linked to their performance.⁴ However, and this is key, motivating managers by linking compensation to performance biases them away from the common objectives, as it makes them care about their own output, thereby making communication and decision-making strategic. When the incentives of individual managers are sufficiently strong, the interests of the synergies manager and the local managers are directly in conflict. Thus, a manufacturing manager who is given a stake in low-cost production will be biased in favor of standardization, while the local managers will be biased in favor of adaptation. As a result of this conflict of interest, communication (which is always cheap talk) cannot be credible. Moreover, decision making is suboptimal, as the manager who controls the standardization decision does not value equally his own and the other managers’ losses. Only if the link between pay and performance is weakened, i.e. the power of incentives is reduced, can managers’ incentives become more aligned with one another, improving communication and decision making.⁵

Thus the tradeoff between incentives and coordination takes two forms. First, as incentives become stronger, standardization decisions become more biased. Second, as incentives become stronger, credible communication is less possible. Thus attaining synergies is costly in the form of (1) lost local adaptation and (2) lower effort because of weaker incentives. Moreover, if communication is desired, so that decisions about synergies take into account

intuition, by focusing on the conflict that we believe is particularly relevant to organizational design: the conflict between effort incentives on one side and communication and efficient decision making on the other.

⁴We assume that only the task allocation is contractible. In contrast, the way the task is carried out (which includes the effort provided, and whether or not to maximize standardization across operations) can only be indirectly influenced through output incentives.

⁵Note that, unlike in most of the previous literature on decision-making authority (e.g. Aghion and Tirole, 1997; Dessein (2002)), we take the view that authority over actions stems directly from task allocation rather than being allocated contractually. This difference is not nominal as it implies that decision-making regarding a task is inalienable from the agent who provides task specific effort. In particular, this is likely to distort decision-making and communication since agent’s incentives are typically narrowly focused on their own task.

the relation between the value of synergies and the value of local adaptation, then incentives may need to be further reduced.

As we would expect, integration is most likely to be preferred when synergies are high. It is also more likely to be preferred the higher the variance of synergies. When the variance of synergies is high, contingent decision making on whether to adapt production to the local circumstances or to impose synergies is important. Finally, integration is weakly less valuable the more important are effort incentives. When effort incentives are sufficiently important, integration, which requires softening incentives to ensure unbiased communication and decision making, becomes too costly.

The bulk of our analysis assumes that centralizing operations in the hands of an operating manager implies that this manager has full control on whether operations are standardized. In Section 6 we weaken somewhat the strong link between authority and task allocation by considering the possibility that the organization may allow local managers to block any standardization effort. Local managers may retain some control over operations, so their cooperation is required for standardization to succeed. In general providing local managers with veto power makes efficient standardization decisions more difficult as only standardization which benefits both managers will be accepted. Still we show that if incentives are important, this structure may be preferred as it allows to implement some standardization that is contingent on local managers' information while maintaining reasonably high-powered incentives.

Our paper contributes to a small, recent literature that 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. ⁶Holmstrom 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. Hart and Moore (2006) study how to allocate authority over the use of assets when agents with several assets (coordinators) can have ideas involving the common use of several of these assets, and

⁶A related strand of literature, under the broad heading of team theory (Marshack and Radner, 1972), studies coordination problems absent incentive issues. For example, Cremer (1980), Genakoplos and Milgrom (1991) and Vayanos (2002) study the optimal grouping of subunits into units in the presence of interdependencies. Harris and Raviv (2002) study the organizational structure that best appropriates synergies when managers are expensive; Roland, Qian and Xu (2006) study the tradeoff between decentralizing and allowing multiple divisions to use their local knowledge versus losing standardization and economies of scale; Cremer, Garicano and Prat (2007) study the limits to firm scope due to the loss of specificity in organizational languages as firm scope grows. Outside of economics an old (and surprisingly discontinued) literature (e.g. Chandler's 1962 and Lawrence and Lorsch's 1967) studies coordination and integration mechanisms in organizations.

when agents are motivated by their own interest rather than that of the organization. Our work differs from theirs in our focus on communication (which is ruled out in their analysis) and that information may be aggregated. Moreover, the incentive conflict in our analysis is endogenous – agents prefer different decisions only if they are given incentives to do so. Hart and Holmstrom (2002), in a framework centering on the managers’ private benefits of control, argue that whereas independent firms coordinate their activities insufficiently, integrated firms have a tendency to realize too many synergies, neglecting private benefits of managers 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. Also, agents’ biases in our framework are endogenous (and derived from the need to provide them with high powered incentives) rather than part of their preferences. Athey and Roberts (2001) study how the allocation of authority affects the tradeoff between giving agents incentives for decisions and for effort provision when only a broad signal that adds both incentives and the output from the project is available. We differ from their approach in two main aspects. First, our emphasis on coordination; there are no synergies in their case, as projects do not interact with one another. Second, communication among agents of the information they obtain is impossible in their analysis – a boss can learn the project payoffs at an additional cost but with no distortion. Communication, as determined endogenously by the available incentives, plays a key role here. Thus the aggregation of information of different agents is absent from their analysis, but plays a central role in organizational design in ours.

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 important step towards a deeper understanding of both organizations and incentives.

1.1 Adaptation, Synergies and Incentives: An Example

Our introduction illustrated two examples of the problem of capturing synergies in merger cases. Similar issues are raised within companies, as previously independent business units are integrated. Consider Jacobs Suchard attempt to capture synergies in the late 1980s. Suchard was a Swiss coffee and confectionery company with the leading EEC market share in confectionery products.⁷ It had a decentralized organizational structure with largely independent business units organized around products and countries run by a general manager, so that 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

⁷What follows comes from Eccles and Holland (1989).

divisions. 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. Profit measurements for business units would be based on transfer prices from the manufacturing plant.

Jacobs Suchard's experience with its new organizational structure demonstrates the trade-offs that arise in attempts to organize to realize synergies. Business unit marketing managers were unable to make decisions because the general manager would disagree. General managers fought standardization in manufacturing that they believed would harm their unit's profits. The outcome was to reduce coordination within business units, increase time and effort to communicate, defend, and debate strategic choice, threaten the firm's entrepreneurial culture, and blunt incentives for general managers. While it is difficult to determine if the organizational change was a good decision or not, it is clear, that the benefits from the attempt to create cross-border synergies did not come without costs. These costs take the form that is the focus of this paper – poorer coordination and incentives within business units, increased conflict and centralized decision-making, and the communication costs that go with it.

2 The model

Production. Production of goods 1 and 2 requires two activities or functions. Potential economies of scope exist only in one of the activities, which we refer to as the 'synergistic activity;' we refer to the other activity as the 'local activity.' For example, potential synergies may arise in manufacturing, in the form of cost-savings from producing the two products in a single plant. Output of product $i, i = 1, 2$, depends on unobservable and private efforts e_L^i and e_S^i exerted in respectively the local (L) and synergistic (S) activity. We denote by v the marginal product of effort in each activity, so that output in activity $J \in \{L, S\}$ for good i is given by ve_{J_i} . We adopt the convention that the local activities produce (net) revenue and the synergistic activities produce cost.

Task Allocation. The 'business unit manager' for each good is in charge of the local activity for that good, and may also be in charge of the synergistic activity. However, in order to realize economies of scope, a 'functional' manager must be put in charge of the synergistic activity for both products. For example, the manufacturing facilities must be consolidated or integrated in one location with a single manager in control. We assume that it is impossible for one manager to do more than two efforts or to do local activities for both products. The local activity requires local market knowledge and managers cannot acquire local knowledge about two markets. For example, each local activity is located in a

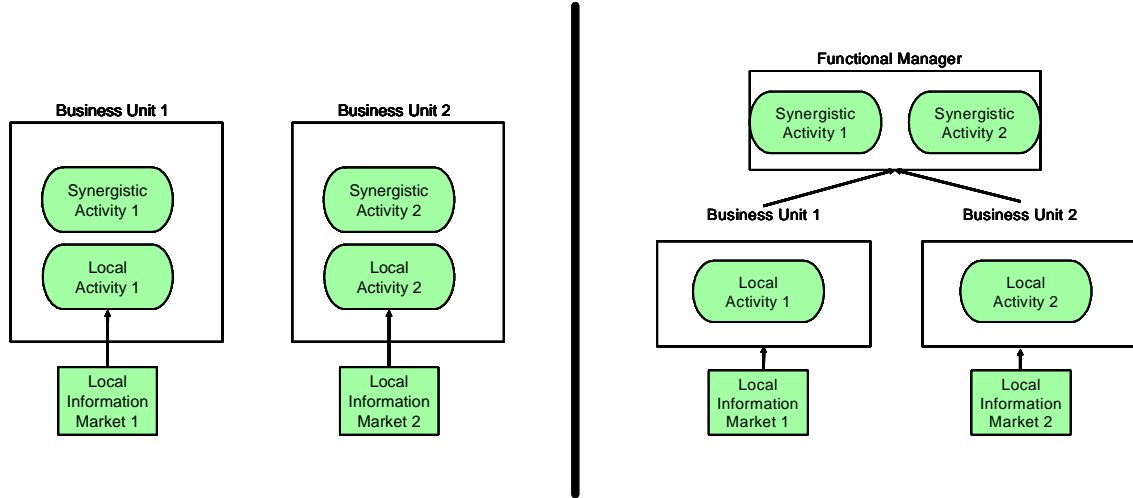


Figure 1: Non integrated structure

Integrated structure

different country. That means that we restrict our attention to two organizational forms, non integrated (*NI*) where each one of two managers undertakes activities (L_i, S_i) for product $i = 1, 2$ and integrated (*I*) where each business unit manager i undertakes activity L_i and the function manager undertakes task (S_1, S_2) .⁸

The utility of a manager who is allocated tasks t , $t \in \{(L_1, S_1), (L_2, S_2), (S_1, S_2), L_1, L_2\}$ is given by

$$w - \sum_t e_j^2$$

where w is the manager's wage.

Synergies. If employed, the functional manager may decide to standardize both of the activities he undertakes, in which case the organization attains total cost savings k on those activities; or instead he may decide to exert the effort on each activity independently. No economies of scope can be achieved if the two efforts are undertaken by two different managers. k is a random variable drawn from a uniform distribution $k \sim U[0, K]$ and privately privately observed by the functional manager.

Standardization results in revenue losses Δ . One can think of Δ as representing the cost of not being *adapted* to the local environment, that is of producing a product that is not ideal for local market conditions. Each business unit manager privately observes the realized adaptation costs Δ for his unit, where each Δ is Δ_l or Δ_h with probability $p = 1/2$. In the equations we will often write p rather than $1/2$ to make them more transparent. We assume

⁸Note that, unlike in most of the previous literature on decision-making authority (e.g. Aghion and Tirole, 1997; Dessein (2002)), we take the view that authority over actions stems directly from task allocation rather than being allocated contractually. This difference is not nominal as it implies that decision-making regarding a task is inalienable from the agent who provides task specific effort. In particular, this link between task allocation and decision making is likely to distort decision-making and communication since agent's incentives are typically narrowly focused on their own task.

that $0 < \Delta_l < \Delta_h$, and that they are independently drawn. We will say that synergies are positive whenever $k - (\Delta_1 + \Delta_2) > 0$. To simplify the analysis, we assume that support of the synergies is such that it is ex-post sometimes optimal to implement synergies regardless of Δ : $0 < K - 2\Delta_h$.

Profits. When the business units are non-integrated (so that there is no functional manager), the profit on each product is given by $\pi_i^{NI} = R_i - C_i - w_i$, where $R_i = ve_L^i$ and $C_i = \mathbb{C} - ve_S^i$, and \mathbb{C} is a constant. The profits on each product are given by $\pi_i^{NI} = ve_{iL} + ve_{iS} - \mathbb{C} - w_i$.

When, instead, production is consolidated, so that a functional manager undertakes the synergistic activity for each product, business unit revenue is given by the effort of the manager working on the product minus the potential loss due to lack of adaptation:

$$R_i = R + ve_{iL} - \Delta_i I$$

for $i = 1, 2$, where I is an indicator variable that describes whether the synergy is implemented. On the other hand, the costs of the (joint) functional unit are reduced whenever standardization is undertaken:

$$C = \mathbb{C} - kI - ve_{1S} - ve_{2S}$$

Total integrated profits on both units are then given by:

$$\pi^I = (k - \Delta_1 - \Delta_2)I + \sum_{i=1,2} (ve_{iL} + ve_{iS} - \mathbb{C} - w_i - w_f)$$

We can normalize the constant \mathbb{C} to 0 without loss of generality: since both ex ante and ex post uncontingent transfers are allowed, this constant plays no role in the analysis. Since agents are risk neutral, and they only need to be paid their reservation wage in expectation, profits can be rewritten as:

$$\pi^I = (k - \Delta_1 - \Delta_2)I + \sum_{i=1,2} \left(ve_{iL} + ve_{iS} - \frac{e_{iL}^2}{2} - \frac{e_{iS}^2}{2} \right) \quad (1)$$

where we have normalized to 0 agent's reservation wages, so that the number of agents has no direct effect on profits—only the total amount of effort involved matters for cost, rather than who undertakes it.

Contracts and Communication. Only total revenues and costs are contractible, that is, we assume that both effort and the degree of standardization are non verifiable.⁹ We assume

⁹For example, a judge may observe that the products are in fact different without knowing the extent to which their designs or production processes have been harmonized to produce cost savings.

that contracts are linear in costs and revenues¹⁰ and that budget balance holds.¹¹ Since manager 1 and 2 are identical, we further restrict attention to allocations in which they are treated symmetrically. These contracts thus can be simply characterized by a fixed wage and a share in revenue, cost or profit. We let $s_1 = s_2 = s_{bu}$ be the share of revenue that accrues to the business unit manager, so that so that $2(1 - s_{bu})$ is the share that accrues to the functional manager; and s_f the share of operating costs that the functional manager receives, so that each business unit manager bears a share $(1 - s_f)/2$ of the operating costs.

Under integration, the first best standardization decision is contingent on the information of all managers, manager 1, 2 and the functional manager. Since actions are not contractible, information aggregation occurs through an informal mechanism: ‘cheap talk.’ In particular we assume that manager 1 and 2 simultaneously send a message to the functional manager regarding the importance of adaptation – the cost of standardization to their unit Δ . Since standardization is not contractible the functional manager cannot commit to react to these messages in certain ways.

3 Non-integration

Under non-integration each business unit is run by one manager who is charge of both local and synergistic activities. Of course, synergies are then not attained. Trivially, optimal contracts give each manager a full share in his cost and revenues. Then each manager’s problem is simply given by:

$$\pi_i^{NI} = \max_e v e_{iL} + v e_{iS} - \frac{e_{iL}^2}{2} - \frac{e_{iM}^2}{2}$$

which results in first best effort, $e_{iL} = e_{iS} = v$. The organization does not incur any non-adaptation costs. Total organizational profits are then $\pi^{NI} = v^2$

4 Integration

4.1 Managerial behavior: Effort and Decision making

To allow for the realization of synergies, the synergistic activities must be centralized and assigned to a functional manager. To make efficient standardization decisions, information must be aggregated; in addition, the functional manager must be given incentives to make

¹⁰Linear shares are unlikely to be optimal – given that standardization is a 0 – 1 decision and the adaptation costs are binomial, it should be possible to make inferences about effort from the distribution of contractible outcomes. Such inferences will be impractical if there is additional noise in the observables; since we assume risk-neutrality, the noise would affect nothing else in the model.

¹¹Budget balance is a natural way to have imperfect alignment in models of team production; alternatively we could consider risk aversion. This would complicate the algebra substantially. We conjecture that our main results would be unaltered. See also footnote 14

the right decisions. However, doing this is in conflict with providing effort incentives for all managers. We explore this conflict in what follows.

The output attained has two components: the value of the effort incentives and the expected realized synergy, which are the cost savings of standardization minus the associated revenue losses.

Effort. The effort component is straightforward. Given s_{bu} and s_f , effort decisions by the business unit and functional managers, respectively, are determined by:

$$\max_{e_{bu}} s_{bu}ve - \frac{e^2}{2}, \max_{e_f} s_fve - \frac{e^2}{2}, \text{ so}$$

$$e_{bu} = s_{bu}v; e_f = s_fv.$$

Decision making and communication. The decision of the functional manager on whether to standardize to some extent the synergistic activities depends on his information. If communication is not feasible, the business unit manager must take this decision by comparing the expected adaptation cost $\bar{\Delta}$ to his observation on the value of standardization k ; if communication, instead, is feasible he can compare the value of standardization with the realized adaptation costs Δ_1 and Δ_2 . We consider next decision making in both cases.

Consider first the case where no communication is feasible between market-facing and functional managers, in which case standardization decisions can only be made contingent on the realization of the cost savings k . Whenever $s_{bu} < 1$, there exists a cutoff k_{nc} such that if $k < k_{nc}$, the functional manager does not impose standardization and the business unit managers are able to adapt locally, while if the cost savings are high enough, $k > k_{nc}$, standardization is imposed. The cut-off k_{nc} is the value of cost savings at which the manager is indifferent between standardizing operations or not, given the expected revenue losses due to a lack of local adaptation. Since the functional manager obtains a share s_f of the cost savings from standardization, and suffers a share $(1 - s_{bu})$ of the revenue losses for each product, k_{nc} solves: $s_fk_{nc} - 2(1 - s_{bu})\bar{\Delta} = 0$, which implies:

$$k_{nc} = \frac{2(1 - s_{bu})\bar{\Delta}}{s_f} \quad (2)$$

In contrast, if business unit managers can send credible messages about the value of adaptation for their respective products, then the functional manager standardizes operations if $s_fk - (1 - s_{bu})(\Delta_1 + \Delta_2) > 0$. This condition determines a decision rule with three cutoff points, k_{LL}, k_{LH} and k_{HH} , with

$$k_{ij} = \frac{(1 - s_{bu})(\Delta_i + \Delta_j)}{s_f} \quad i, j = L, H \quad (3)$$

such that given Δ_i and Δ_j , the functional manager standardizes operations if cost savings

k are above the cut-off value k_{ij} . Note that the first best standardization cut-off is $k_{ij}^{fb} = (\Delta_i + \Delta_j)$.

Thus the extent to which we have inefficiently too much standardization or too little standardization by the functional manager depends on whether $\frac{1 - s_{bu}}{s_f} \geq 1$. In particular, if $\frac{1 - s_{bu}}{s_f} < 1$, we will have that $k_{ij} < k_{ij}^{fb}$, and the functional manager implements synergies too often and allows for too little local adaptation. It follows that

$$\ell \equiv (1 - s_{bu})/s_f$$

is a measure of how balanced incentives are. If $\ell = 0$ then the functional manager only cares about cost savings and the business unit managers only care about revenues. In contrast, when $\ell = 1$ all managers maximize expected profits (revenues minus costs) strength, and the cut-off values k_{ij} and k_{pool} for standardization are set at first-best. Thus we have a tradeoff between effort incentives (which requires $s_i = 1$) and decision making.

Remark 1 *If first-best effort incentives are provided to all managers ($s_f = s_p = 1$), synergies are always implemented and integration is value destroying.*

Standardization decisions sensitive to the size of synergies and benefits of adaptation require that the aims of the managers involved not be completely opposed. Strong incentives are thus an obstacle to the ability of the organization to implement tradeoffs between synergies and adaptation.

Reducing the share of output that each manager obtains from his or her own unit may mitigate this problem. First, conditional on the communication that takes place, such a reduction in effort incentives improves implementation, by giving the functional manager a stake in the organization-wide benefits that obtain when there is better local adaptation. A functional manager that profits somewhat from the product-adaptation decision may sometimes decide to give up on implementing the functional synergies (when k is low) and agree to allow local adaptation by the product managers. This would be the case even if no truthful communication from the product manager occurs. Second, if incentives are sufficiently aligned, communication where product managers can credibly represent the costs to them not adapting to local conditions, may be possible.

In the next section we consider the first of these problems: ignoring the possibility that truthful communication can take place, design incentives so that implementation is improved, at the cost of reducing effort incentives.

We can now proceed to the two maximization problems (with and without communication) that allow us to determine the optimal choice of s_f and s_{bu} .

4.2 Incentives and Decision-making with exogenous communication

We consider now incentive design, taking as given the communication – or lack thereof – between operating and business unit managers. As argued above, with first best output shares $s_f = s_{bu} = 1$ the functional manager always chooses to standardize operations across the two products. If the functional manager is given a share in the revenues of the business units, however, he will choose not to standardize whenever the cost savings k are sufficiently low.

If no communication is feasible, then given s_f and s_{bu} profits of the organization are¹²

$$\begin{aligned} \max_{s_{bu}, s_f} \pi &= \max_{s_{bu}, s_f} \frac{(1-p)^2}{K} \int_{k_{nc}}^K (k - 2\Delta_L) dk + \frac{2(1-p)p}{K} \int_{k_{nc}}^K (k - \Delta_L - \Delta_H) dk + \\ &+ \frac{p^2}{K} \int_{k_{nc}}^K (k - 2\Delta_H) dk + v s_{bu}(2 - s_{bu}) + v s_f(2 - s_f) \end{aligned} \quad (4)$$

If product managers communicate their information (or if Δ_1 and Δ_2 are public knowledge) the organization's profits are:

$$\begin{aligned} \max_{s_{bu}, s_f} \pi &= \max_{s_{bu}, s_f} \frac{(1-p)^2}{K} \int_{k_{LL}}^K (k - 2\Delta_L) dk + \frac{2(1-p)p}{K} \int_{k_{LH}}^K (k - \Delta_L - \Delta_H) dk \\ &+ \frac{p^2}{K} \int_{k_{HH}}^K (k - 2\Delta_H) dk + s_{bu}(2 - s_{bu})v + s_f(2 - s_f)v \end{aligned} \quad (5)$$

Rather than s_{bu} and s_f , it will be useful to maximize over $\ell \equiv (1 - s_{bu})/s_f$ and s_f . Assume for now that whether or not communication is IC is exogenous. Then, substituting the value for s_{bu} and k_{nc} (from 2) into π^I , we have a function $\pi^I(\ell, s_f)$. Taking first order conditions with respect to ℓ and s_f , we can write the first order conditions of both of the above problems (4 and 5) in the same way

$$\pi_\ell = \frac{1}{2} [1 - \ell] \frac{\gamma}{K} - 2s_f^2 \ell v = 0 \quad (6)$$

$$\pi_{s_f} = 2 [(1 - s_f) - s_f \ell^2] v = 0, \quad (7)$$

where $\gamma = \gamma^{nc} \equiv 4\bar{\Delta}^2$ if Δ_1 and Δ_2 are unknown to the functional manager (that is, communication is infeasible) and $\gamma^c = E(\Delta_1 + \Delta_2)^2$ if Δ_1 and Δ_2 are known. For future reference, we will denote by s_f^{nc} and s_{bu}^{nc} the optimal shares when Δ_1 and Δ_2 are unknown (and thus $\gamma = \bar{\gamma}$) and \tilde{s}_f^c and \tilde{s}_{bu}^c the optimal shares when Δ_1 and Δ_2 are observable to the functional manager (and thus $\gamma = \gamma^c$).¹³

¹²To simplify notation, we drop the superscript I in this section and write π for profits under integration.

¹³We reserve the notation s_f^c and s_{bu}^c for the optimal shares when communication is endogenous and s_f and s_{bu} must satisfy an additional communication constraint.

From these first-order conditions, two immediate results obtain for both nc and c cases. First, the effort incentives of the functional manager are not first-best, that is improving the standardization decision of the functional manager requires distorting effort incentives of all managers. Indeed, $\ell > 0$ otherwise $\pi_\ell > 0$, from which $s_{bu} < 1$ and, since $\pi_{s_f} = 0$, also $s_f < 0$. Second, decision-making by the functional manager is biased towards cost savings, whereas business unit managers are biased towards revenues. Indeed, $\ell < 1$ otherwise $\pi_\ell < 0$. In sum, the organization trades off more efficient standardization decisions against better effort incentives for the managers.

Lemma 1 *The agents outputs shares are such that $s_{bu} < 1$ and $s_f < 1$, so that both agents produce less than first-best effort. Moreover, functional decision making is distorted as incentives are never perfectly aligned, that is $s_f/(1 - s_{bu}) > 1$. Thus too much standardization is imposed in equilibrium, that is the equilibrium cutoff values for standardization are too low: $k_{ij} < k_{ij}^{fb}$ for $i, j = L, H$ under communication and $k_{nc} < k_{nc}^{fb}$ under no communication.*

Intuitively, at $s_i = 1$ we have first-best incentives for effort, and a decrease in s_i results in a second order loss in effort incentives and a first-order gain in decision-making incentives (because the lower bound of the distribution of k is 0); while at $s_f = 1 - s_{bu}$ we have first-best decision-making incentives, and an increase in the shares results in a first-order gain in effort incentives and a second-order loss in decision-making incentives. Thus in order to ensure more efficient ex-post decision-making, the organization may choose to distort somewhat effort incentives.

Since incentives are always somewhat misaligned means that the functional manager cares slightly more about his own output. It follows immediately that he will choose standardization even when, in fact, synergies are not positive but his share of the business unit profits is not high enough to compensate him for his foregoing the standardization costs. For example, in the non-communication costs, while the efficient decision is standardize if $k - 2\bar{\Delta} > 0$, the actual rule he follows is standardize if $s_f k > 2(1 - s_{bu})\bar{\Delta}$ which is always (since by the previous lemma, easier to satisfy. As a result, sometimes standardization is imposed when not efficient.

We next analyze the determinants of the extent of this distortion, and the role that information, expected cost savings and the importance of effort play in it. From the first order conditions (6) and (7), we have that

$$\frac{\partial^2 \pi(s_f, \ell)}{\partial(-\ell)\partial\tau} > 0 \quad \text{and} \quad \frac{\partial \pi(s_f, \ell)}{\partial s_f \partial \tau} > 0$$

for $\tau \in \{\nu, K, -\gamma\}$. Since also

$$\frac{\partial^2 \pi(s_f, \ell)}{\partial(-\ell)\partial s_f} > 0,$$

then $\pi(s_f, -\ell, \tau)$ is supermodular for $\tau \in \{\nu, K, -\gamma\}$. The following lemma follows immediately

Lemma 2 *Functional decision-making distortions, as given by $1/\ell = s_f/(1 - s_{bu})$, and functional effort incentives s_f are increasing in v, K and $-\gamma$.*

First, providing balanced incentives to the functional manager (setting ℓ close to 1) is less relevant when the expected cost saving $E(k) = K/2$ are high, or when effort incentives are very important (v high).

Second, providing balanced incentives is more important when the functional manager is informed about the values of Δ_1 and Δ_2 . Indeed, given that $\gamma^{nc} \equiv 4\bar{\Delta}^2 > \gamma^c = E(\Delta_1 + \Delta_2)^2$, we have that $s_f^{nc}/(1 - s_{bu}^{nc}) > s_f^c/(1 - s_{bu}^c)$. It is clear that the functional manager makes better decisions when he is better informed. Thus, intuitively, the value of efficient decision-making is higher the better informed the agents are. Better information by the functional manager about the revenue losses associated with adaptation raises the marginal value of more balanced incentives in terms of efficient decision-making, without affecting the marginal cost in terms of incentives for effort.¹⁴

One implication is that communication between market-facing and functional manager reduces effort incentives, even if communication comes "for free". In the next section, we analyze when and how the organization may need to further dull incentives in order to induce such communication.

4.3 Incentives and communication

The first order conditions (6) and (7) trade-off efficient decision-making by the functional manager versus effort incentives of all managers, taking the quality of information aggregation as given. In addition to aligning decision-making on behalf of the functional manager, however, the organization must decide whether or not to induce communication between business unit and functional managers.

Communication constraint Communication can be improved by giving business unit managers a stake in the functional cost savings, and giving the functional manager a stake in revenues. We now write the truth-telling constraint of a business unit manager who must decide whether or not to truthfully report the cost of implementing a synergy in terms of lost local adaptation. When the business unit manager sends a message to the functional manager, he knows nothing about the value of cost savings k . To decide whether truth-telling is in his interest, he must form an expectation over k . To write the incentive compatibility constraint, note that the business unit manager who is tempted to lie is one for whom revenue losses from standardization are limited, that is $\Delta_i = \Delta_L$ since it is in that case that standardization is

¹⁴In our model, budget balance imposes a mechanical link between providing balanced incentives to the business unit managers and providing balanced incentives for the functional manager. The above observation shows that this complementarity holds more generally if business managers need to be motivated to communicate Δ_1 and Δ_2 . Providing business unit managers with balanced incentives is then more valuable if also the functional manager is induced to make efficient standardization decisions. It is for this reason that we believe budget balance is less restrictive than it may appear and does not affect our results.

more likely to be implemented by the column manager. Truthfully reporting Δ_L is preferred if:

$$\begin{aligned} & \frac{(1-p)}{K} \int_{k_{LL}}^K \left((1-s_f) \frac{k}{2} - s_{bu} \Delta_L \right) dk + \frac{p}{K} \int_{k_{LH}}^K \left((1-s_f) \frac{k}{2} - s_{bu} \Delta_L \right) dk \\ & \geq \frac{(1-p)}{K} \int_{k_{LH}}^K \left((1-s_f) \frac{k}{2} - s_{bu} \Delta_L \right) dk + \frac{p}{K} \int_{k_{HH}}^K \left((1-s_f) \frac{k}{2} - s_{bu} \Delta_L \right) dk. \end{aligned}$$

The left-hand side of this inequality is the payoff of correctly communicating Δ_L . In this case, with probability $(1-p)$ the other agent also reports Δ_L , in which case the probability of synergies being implemented is the probability that $k > k_{LL}$; while with probability p the other agent reports Δ_H , in which case the probability of synergies being implemented is the probability that $k > k_{LH}$. On the other hand, if the agent lies, the integral is taken over a smaller set of k 's: in the first case (if, the other agent draws Δ_L) for values $k > k_{LH}$, in the second (when, with probability p , the other agent draws Δ_h) over $k > k_{HH}$. That is, the value of lying is in the increase in the value of k that the functional manager has to observe before he decides to implement synergies. The integrals simplify in the obvious way, and the IC constraint becomes:

$$\frac{(1-p)}{K} \int_{k_{LL}}^{k_{LH}} \left((1-s_f) \frac{k}{2} - s_{bu} \Delta_L \right) dk + \frac{p}{K} \int_{k_{LH}}^{k_{HH}} \left((1-s_f) \frac{k}{2} - s_{bu} \Delta_L \right) dk > 0, \quad (8)$$

where the value of the cutoff k_{ij} is given by (3). Since $p = 1/2$, the IC constraint becomes after some simple manipulation:

$$\frac{(1-s_f)(1-s_{bu})}{s_{bu}s_f} \geq \frac{2\Delta_L}{\Delta_L + \Delta_H} \quad (9)$$

Thus, for given shares, the IC constraint is more likely to bind when Δ_H and Δ_L are close to each other. Second, for a given pair of Δ s, the constraint is less likely to bind when the left hand side is higher, that is when the shares are more balanced. In particular, if both shares are $1/2$, the left hand side of the IC constraint is 1, and truthful communication is always incentive compatible regardless of the values of Δ . We next consider the optimal choice of incentives in two cases. First, when the optimal choice of s_{bu} and s_f for implementation is such that the constraint is not binding – in this case communication does not involve further distortions beyond the implementation distortions. Second, we analyze the case where communication requires that the constraint binds.

Effort provision versus communication Whether the constraint (9) binds is crucial for how incentives will be chosen. Recall that \tilde{s}_f^c and \tilde{s}_{bu}^c , given by (6) and (7) with $\gamma =$

$E(\Delta_1 + \Delta_2)^2$, are the optimal incentives when Δ_1 and Δ_2 are observable. If the constraint (9) does not bind given \tilde{s}_f^c and \tilde{s}_{bu}^c , then trivially, it is always optimal for the organization to induce communication and incentives are \tilde{s}_f^c and \tilde{s}_{bu}^c .

If on the other hand, (9) is binding, then the cost of ensuring truthful communication is that it may require reducing the effort incentives of managers, thereby further distorting their incentives. Intuitively, for communication to be truthful the incentives of market-facing and functional managers must be better aligned, and this requires that their incentives be weakly lower than without communication. Organizations then can choose between strong incentives with little information flow between units or weak incentives with better communication.

Let us denote by s_f^c and s_{bu}^c , the optimal incentives when the organization chooses to induce truthful communication between business unit and functional managers. The lemmas show how this requires dulling effort incentives, relative to a case where (i) the operation manager is uninformed about Δ_1 and Δ_2 (optimal incentives s_f^{nc} and s_{bu}^{nc}) and (ii) the functional manager publicly observes Δ_1 and Δ_2 (optimal incentives \tilde{s}_f^c and \tilde{s}_{bu}^c).

Lemma 3 *Let s_f^c and s_{bu}^c be the optimal incentives when the organization induces communication, then*

$$s_f^c/(1 - s_{bu}^c) \leq \tilde{s}_f^c/(1 - \tilde{s}_{bu}^c) < (1 - s_{bu}^{nc})/s_f^{nc}$$

where the first inequality is strict whenever the communication constraint (9) is binding given \tilde{s}_f^c and \tilde{s}_{bu}^c .

4.4 Effort, Communication and Decision-making: Comparative Statics

Having identified the trade-offs between incentives and decision-making and incentives and communication, we are now able to characterize communication, decision-making distortions and effort incentives as function of the parameters of our model.

Lemma 1 clarifies the cost of inducing communication. We now discuss the consequences of these choices as when communication is preferred. The following proposition establishes that as the average size of the synergies K increases and as the importance of effort v increases, inducing communication becomes less attractive to the organization:

Proposition 1 *If it is optimal for the organization to induce communication given K' and v' , then it is also to induce communication for any (K, v) with $K \leq K'$ and $v \leq v'$. Similarly, for a given $\bar{\Delta}$, if it is optimal for the organization to induce communication given Δ_H, Δ_L then it is optimal to induce for any Δ'_H, Δ'_L , such that $\bar{\Delta}$ is constant and $\Delta'_H - \Delta'_L > \Delta_H - \Delta_L$. In contrast, if either $K > K'$ or $v > v'$ or $\Delta'_H - \Delta'_L < \Delta_H - \Delta_L$, then the organization may decide to forego communication. Since $s_f^c/(1 - s_{bu}^c) < s_f^{nc}/(1 - s_{bu}^{nc})$, this is accompanied by a discrete increase in functional effort incentives and distortions in decision-making.*

Figure 1 below presents an example of this result. In the example, when expected synergies are relatively low, making the standardization decision contingent on the associated

adaptation costs is important. Moreover, it is relatively easy to align the incentives of functional and business unit managers to ensure communication. Inducing communication then comes at no cost, and it is always optimal to do so. As expected synergies increase, functional managers are too prone to want to impose standardization, and thus it is difficult to motivate business unit managers with low adaptation costs to communicate that this is the case. Truthful communication requires distorting the incentives of managers to align both of them. In this case, the organization faces a trade-off between communication and effort incentives. If expected synergies are sufficiently high, ensuring communication about the local adaptation parameter becomes too costly, and the organization foregoes communication in order to allow for higher powered effort incentives. Similar intuition holds for the value of effort incentives v .

In Lemma 2, we have already shown how functional effort and decision-making distortions are increasing in the level of synergies K and the value of effort, v , when communication is exogenous. Similarly, Proposition 2 shows how an increase in K and v may result in a discrete jump in effort and decision-making distortions when the organizations decides to forego communication. The following proposition provides a full characterization of these comparative statics, where communication is an organizational choice and must be endogenously induced:

Proposition 2 *Let s_f^* and s_{bu}^* be optimal incentives for the functional and business unit managers. Distortions in decision-making by the functional manager, as characterized by $s_f^*/(1 - s_{bu}^*)$, and business unit effort incentives, s_{bu}^* , are increasing in value of effort v and the level of the synergies K . Effort incentives for the functional manager s_f^* are increasing in K and v , except when the communication constraint is binding and the organization chooses to induce communication.*

5 The Costs and Benefits of Integration

An organization can realize synergies by reallocating tasks and employing a functional manager in charge of finding them. As we show, such a manager will be endogenously biased in favor of standardization. Because it is not possible to distinguish whether costs were low because the manager worked hard or because he standardized output and reduced adaptation, the only way to avoid bias is by dulling his incentives for cost reduction. Moreover in order to make decisions contingent on all available information, communication must be credible, which requires dulling the incentives of the business unit managers. In other words, the benefit of integration is that synergies may be captured; the cost is that incentives must be dulled to achieve some incentive alignment, and local adaptation is neglected. As we show next, a firm may therefore strictly prefer to forego any potential synergies and stick to a non-integrated organization.

When is integration preferred? The following proposition states that integration is only useful if expected cost savings from standardization, measured by K , are sufficiently large,

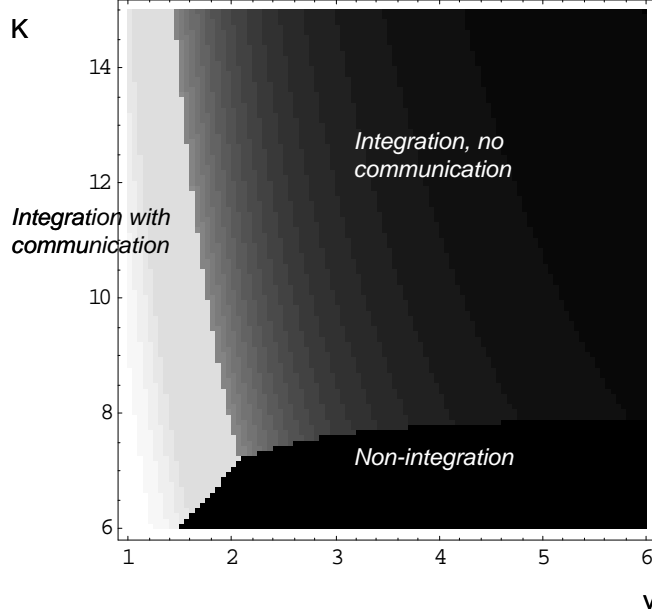


Figure 2: Integration choice and effort incentives as a function of the marginal value of effort, v , and the importance of the synergies, K . Darker color means higher effort incentives.

where the threshold value for K is increasing in the importance of incentives.

Proposition 3 *Assume $K = 2\Delta_H$, then there exists a \tilde{v} such that for $v > \tilde{v}$, integration is suboptimal, and the organization strictly prefers to keep the business units separate. (2) For any $v > \tilde{v}$, there exists a $\bar{K} > 2\Delta_H$, such that integration is optimal if and only if $K \geq \bar{K}$, where \bar{K} is strictly increasing in v .*

The example below illustrates the results in this proposition in this section, and shows that involving a functional manager is optimal whenever the synergies are important enough.

Example 1. Let $\Delta_h = 3, \Delta_l = 1$. Figure 1 computes the optimal organizational structure for values of $k \in [6, 15]$, and $v \in [1, 6]$, and shows as well the incentive strength through the darkness of the color (the darker, the more high powered managerial incentives). The example shows that the space is divided in three regions. When v is sufficiently low, integration with communication and low powered incentives is the optimal design. As v grows, providing higher powered incentives is necessary, and communication must be sacrificed, as the incentive cost of aligning incentives so that communication is credible becomes too high. If the expected cost savings from standardization K are relatively low, then very high powered incentives can be provided through non-integration; synergies are then sacrificed. If instead, cost savings K are relatively high, then integration without communication is preferred.

Note from the figure that in general, effort incentives (and effort distortions) are non-monotonic in standardization savings K . When K is low, two non-integrated business units are best, as they provide maximum incentives. When expected gains from standardization increase, contingent decision making is valuable. This requires providing low-powered incentives to the business units so that communication from them is credible. Finally, for high standardization savings and thus high expected synergies, the organization gives up on communication; this allows for a large discrete increase in incentives with little loss, since the likelihood that synergies are positive is high.

Remark 2 *If non-integration is optimal for K small, then incentives are non-monotonic in the cost savings of standardization K .*

Beyond the expected value of synergies, a second important determinant of the choice of functional form is the variance of foreseeable adaptation costs ($\Delta_1 + \Delta_2$) as characterized by $\Delta_H - \Delta_L$. This variance measures the value of ex post (conditional on realized k and Δ) decision making for the organization. Intuitively, increasing this variance makes it easier to satisfy the communication constraint. Moreover, it also makes it more valuable to make decisions ex post. As a result, when the spread increases, the organizational design shifts towards functional authority, as the next proposition shows.

Proposition 4 *If the variance of adaptation costs as characterized by $(\Delta_H - \Delta_L)$ increases (for a given mean $\bar{\Delta}$), organization may shift from non-integration to integration but never the other way around.*

Example 2. Figure 2 presents illustrates this result for some parameter values. In particular, $k = 6, \bar{\Delta} = 2, v \in [0.25, 4]$, and $\Delta_H - \Delta_L \in [0.25, 1]$. The figure shows two of the regions described in Figure 1. As we increase the spread of Δ we move from full decentralization towards functional authority with separation. Intuitively, the latter form allows contingent decision-making which is both cheaper (as the incentive constraint is less likely to bind) and more profitable (as contingent decision-making is more valuable) when uncertainty is higher.

Since equilibrium results in suboptimal effort and standardization decisions, the value increase from the merger will be less than the size of the potential synergies. This gap is the ‘organizational discount’ that must be applied in valuing a merger. The analysis in the propositions above provides some insights into the size of this organizational discount.

First, Proposition 3 shows that the higher the synergies, the lower the ‘organizational discount’ that must be applied to a merger, all else constant. The reason is that, as synergies get sufficiently high, contingent decision-making is less important and so are balanced incentives. For sufficiently high synergies, high powered incentives to the functional managers have few costs in terms either of inefficient decisions, and in terms of non-credible communication from business unit managers (it can be ignored with a high likelihood anyway). Second, the

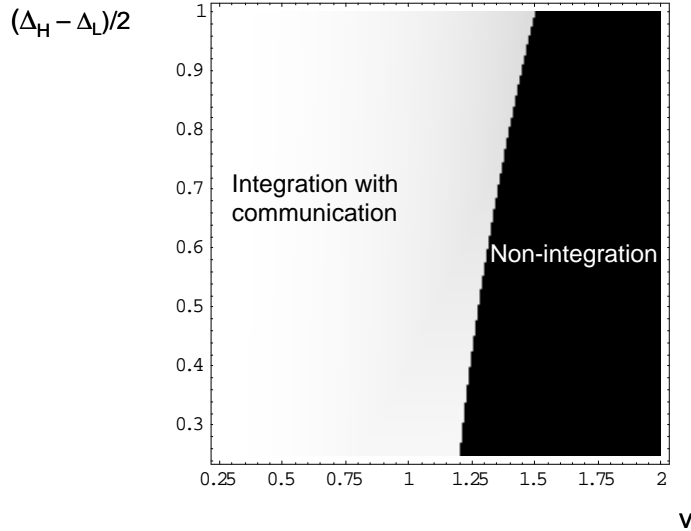


Figure 3: Organizational choice and communication regime as a function of the value of the marginal value of effort v and the spread $\Delta_H - \Delta_L$

organizational discount increases with the importance of incentives, and integration decisions are less likely to be undertaken where incentives matter. Third, as Proposition 4 shows, more uncertainty in the form of variability favors the merger, as part of the merger upside is that by undertaking it one preserves the option to standardize production processes and capture potentially large synergies, and as credible communication is facilitated when the variance in outcomes is high.

Thus whether or not a merger is valuable depends both on the level of synergies and on how easy it will be to capture them, including the cost in terms of reduced incentives to achieve second-best implementation decisions. Indeed, some potential synergies will not be implemented because the organizational costs are too high.

6 Functional Initiative versus Functional Control

A common way organizations use to try to gain synergies while minimizing the disruptions created in the existing business units is to give the manager of the synergistic activity only ‘dotted-line’ control— that is he may initiate standardization and cost saving efforts but he needs the cooperation and support, the so called ‘buy in,’ of the business unit managers to make them succeed. In this section we study when such design could be useful.

In the previous section, we assumed that realizing economies of scope in the synergistic activity required that a functional manager be employed to undertake that activity for both products. As part of his task assignment, the functional manager exerts effort in each of the synergy activities and decides to what extent to standardize the way he carries them out. Im-

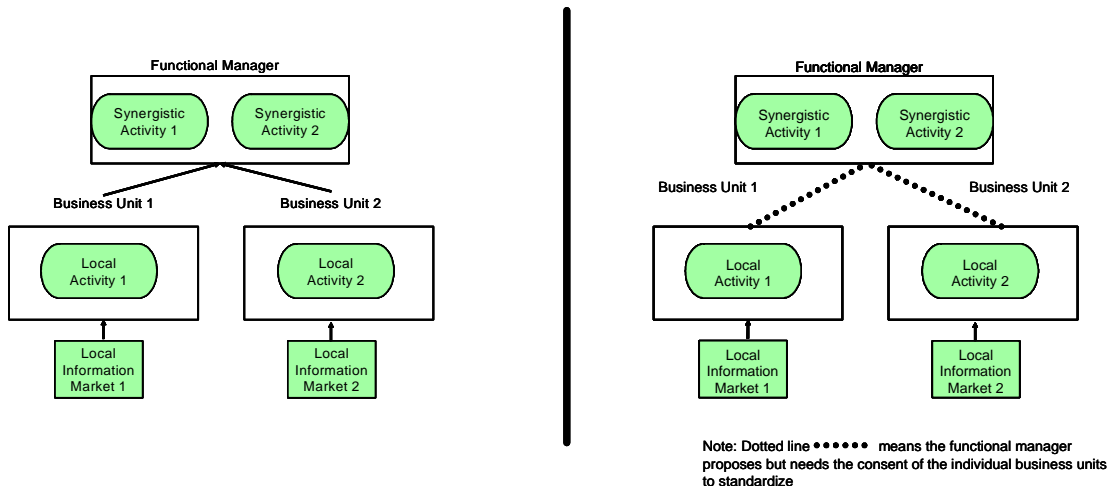


Figure 4: Integration- Functional Control Integration- Functional Initiative

pllicit in this view is that business unit managers have no power to affect this standardization. Under ‘dotted-line’ control, it is possible for the business unit managers to block standardization efforts. For example, the business unit manager could control vital information, or other inputs in production, which implies that its cooperation is needed for standardization to be feasible. As before, we posit that, in this case, whether or not a business unit manager cooperates with the functional manager is non-contractible, and can only be affected by output incentives. Moreover, for standardization to be feasible, both business unit managers need to cooperate.

The game proceeds in the same way as before, the only difference being that a final stage is added in which product managers must decide whether or not to block the standardization effort from the functional manager. The business unit managers thus first communicate their type to the functional manager, who then must decide whether or not to launch a standardization effort. If a standardization effort is undertaken, each business unit manager decide whether or not to oppose this. In the Appendix we show that is always optimal for product managers to communicate their type before the functional manager takes an action.

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¹⁵In our extensive form, the functional manager either makes a standardization effort or no standardization effort, but we do not allow for any additional communication between the functional and product managers at this stage. If both Δ_L and Δ_H business unit managers accomodate the functional manager’s standardization effort, however, and the first stage communication is uninformative, one may wonder whether it is feasible for the functional manager to make his standardization effort contingent on the business unit manager’s type. Concretely, when making a standardization effort, the functional manager could provide the following guidance to business unit managers: always accomodate me, or accomodate my standardization effort if your type is Δ_L . The following lemma states that a necessary condition for such a conditional standardization "recommendation" to be feasible, is that the the communication constraint in the first stage is non-binding. Moreover, if the communication constraint in the first stage is non-binding, it is always strictly optimal to let the business unit managers first reveal their type before the functional manager makes his standardization effort or recommendation. Together, besides letting the functional manager express his desire to standardize

The analysis of this game divides into three cases. First, business unit managers never cooperate with any standardization effort. Note that in the latter case, it will be optimal to set s_f and s_{bu} equal to 1, in which case business unit managers indeed never benefit from any potential synergy. We analyzed this case in Section 3. Second, only the business unit managers who find that the cost standardization is low, Δ_L , cooperate with the standardization efforts of the functional manager. Third, business unit managers always cooperate with the standardization efforts of the functional manager. This last case is equivalent to the functional manager having full control over whether or not the synergy activity is standardized across business units.

6.1 The risks of dotted line control: Implementing win-win and win-lose synergies

If business unit managers always cooperate with the functional manager, it is *as if* the functional manager has control. We refer to this as "informal" functional control. The key difference with the "formal" functional control, analyzed in Section 4, is that s_f and s_{bu} must satisfy an additional constraint which guarantees that a Δ_H manager is effectively willing to cooperate with the functional manager. Hence, if it is optimal to induce all business unit managers to cooperate with any standardization effort, then we can do at least as well by giving the functional manager formal control. Clearly, then, formal functional control is at least as good as informal control.

Formal functional control is particularly likely to dominate "informal functional control" when the communication constraint is binding or violated. The communication constraint requires that a Δ_L manager wants, on the margin, standardization to occur. As long as K is not too large, this constraint is typically much easier to be satisfied than the additional Δ_H "acceptance constraint" under informal functional control, which imposes that a business manager facing a high adaptation cost, Δ_H , wants, on average, standardization to occur. As we show in the Appendix, whenever $K = 2\Delta_H$, the additional "acceptance" constraint under informal functional control always binds, regardless of the importance of effort incentives v .¹⁶

Note that this implies that functional initiative is inefficient at implementing standardization when at least one business unit faces high adaptation costs. In particular, this requires the organization to distort effort incentives to a larger degree than under functional authority. Intuitively, for a given set of shares, when one manager has a high adaptation cost Δ_H , optimal standardization will often result in a winner and a loser among the business managers – that is the Δ_H business unit manager will actually be better off without it. In this case, under

or not, it is without loss of generality to ignore any other communication between the functional manager and business unit managers at the final stage.

¹⁶For a given set of output shares $s_f < 1$ and $s_p < 1$, there always exists a K sufficiently large such that a Δ_H manager benefits "on average" from standardization. When communicating with the functional manager, however, a Δ_L manager may then still want to pretend to be a Δ_H type in order to change the standardization decision "on the margin". By doing so, he moves up the cut-off point at which the functional manager initiates or implements standardization.

‘dotted line’ control, losers will block standardization moves. In contrast, under functional control this is not a problem, since the functional manager does not need the consent of the high cost business unit. Moreover, efficient information aggregation will take place, since the winner – the Δ_L manager who benefits from standardization – will be happy to reveal his type. The following proposition shows this formally.

Proposition 5 *If, under functional initiative, business unit managers optimally always cooperate, integration with functional control is weakly preferred to integration with functional initiative. This preference is strict if v is large enough or K is small enough.*

An implication of this result is that functional initiative will only be efficient at implement win-win standardization. As we show next, it can in fact implement win-win standardization at a lower cost than functional control. This generates a trade-off. Either the organization tries to implement both win-win and win-lose synergies, in which case functional control will be preferred; or the organization restricts itself to win-win synergies, in which case it can achieve it cheaply (in terms of effort distortions) through functional initiative. We study next this win-win standardization case.

6.2 Win-win synergies and functional initiative

Acceptance constraint We first characterize the conditions under which a Δ_L manager cooperates with the functional manager. If only Δ_L managers cooperate, we can neglect the first communication stage where business unit managers transmit information about the value of adaptation to them. Since their advice only matters if both business unit managers are of type Δ_L , the functional manager attempts to standardize if and only if it is more valuable for him in the knowledge that both business unit face revenue losses Δ_L , that is if $s_f k > 2(1 - s_{bu}) \Delta_L$ or:

$$k > k_{LL} = \frac{(1 - s_{bu})}{s_f} [2\Delta_L]$$

Given this cut-off, the Δ_L manager must compare expected profits if standardization takes place $\frac{1}{2}(1 - s_f)E[k]$, with his adaptation losses $s_{bu}\Delta_L$. It follows that a Δ_L product manager will cooperate with a standardization effort if and only if

$$\frac{K + k_{LL}}{4} > \frac{s_{bu}}{1 - s_f} \Delta_L$$

or still

$$K > \left[\frac{2s_{bu}}{1 - s_f} - \frac{1 - s_f}{s_f} \right] 2\Delta_L \quad (\text{AC})$$

We refer to the above incentive constraint, (AC), as the ‘Acceptance constraint’, or AC. It plays a similar role in the analysis as the communication constraint in the case of integration with functional control, studied in Section 4.

The following lemma shows that the acceptance constraint is always easier to satisfy than the communication constraint.

Lemma 4 *A Δ_L manager is willing to accommodate a standardization effort for any s_f and s_{bu} , (with $s_f + s_{bu} > 1$, which always holds in equilibrium) such that the communication constraint (8) is satisfied.*

Intuitively, it is easier to induce a Δ_L business unit manager to reveal his type when he has the power to block any standardization effort. Note the business unit strictly prefers standardization for sufficiently high cost savings k . In this sense, lying is not that costly under functional control (Section 4), since the functional manager implements standardization for high values of k regardless of the information transmitted. Instead, under functional initiative, blocking the standardization initiative means that standardization never occurs. This makes blocking more expensive than lying. More generally, giving control over actions to those with private information allows for a better use of this information.¹⁷

Optimization The design problem now involves choosing incentives that trade off efficient standardization decisions and effort, conditional on the Δ_L manager being willing to rubberstamp a standardization effort. Analogously to Section 4, the expected profits of the organization can now be written as:

$$\max_{s_{bu}, s_f} \pi = \max_{s_{bu}, s_f} \frac{(1-p)^2}{K} \int_{k_{LL}}^K (k - 2\Delta_L) dk + s_{bu}(2 - s_{bu})v + s_f(2 - s_f)v \quad (10)$$

subject to (AC).

When the constraint does not bind, the first order conditions are analogous to the ones under functional control:

$$\pi_\ell = \frac{1}{2} [1 - \ell] \frac{\gamma^{fi}}{K} - 2s_f^2 \ell v = 0 \quad (11)$$

$$\pi_{s_f} = 2 [(1 - s_f) - s_f \ell^2] v = 0, \quad (12)$$

where $\gamma^{fi} = \Delta_L^2$

Note the similarity between these first order conditions and the ones under integration with functional control. The benefit of high-powered effort incentives is as before; the cost is

¹⁷That it may be useful to have control colocated with information is not surprising in contexts where communication is not possible or very expensive (e.g. Jensen and Meckling 1992). We show (as has Dessein 2002) that this is also the case when communication is not costly but strategic and hence agents are prone to distort their information to influence decision making.

now less severe, as there is only standardization when both $\Delta_1 = \Delta_2 = \Delta_L$. Moreover as we have noted before, this optimization is subject to an incentive compatibility constraint that is strictly weaker than the one under separation.

Analysis

Proposition 6 *Under functional initiative with win-win synergies, decision making distortions as measured by $s_f/(1 - s_{bu})$ are strictly increasing in K and v , and decreasing in Δ_L . They do not depend on Δ_H . Moreover, $s_f^*/(1 - s_{bu}^*) > 1$.*

Intuitively, as K increases, business unit managers are more willing to accommodate a standardization effort. This implies that incentives for business unit managers can be raised without violating the acceptance constraint. Secondly, if the acceptance constraint is non-binding, a larger K makes it less important to discipline the functional manager and improve the quality of his recommendation. In the same vein, a decrease in Δ_L makes it easier to satisfy the acceptance constraint and decreases the benefits to improve the functional manager's recommendation. Note that the intuition for the comparative statics with respect to K is similar to that provided under integration with functional control, except that there, K affects business unit manager communication (as opposed to decision-making) and functional manager decision-making (as opposed to communication).

We now compare optimal incentives under integration with functional initiative with those under integration with functional control. Intuitively, there is now less value to align the incentives of the functional manager because his decision only matters if both types are Δ_L , which happens with probability p^2 under functional initiative. In addition, as we argued before, the acceptance constraint which guarantees that business unit managers of type Δ_L are willing to accommodate the functional manager, is strictly weaker than the communication constraint under functional control. It follows that if the communication constraint is satisfied under functional control, it must be that incentives are higher under functional initiative.

Proposition 7 *Let s_f^c and s_{bu}^c be the optimal incentives under functional control with (Δ_L) communication and s_f^{fi} and s_{bu}^{fi} be the optimal incentives under functional initiative with Δ_L cooperation, then $s_f^{fi}/(1 - s_{bu}^{fi}) > s_f^c/(1 - s_{bu}^c)$.*

6.3 Organizational design

The above analysis has identified some of the pitfalls and advantage of functional initiative. We now derive implications for organizational design: when is it desirable for the organization to limit the control of the functional manager over the synergistic activity? When should the functional manager only be allocated dotted line-control?

In what follows, we distinguish between organizations with low and high-powered effort incentives. As we show, when effort incentives are not very important, functional control is

always optimal. If effort incentives become more important, however, functional initiative becomes an option, which is particularly attractive if there is a large variance in the cost of local adaptation.

Functional Initiative versus Functional Control: Low powered incentives.

When effort incentives are not very important, the organization does not want to compromise efficient standardization decisions in order to boost effort incentives. Standardization is then optimally made contingent on both the cost savings k from standardization and the associated revenue losses Δ_1 and Δ_2 due to a loss of adaptation. Moreover, efficiency requires standardization when cost savings k are sufficiently large, even if cost of doing so are asymmetrically distributed among the business units, that is $\Delta_1 > \Delta_2$. As argued above, however, in order to implement such win-lose synergies, functional initiative requires more effort distortions than functional control.

To illustrate the ineffectiveness of functional initiative at implementing win-lose synergies, the following proposition focuses on cases where, a priori, the expected value of synergies is limited. Since functional initiative limits the ability of the functional manager to implement standardization, one might suspect that functional initiative would be more attractive when expected cost savings from synergies are small. In fact, when effort incentives are not very important, functional initiative is, in this low synergy case, always strictly dominated. If expected synergies are more important, functional initiative can at best do equally good as functional control

Proposition 8 There exists a \tilde{v} such that functional control is preferred over functional initiative whenever $0 < v < \tilde{v}$. If $K \leq 2\Delta_H + (\Delta_H - \Delta_L)/2$, this preference is always strict.

Intuitively, when expected cost savings from standardization $E(k)$ are limited, then whenever two business unit managers face different adaptation costs, it is virtually impossible for standardization to be desirable to both of them, that is for standardization to be win-win, even if $s_f = s_{bu} = 1/2$. In contrast if expected synergies are very large, everyone may benefit from standardization provided that there is enough revenue sharing. Functional initiative may then be equally efficient as functional control as long as s_f and s_{bu} are sufficiently close to $1/2$ at the optimum.

To see this more clearly, consider the case where $K = 2\Delta_H$. With balanced incentives, that is $s_f = s_{bu} = 1/2$, functional control implements first-best standardization decisions. The functional manager then puts as much weight on his cost savings as on the revenue losses in the two business units. Consider now the same balanced incentives under functional initiative and let business unit 1 faces a high adaptation cost Δ_H and business unit 2 a low adaptation cost Δ_L . Given $s_f = s_{bu} = 1/2$, the functional manager initiates a standardization effort if and only if $k > \Delta_H + \Delta_L$. Note that this standardization cut-off is first best. Also business unit

manager 1, facing a low adaptation cost, is willing to cooperate. Unfortunately, business unit manager 2, who faces a high adaptation cost, is strictly worse off with standardization and will block it. Indeed, his share in cost savings is only $(1 - s_f)/2$. Hence, given $s_{bu} = s_f = 1/2$, he will cooperate with a standardization effort if and only if

$$s_{bu}\Delta_H = \frac{\Delta_H}{2} < \frac{1 - s_f}{2} E(k) = \frac{1}{4} \left[\frac{1}{2} (\Delta_H + \Delta_L + 2\Delta_H) \right]$$

which is always violated.

Only if K is much larger, a Δ_H manager may be willing to cooperate. Indeed, let $\Delta_1 = \Delta_L$ and $\Delta_2 = \Delta_H$, then conditional on a standardization effort by the functional manager, the expected level of cost savings equal $E(k) = \frac{1}{2} (\Delta_H + \Delta_L + K)$. A functional manager then will cooperate if and only if

$$s_{bu}\Delta_H = \frac{\Delta_H}{2} < \frac{1 - s_f}{2} \frac{1}{2} (\Delta_H + \Delta_L + K)$$

If K is sufficiently large and s_f and s_{bu} are sufficiently close to $1/2$, a Δ_H manager may then be willing to cooperate. Functional initiative can then be equally efficient as functional control.

Functional Initiative versus Functional Control: high powered incentives

In Section 4, we have shown that as effort incentives become more important, at some point the organization optimally gives up on communication and forgoes fully contingent standardization decisions. In particular Proposition 1 shows that there exists a cut-off value \tilde{v} such that whenever effort incentives $v > \tilde{v}$, standardization decisions are only contingent (since there is no credible communication) on the information of the functional manager, that is on the realization of cost savings k . Without a need to induce communication between the business unit managers and the functional manager the organization can provide higher powered effort incentives. The organization thus trades off efficient standardization decision with higher powered effort incentives.

If functional initiative is feasible, however, the organization has another option to boost effort incentives. Rather than making standardization uniquely contingent on associated cost savings k , standardization can be made mainly contingent on the associated adaptation losses $(\Delta_1 + \Delta_2)$. In particular, by making cooperation from the business unit managers essential, the organization may choose to implement standardization only if both business units face low adaptation costs. Whereas only win-win synergies are then realized, this requires less effort distortions than functional control with fully contingent standardization, as shown in Proposition 7. Functional initiative with win-win synergies is therefore an alternative to functional control without communication as a means to boost effort incentives.

The following proposition states that as effort incentives become more important, the organization moves from fully contingent standardization (functional control with communication) to an organizational design in which standardization is either contingent on the

cost savings from standardization (functional control without communication) or an organizational design in which standardization is (mainly) contingent on the adaptation costs associated with standardization (functional initiative with win-win synergies):

Proposition 9 (ii) *An increase in v may result in a shift from Functional Control with communication (standardization contingent on k , Δ_1 and Δ_2) to Functional Initiative (with standardization only if $\Delta_1 = \Delta_2 = \Delta_L$, win-win synergies), but never the other way around*
 (iii) *An increase in v may result in a shift from Functional Control with communication (standardization contingent on k , Δ_1 and Δ_2) to Functional Control without communication (standardization contingent only on cost savings k) but never the other way around.*

Figure 3 shows graphically the optimal organizational design as a function of the value of effort and the variance in Δ . The size of K and the expected value of Δ is kept fixed so that the expected value of synergies, $E(k - \Delta_1 - \Delta_2)$, equals zero. This implies that integration is always optimal. The only question is whether integration is best achieved through functional control or functional initiative (dotted line-control).

When effort is unimportant, it is optimal for the organization to ensure that standardization decisions are based on the most complete information aggregation, even if this comes at the expense of low powered incentives. From Propositions 5 and 8, such full information sharing is best achieved through integration with functional control. Although business unit control can also support full information sharing, it does so at a (weakly) greater organizational costs. As v increases, it is increasingly important to provide higher power incentives. The organization then either gives up on communication in which case standardization decisions uniquely depend on the size of the cost savings k , or the organization moves to integration through functional initiative, where standardization only occurs if the resulting synergies are win-win, that is both business unit managers face low adaptation costs Δ_L . Put differently, as effort becomes more important, standardization decision become (mainly) dependent on either the costs or benefits from standardization.

Example 3 suggest that for high-powered incentives, the choice between (i) making standardization decisions uniquely contingent on cost savings (functional control without communication) or (ii) making standardization contingent on both business units facing low adaptation costs (functional initiative with win-win synergies) depends on the variance in Δ . Indeed, from Figure 3, the organization will choose to boost effort incentives by moving to functional initiative, whenever the variance in Δ is sufficiently large. Intuitively, rather than boosting effort incentives by making standardization uniquely contingent on cost savings, as the spread in Δ increases, it may be optimal to boost effort incentives by having standardization only if both manager face low adaptation costs. The lower is Δ_L , the lower are the incentive costs of implementing such win-win synergies and the more valuable are win-win synergies. Indeed, when Δ_L is small, effort incentives only require marginal distortions for a Δ_L manager to be willing to cooperate with a standardization effort. Similarly, since Δ_H

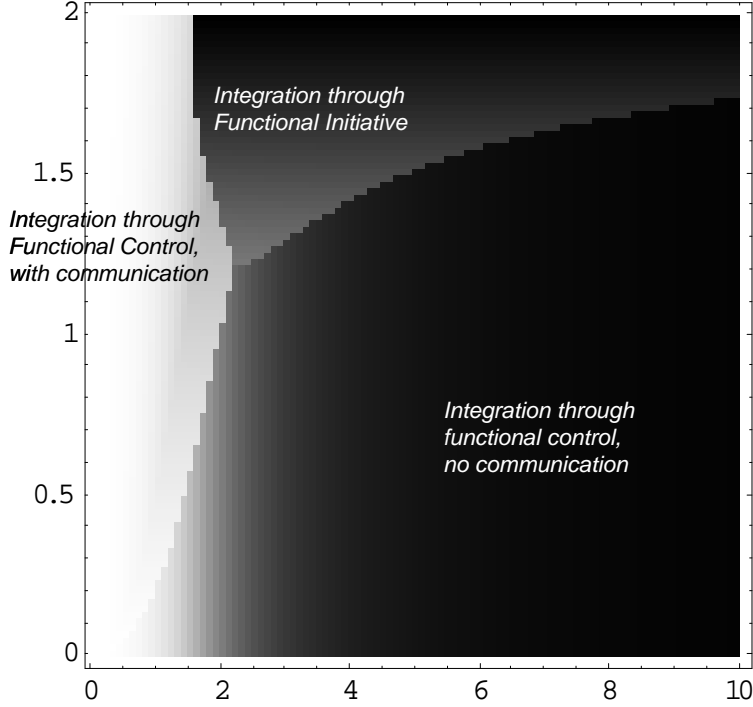


Figure 5: Organizational choice and communication regime as a function of the value of the marginal value of effort v and the spread $\Delta_H - \Delta_L$

is increasing, synergies where at least one of the manager face high adaptation cost become less valuable on average. Ruling out such synergies is then less costly. Intuitively, for a given K and given incentives s_f and s_{bu} , making standardization contingent mainly on Δ will be more valuable if there is a large variance in adaptation costs.

Example 5. Figure 4 illustrates the impact of the spread Δ , $\Delta_H - \Delta_L$ on organizational choice. It has $\bar{\Delta} = 2$, $K = 8$, $\Delta_H - \Delta_L \in [0, 2]$, $v \in [0, 9]$.

7 Conclusion

We have developed a simple model to capture the tradeoffs that guide organizational and incentive structure in the presence of coordination problems created by the need to implement synergies. In our model, extracting such synergies requires allocating the synergistic activities to a functional manager, who may or may not have full control over the extent to which activities are standardized. Efficient decision-making requires communication of private information, but communication requires weakening incentives, as managers with high-powered local incentives will misrepresent their information. The reason for this misrepresentation is that, in equilibrium, managers are biased in favor of their own unit. These biases are not

assumed, but are the result of the optimal incentive design of the organization. We characterize the optimal choice of organizational structure as a function of the value of synergies and local adaptation, the importance of incentives and the structure of private information.

The model allow us to characterize the extent to which organizational costs constrain the ability of firms to capture synergies through integration. When the synergies are large and well known – that is when contingent decision making is not important– a large share of these synergies may be captured through integration of previously separate units. The reason is that, if contingent decision making is not necessary, the incentives of business unit and functional managers need not be aligned too closely. As a result, it is possible for the organization to keep high powered incentives without fearing the resulting conflicts. Instead, if contingent decision making ex post is important, synergies will be hard to capture through integration. In this case, managers must be sufficiently aligned that truthful communication among them is possible. This requires lower powered incentives. A relevant case where contingent decision making would be important would be, when there are lots of little decisions that must be taken that may lead to synergies.

Organizations often try to achieve at least a certain level of scale economies or synergies between different business units without providing authority to the functional managers. In the Suchard example we discussed in the introduction, for example, the company tried a different approach to attain marketing synergies from the one it had followed in trying to attain manufacturing ones. In manufacturing, it consolidated production and shifted control to new plant managers (see the introduction). In marketing, it 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. However, the ultimate authority remained with the country (general) managers; the sponsors could only suggest standardization initiatives. Similarly, after the first World Trade Center attack (in 1993), the FBI, which previously was structured in a decentralized way around the field offices, determined that this organization served badly the counterterrorism task. However, to achieve these synergies it created a separate Counterterrorism and Counterintelligence Divisions “intended to ensure sufficient focus on these two national security missions.” However, the FBI changed neither the career incentives nor the authority of the local offices,¹⁸ and by all accounts, it captured very few of the existing between office synergies (particularly in counterterrorism). In Section 6, we study the extent to which this type of ‘dotted line’ control, which we call ‘functional initiative’ can succeed, and when such a design may be preferred to providing the functional managers with the necessary control to implement synergies.

Functional initiative is only efficient at implementing win-win standardization– that is

¹⁸All of the information on the FBI comes from the National Commission on Terrorist Attacks upon the United States, Staff Statement No. 9: “Law Enforcement, Counterterrorism, and Intelligence Collection in the United States Prior to 9/11.”

functional initiative cannot impose synergies when at least one of the business units is opposed to the standardization moves. On the other hand, it can implement these standardization moves at relatively low cost, as communication is cheaper to sustain. As a result, the choice between functional initiative and functional control presents organizations with a trade-off. Functional control can more efficiently implement synergies, but at a higher incentive cost; functional initiative cannot implement win-lose synergies, but it can sustain stronger incentives. It follows that, when incentives are not too important, functional control is always preferred; when they are, functional initiative may be chosen, particularly if the variance of adaptation costs is high.

We view the analysis in this paper as a starting point to a deeper exploration of the way organizational structure can be designed to facilitate coordination while maintaining incentives. Much remains to be done. We have seek to present the simplest possible model involving the four elements we consider critical: synergies, adaptation, effort incentives and (strategic) communication. In doing this, we have drastically simplified the incentive structure and the information structure. Future work must explore the robustness of the model to richer incentive and information structures. It may also explore how other organizational design options, beyond the ones we have studied here, can allow organizations to capture synergies. We suggest two avenues in particular.

First, 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. In the future, we plan to investigate a structure with centralized conflict resolution in which disagreements can arise between business unit and functional managers. We speculate that conflict resolution allows for an increase in incentive strength, as the main cost of strong incentives is worse ex post implementation of synergies, and conflict resolution allows for some ex post conditional implementation. However, conflict resolution reduces horizontal communication, since some ex post implementation can be ensured through the senior management intervention. Given this tradeoff, a particularly interesting question is the extent to which introducing red tape, by increasing the costs of appealing to senior management, may be beneficial in facilitating communication among business unit and functional managers.

A second interesting extension would analyze the impact of having synergies in multiple functions. We expect that, as the functions in which the synergies are important increase, the value of leaving the other functions in the business unit decreases, as not much adaptation can take place.

Organizations exist to coordinate complementary activities in the presence of specialization. Organizational structure, through its impact on the information available to decision-makers and their incentives, exhibits tradeoffs between coordination through communication and effort. This paper suggest a way to place these tradeoffs at the center of a deeper study of organizational design.

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A Appendix

A.1 Proofs of Section 4

Lemma 3: Let s_f^c and s_{bu}^c be the optimal incentives when the organization induces communication, then

$$(1 - s_{bu}^c)/s_f^c \geq (1 - \tilde{s}_{bu}^c)/\tilde{s}_f^c > (1 - s_{bu}^{nc})/s_f^{nc}$$

where the first inequality is strict whenever the communication constraint (9) is binding given \tilde{s}_f^c and \tilde{s}_{bu}^c .

Proof. A. $(1 - \tilde{s}_{bu}^c)/\tilde{s}_f^c > (1 - s_{bu}^{nc})/s_f^{nc}$: We have that \tilde{s}_f^c and \tilde{s}_{bu}^c are given by equations (6) and (7) with $\gamma = E(\Delta_L + \Delta_H)^2$. Since s_f^{nc} and s_{bu}^{nc} are also given by (6) and (7) but with $\gamma = 4\bar{\Delta}^2 < E(\Delta_L + \Delta_H)^2$, the inequality follows directly from lemma 2.

B. $(1 - s_{bu}^c)/s_f^c \geq (1 - \tilde{s}_{bu}^c)/\tilde{s}_f^c$: If the communication constraint (9) is non-binding, then trivially $s_f^c = \tilde{s}_f^c$ and $s_{bu}^c = \tilde{s}_{bu}^c$. Assume therefore that (9) is binding. Then s_f^c and $\ell^c = (1 - s_{bu}^c)/s_f^c$ satisfy the following Kuhn-Tucker conditions:

$$\frac{1}{2} [1 - \ell] \frac{\gamma}{K} - 2s_f^2 \ell v + \lambda \left[\frac{2s_f}{1 - s_f} + 1 + \frac{\Delta_H}{\Delta_L} \right] = 0 \quad (13)$$

$$2 [(1 - s_f) - s_f \ell^2] v - \lambda \left[2 \frac{1 - \ell}{(1 - s_f)^2} \right] = 0, \quad (14)$$

where $\gamma = E(\Delta_L + \Delta_H)^2$. Similarly, $\tilde{\ell}^c$ and \tilde{s}_f^c satisfy the following first-order conditions:

$$\pi_\ell = \frac{1}{2} [1 - \ell] \frac{\gamma}{K} - 2s_f^2 \ell v = 0 \quad (15)$$

$$\pi_{s_f} = 2 [(1 - s_f) - s_f \ell^2] v = 0, \quad (16)$$

where, by assumption, $\tilde{\ell}^c$ and \tilde{s}_f^c , violate (19). Manipulating the above four conditions, we obtain

$$\frac{1}{2} [1 - \ell^c] \frac{\gamma}{K} - 2(s_f^c)^2 \ell^c v < \frac{1}{2} [1 - \tilde{\ell}^c] \frac{\gamma}{K} - 2(\tilde{s}_f^c)^2 \tilde{\ell}^c v \quad (17)$$

or still

$$\ell^c \left(\frac{1}{2} \frac{\gamma}{K} + 2(s_f^c)^2 v \right) > \tilde{\ell}^c \left(\frac{1}{2} \frac{\gamma}{K} + 2(\tilde{s}_f^c)^2 v \right) \quad (18)$$

From lemma ??, we know that s_f^c is continuously decreasing in v whenever (19) is binding, whereas \tilde{s}_f^c is increasing in v . Moreover, we can always find a v such that (19) holds at the equality given $\tilde{s}_f^c(v)$ and $\tilde{\ell}^c(v)$. It follows that whenever \tilde{s}_f^c and $\tilde{\ell}^c$ are such that (19) is violated, then $\tilde{s}_f^c > s_f^c$. But from the above condition, it then must also be that $\ell^{nc} < \ell^c$, or equivalently $\tilde{s}_f^c/(1 - \tilde{s}_{bu}^c) > s_f^c/(1 - s_{bu}^c)$.

■

It will be useful to first prove proposition 2, and then only proposition 1.

Proposition 2: *Let s_f^* and s_{bu}^* be optimal incentives for the functional and business unit managers. Distortions in decision-making by the functional manager, as characterized by $1/\ell = s_f^*/(1 - s_{bu}^*)$, and business unit effort incentives, s_{bu}^* , are increasing in value of effort v and the level of the synergies K . Effort incentives for the functional manager s_f^* are increasing in K and v , except when the communication constraint is binding and the organization chooses to induce communication, in which case s_f^* are decreasing in K and v .*

Proof: We first proof that the above statements hold for a given equilibrium "regime" (that is "pooling", "separating with non-binding communication constraint", "separating equilibrium with binding communication constraint"). We subsequently show that the statement is also true when a change in K or v induces a shift in regime.

A. In a pooling equilibrium or separating equilibrium with non-binding communication constraint, s_f , s_{bu} and $1/\ell$ are increasing in $\tau \in \{v, K\}$. In a separating equilibrium with binding communication constraint, s_{bu} and $1/\ell$ are increasing, but s_f is decreasing in $\tau \in \{v, K\}$.

(1) Pooling equilibria or separating equilibria with non-binding communication constraint: In the text, we have already shown that $(-\ell)$ and s_f are increasing in v and K .¹⁹ We now show that the same holds for s_{bu} . Given that $\ell < 1$, the second first order condition (7) implies that $s_f > 1/2$. Substituting s_{bu} , we have that

$$2[(1 - s_f)s_f - (1 - s_{bu})^2]v = 0$$

from which it follows that also s_{bu} is increasing in $\tau \in \{v, K, -\gamma\}$.

(2) Separating equilibria with binding communication constraint: The communication constraint (9) can be rewritten as

$$\frac{2s_f s_{bu} - (1 - s_f)(1 - s_{bu})}{(1 - s_f)s_f} - \frac{1 - s_{bu}}{s_f} \frac{2\Delta_H}{2\Delta_L} \leq 0$$

or still, as a function of s_f and ℓ

$$\left[\frac{1 - \ell s_f}{1 - s_f} - \ell \right] - \ell \frac{2\Delta_H}{2\Delta_L} \leq 0 \quad (19)$$

Thus, when (9) is binding, profits can be rewritten as a function of ℓ

$$\pi^c = \pi^c(\ell^c, s_f^c(\ell^c)) \equiv \pi_i^c(\ell^c) + \pi_e^c(\ell^c, s_f^c(\ell^c))$$

where

$$s_f^c(\ell) = \frac{\ell + \frac{\ell\Delta_H}{\Delta_L} - 2}{\frac{\ell\Delta_H}{\Delta_L} - \ell} = \frac{1 + \frac{\Delta_H}{\Delta_L} - 2/\ell}{\frac{\Delta_H}{\Delta_L} - 1} \quad (20)$$

and where π_i^c reflects the impact of the equilibrium cut-off values of standardization and

¹⁹In particular, $\pi(s_f, -\ell, \tau)$ is supermodular for $\tau \in \{v, K, -\gamma\}$.

uniquely depends on ℓ , and π_e^c is the part of the profits function reflecting the impact on profits of effort provision. Thus

$$\pi_e^c(\ell, s_f^c(\ell)) = \left\{ \left[1 - (s_f^c(\ell))^2 \ell^2 \right] + s_f(\ell)(2 - s_f(\ell)) \right\} v$$

Note first that since $s_f(\ell) < 1$, it follows from the expression of $s_f(\ell)$ that $\ell < 1$. Secondly, the following first order condition with respect to ℓ yields

$$\frac{1}{2} [1 - \ell] \frac{\gamma}{K} - 2s_f^2(\ell)\ell v + 2v [(1 - s_f(\ell)) - s_f(\ell)\ell^2] \frac{1}{\ell^2} \frac{2}{\frac{\Delta_H}{\Delta_L} - 1} = 0$$

Since $\partial s_f(\ell)/\partial \ell > 0$, one can further verify that

$$\frac{d^2 \pi^c(s_f(\ell), \ell)}{d\ell^2} < 0$$

Since $\ell < 1$, it follows that in a separating equilibrium with binding communication constraint, ℓ and s_f are continuously decreasing in v and K , but increasing in γ . Since $\ell = (1 - s_{bu})/s_f$, this implies that s_{bu} is continuously increasing in $\tau \in \{v, K, -\gamma\}$.

B. A regime shift induced by a change in K and v results in an increases $1/\ell^*$ and s_{bu}^* .

1) From Proposition 1, an increase K or v may result in a shift from a separating equilibrium where the incentive constraint (9) is binding to a pooling equilibrium, but never the other way around. From lemma 3, such a shift from a separating equilibrium to a pooling equilibrium results in a discrete increase in s_f^* , s_{bu}^* and $1/\ell^*$.

2) As long as it is optimal for the organization to induce communication s_f^* and s_{bu}^* are continuous in K and v . The comparative statics with respect to K and v then follow directly from the "within regime" comparative statics analyzed under (1) and (2) : s_{bu}^* is continuously increasing in K and v whereas s_f^* is continuously increasing in K and v as long as the incentive constraint is non-binding decreasing afterwards. Since the LHS of the incentive constraint (9) is decreasing in s_f and s_{bu} , and s_f^* and s_{bu}^* are increasing in K or v in a separating equilibrium with non-binding communication, an increase K or v may result in a shift from a separating equilibrium where the incentive constraint (9) is non-binding to a separating equilibrium where (9) is binding, but never the other way around. From (A) above, s_f^* is then decreasing in K and v . QED.

Proposition 1 *If it is optimal for the organization to induce communication given K' and v' , then it is also to induce communication for any (K, v) with $K \leq K'$ and $v \leq v'$. Similarly, for a given $\bar{\Delta}$, if it is optimal for the organization to induce communication given Δ_H, Δ_L then it is optimal to induce for any Δ'_H, Δ'_L , such that $\bar{\Delta}$ is constant and $\Delta'_H - \Delta'_L > \Delta_H - \Delta_L$. In contrast, if either $K > K'$ or $v > v'$ or $\Delta'_H - \Delta'_L < \Delta_H - \Delta_L$, then the organization may decide to forego communication. Since $s_f^c/(1 - s_{bu}^c) < s_f^{nc}/(1 - s_{bu}^{nc})$, this is accompanied by a discrete increase in functional effort incentives and distortions in decision-making.:*

Proof. We first show that an increase K or v may result in a shift from a separating equilibrium where the incentive constraint (9) is binding to a pooling equilibrium, but never the other way around. We denote by $\pi^c(\ell^c, s_f^c)$ profits in a separating equilibrium with binding communication constraint given optimal incentives ℓ^c and $s_f^c = s_f(\ell^c)$ and by $\pi^{nc}(\ell^{nc}, s_f^{nc})$ profits in a pooling equilibrium given optimal incentives $\tilde{\ell}^c$ and \tilde{s}_f^c . Using the envelope theorem and Proposition 3, it is easy to verify that both $d(\pi^c(\ell^c, s_f^c(\ell^c)) - \pi^{nc}(\ell^{nc}, s_f^{nc}))/dK < 0$ and $d(\pi^c(\ell^c, s_f^c(\ell^c)) - \pi^{nc}(\ell^{nc}, s_f^{nc}))/dv < 0$.

Second, we show that the same holds for an increase in the spread $\delta = \Delta_H - \Delta_L$, keeping $\bar{\Delta}$ fixed. Note first that profits in a pooling equilibrium are independent of $\delta = \Delta_H - \Delta_L$, that is $d(\pi^{nc}(\ell^{nc}, s_f^{nc}))/d\delta = 0$, hence it will be sufficient to show that $d(\pi^c(\ell^c, s_f^c(\ell^c)))/d\delta > 0$. From the envelope theorem, we have that

$$\begin{aligned} \frac{d\pi^c(\ell^c, s_f^c(\ell^c))}{d\delta} &= \frac{d\pi^c}{d\ell^c} \frac{\partial \ell^c}{\partial \delta} + \frac{\partial \pi^c}{\partial s_f^c} \frac{\partial s_f^c(\ell^c)}{\partial \delta} + \frac{d\pi^c}{d\delta} \\ &= \frac{\partial \pi^c}{\partial s_f^c} \frac{\partial s_f^c(\ell^c)}{\partial \delta} + \frac{\partial \pi^c}{\partial \delta} \end{aligned}$$

From (20), we have that $\partial s_f^c(\ell^c)/\partial \delta > 0$. Moreover, since from proposition 2 $\ell^c < \tilde{\ell}^c$ and $s_f^c < \tilde{s}_f^c$, where \tilde{s}_f^c and $\tilde{\ell}^c$ satisfy the first order condition (7)

$$2(1 - \tilde{s}_f^c)v - 2\tilde{s}_f^c (\tilde{\ell}^c)^2 v = 0,$$

it must be that

$$\frac{\partial \pi^c}{\partial s_f^c} = 2(1 - s_f^c)v - 2s_f^c(\ell^c)^2 v > 0$$

Finally, we have that

$$\begin{aligned} \frac{\partial \pi^c}{\partial \delta} &= 2\ell^c \frac{1}{4K} (\ell^c 2\Delta_L - 2\Delta_L) dk \\ &\quad - 2\ell^c \frac{1}{4K} (\ell^c 2\Delta_H - 2\Delta_H) + \frac{1}{4K} \int_{k_{LL}}^{k_{HH}} 2dk \\ &= \ell^c (2 - \ell^c) \frac{[\Delta_H - \Delta_L]}{K} > 0 \end{aligned}$$

It follows that $d\pi^c/d\delta > 0$. ■

A.2 Proofs of Section 5

Proposition 3: *Assume $K = 2\Delta_H$, then there exists a \tilde{v} such that for $v > \tilde{v}$, integration is suboptimal, and the organization strictly prefers to keep the business units separate. (2) For any $v > \tilde{v}$, there exists a $\bar{K} > 2\Delta_H$, such that integration is optimal if and only if $K \geq \bar{K}$, where \bar{K} is strictly increasing in v .*

Proof. We first proof the second part of the proposition. Denote profits under non-integration as π^{NI} and under integration as π^I . Given the first part of the proposition, we only need to show that $d(\pi^I - \pi^{NI})/dK > 0$ for $K > 2\Delta_H$, and $d(\pi^I - \pi^{NI})/dv < 0$. Since profits under integration are continuous in K and v even as we move from a separating to a pooling equilibrium, it will be sufficient to show that $d(\tilde{\pi}^c - \pi^{NI})/dK > 0$, $d(\pi^c - \pi^{NI})/dK > 0$ and $d(\pi^{nc} - \pi^{NI})/dK > 0$, and $d(\tilde{\pi}^c - \pi^{NI})/dv > 0$, $d(\pi^c - \pi^{NI})/dv > 0$, and $d(\pi^{nc} - \pi^{NI})/dv > 0$. Whereas $d\pi^{NI}/dK = 0$, it follows from the implicit function theorem that

$$\begin{aligned} \frac{d\pi^{nc}(K, s_f, s_{bu})}{dK} &= \frac{\partial\pi^{nc}(K, s_f, s_{bu})}{\partial K} + \frac{ds_f}{dK} \frac{\partial\pi^{nc}(K, s_f^*, s_{bu}^*)}{\partial s_f} + \frac{ds_{bu}}{dK} \frac{\partial\pi^{nc}(K, s_f^*, s_{bu}^*)}{\partial s_{bu}} \\ &= \frac{\partial\pi^{nc}(K, s_f, s_{bu})}{\partial K} \\ &> 0 \end{aligned}$$

The same is true for $d\tilde{\pi}^c/dK$ and $d\pi^c/dK$. Similarly, we have that

$$\begin{aligned} \frac{d\pi^{nc}(v, s_f, s_{bu})}{dv} &= \frac{\partial\pi^{nc}(v, s_f, s_{bu})}{\partial v} + \frac{ds_f}{dv} \frac{\partial\pi^{nc}(v, s_f, s_{bu})}{\partial s_f} + \frac{ds_{bu}}{dv} \frac{\partial\pi^{nc}(v, s_f^*, s_{bu}^*)}{\partial s_{bu}} \\ &= \frac{\partial\pi^{nc}(v, s_f, s_{bu})}{\partial v} \\ &= s_{bu} [2 - s_{bu}] + s_f (2 - s_f) \\ &< 2 = \frac{d\pi^{NI}}{dv} \end{aligned}$$

The same is true for $d\tilde{\pi}^c/dv$ and for $d\pi^c/dv$.

Consider now the first part. Since $d(\pi^I - \pi^{NI})/dv < 0$, it is enough to show that given $K = 2\Delta_H$, for v very large, $\pi^{NI} > \pi^I$. If we set $s_f = s_{bu} = 1$, profits under integration are given by

$$\begin{aligned} \pi^I &= K/2 - 2\bar{\Delta} + 2v \\ &= \Delta_H - 2\bar{\Delta} + 2v \\ &= \pi^{NI} - \Delta_L \end{aligned}$$

Since $\lim_{v \rightarrow \infty} s_f = \lim_{v \rightarrow \infty} s_{bu} = 1$, it follows that there always exists a v large enough such that $\pi^{NI} > \pi^I$.

■

Proposition 4: *If synergies ($k - (\Delta_1 + \Delta_2)$) increase in variance, organization may shift from non-integration to integration but never the other way around.*

Proof. Consider first an increase in the variance of $\Delta_1 + \Delta_2$, keeping $\bar{\Delta}$ fixed. Note first that π^{NI} and π^{ncI} are independent of $\Delta_H - \Delta_L$ as long as one keeps $\bar{\Delta}$ fixed. In contrast,

equilibrium profits under integration are increasing in $\delta = \Delta_H - \Delta_L$ whenever there is communication (seperating equilibrium).consider first an equilibrium with communication where the communication constraint is non-binding. Then $\ell^* = \tilde{\ell}^c$ and $s_f^* = \tilde{s}_f^c$, and from the envelope theorem

$$\begin{aligned}\frac{d\tilde{\pi}^c}{d\delta} &= \frac{d\tilde{\pi}^c}{d\tilde{\ell}} \frac{\partial \tilde{\ell}^c}{\partial \delta} + \frac{d\tilde{\pi}^c}{d\tilde{s}_f} \frac{\partial \tilde{s}_f^c}{\partial \delta} + \frac{\partial \tilde{\pi}^c}{\partial \delta} \\ &= \frac{\partial \tilde{\pi}^c}{\partial \delta}\end{aligned}$$

where as shown in the proof of proposition 1

$$\frac{d\tilde{\pi}^c}{\partial \delta} = \tilde{\ell}^c \left(2 - \tilde{\ell}^c \right) \frac{\delta}{K} > 0 > 0$$

Similarly, if the communication constraint is binding, then $\ell^* = \ell^c$ and $s_f^* = s_f^c(\ell^c)$, in which case we have already shown in the proof of proposition 1 that

$$\begin{aligned}\frac{d\pi^c}{d\delta} &= \frac{d\pi^c}{d\ell^c} \frac{\partial \ell^c}{\partial \delta} + \frac{\partial \pi^c}{\partial s_f^c} \frac{\partial s_f^c(\ell^c)}{\partial \delta} + \frac{d\pi^c}{d\delta} \\ &= \frac{\partial \pi^c}{\partial s_f^c} \frac{\partial s_f^c(\ell^c)}{\partial \delta} + \frac{\partial \pi^c}{\partial \delta} > 0\end{aligned}$$

■

A.3 Proofs of Section 6

We first proof, as claimed in footnote XX, that the extensive form assumed under functional initiative is without loss of generality.

First, one might wonder whether it is sometimes optimal to let the functional manager initiate a standardization effort before communication takes place. The following proposition shows that this is never optimal. Second, one might wonder whether, if communication is uninformative, the functional manager may be able to give guidance to the business managers as when to accomodate his standardization effort. For example, the functional manager could sometimes advice to Δ_H managers to block his standardization effort. The following proposition shows that if the communication constraint of the business unit managers is violated, then the functional manager never can make his standardization effort conditional on the business unit manager's type:

Proposition A.3.1. *(i) If s_f and s_{bu} are such that the communication constraint of the business unit managers is violated, then the functional manager has the choice between initiating a standardization effort or not initiating a standardization effort. However, he never can make a recommendation to the business unit managers as when to accomodate his stan-*

standardization effort.

(ii) If s_f and s_{bu} are such that the communication constraint of the business unit managers is satisfied, then it is always optimal to let the business unit managers communicate their type prior to the functional manager's standardization effort.

Proof. (1) Assume that the functional manager, when making a standardization effort, recommends to the business unit manager when to accommodate it. Since there are only two types of business unit managers, this is equivalent to the functional manager making a three-type recommendation: never accommodate standardization (which is equivalent to the functional manager not initiating a standardization), always accommodate standardization, accommodate standardization if your type is Δ_L . Under such three type recommendation, the functional manager recommends "always accommodate" if and only if $k > k_{LH}$; he recommends "accommodate if type Δ_L " if $k_{LL} < k \leq k_{LH}$; and he recommends "never accommodate" if $k \leq k_{LL}$. Two incentive constraints need to be satisfied: the acceptance constraint of the Δ_H manager upon hearing the message "always accommodate", and the acceptance of the Δ_L manager upon hearing the message "accommodate if type Δ_L ". Upon hearing the latter message, the Δ_L manager knows that $k_{LL} < k \leq k_{LH}$. Since given s_f and s_{bu} , the communication constraint is violated, we know that a Δ_L manager would want to block standardization if he knows that $k \in (k_{LL}, k_{LH}]$ with probability bu , and $k \in (k_{LH}, k_{HH}]$ with probability $(1 - bu)$. He therefore certainly wants to block a standardization if he knows that $k \in (k_{LL}, k_{LH}]$ for sure.

(2) Assume that the above described three-type communication is feasible if the functional manager talks first (that is, the business managers have no option to communicate prior to the standardization effort of the functional manager). The only difference with the equilibrium that prevails when the business unit managers communicate first, is that now for $k \in (k_{LH}, k_{HH}]$ standardization is implemented even if both business unit managers are of type Δ_H . This is obviously welfare reducing. Hence, if a s_f and s_{bu} are such that the communication constraint of the business unit managers is satisfied, then it is always optimal to let the business unit managers communicate first. It is then without loss of generality to let the functional manager simply choose between initiating standardization and not initiating standardization and restrict any further communication from the functional manager to the business unit manager.

■

Proposition 5 *If, under functional initiative, business unit managers optimally always cooperate, integration with functional control is weakly preferred to integration with functional initiative. This preference is strict if v is large enough or K is small enough.*

Proof. If, under functional initiative, business unit managers always cooperates with a standardization initiated by the functional manager, then the only difference with the optimization problem under functional control is that s_f and s_p must satisfy the additional acceptance constraint of the Δ_H type. Let s_f^* and s_{bu}^* be the solution to the maximization problem under functional control, then if given s_f^* and s_{bu}^* , a business unit manager of type

Δ_H is willing to cooperate with any synergy proposed by the functional manager, then the optimal output shares s_f and s_{bu} are identical to s_f^* and s_{bu}^* . Functional control and functional initiative are then equivalent. In contrast, if s_f^* and s_{bu}^* violate the acceptance constraint of the Δ_H manager, then given that it is optimal to induce both Δ_H and Δ_L managers to cooperate, functional initiative is strictly dominated by functional control. We now characterize when this strict dominance will occur.

Assume first that s_f^* and s_{bu}^* are such that there is no communication under functional control. Under functional initiative, there will then neither be communication given s_f^* and s_{bu}^* . Moreover, the functional manager will initiate a standardization effort whenever $k > k_{LH}$. Hence, an Δ_H business unit manager will give up control if and only if his expected share in the cost savings of standardization outweighs his share in the revenue losses. This yields the following acceptance constraint:

$$\frac{1 - s_f^*}{2} \left(\frac{K}{2} + \frac{k_{LH}}{2} \right) > s_{bu}^* \Delta_H$$

For $K = 2\Delta_H$, this acceptance constraint is equivalent to

$$\frac{1}{2} \left(\Delta_H + \frac{1 - s_{bu}^*}{s_f^*} \frac{\Delta_H + \Delta_L}{2} \right) > \frac{s_{bu}^*}{1 - s_f^*} \Delta_H \quad (21)$$

Since $s_f^* > 1/2$ and $s_{bu}^* > 1/2$, this constraint will be violated for any v or Δ_H and Δ_L . The same results can be shown to hold for any $K < 2\Delta_H + (\Delta_H - \Delta_L)/2$. More generally, since we always have that $s_f^* > 1/2$ and $s_{bu}^* > 1/2$, given $v > 0$ and $\Delta_H > \Delta_L$, there exists a $K' > 2\Delta_H + (\Delta_H - \Delta_L)/2$ such that the acceptance constraint is violated if $K < K'$. This proves the claim that functional initiative is always strictly dominated if K is sufficiently small. Finally, since s_f^* and s_{bu}^* are increasing in v and go to 1 as v goes to infinity, it follows that the acceptance constraint will always be violated if v is sufficiently high. Similarly, let $K'(v)$ be the highest value of K such that (21) is violated for all $K < K'(v)$. Since s_{bu}^* and $1/s_f^*$ are increasing in v , it follows from (21) that $K'(v)$ is increasing in v . This proves the claim that functional initiative is always strictly dominated if v is sufficiently large.

Consider now the case where there is communication under functional control. If one manager is of type Δ_L and the other of type Δ_H , then the functional manager initiates a standardization effort whenever $k > \bar{k}$, yielding again the same acceptance constraint (21), which will be violated under the same conditions.

■

Lemma 4: *A Δ_L cooperate with a standardization effort for any s_f and s_{bu} , (with $s_f + s_{bu} > 1$, which always holds in equilibrium) such that the communication constraint (8) is satisfied.*

Proof. We can rewrite the acceptance constrain (AC) as:

$$K > \left[\frac{2s_{bu}s_f - (1 - s_{bu})(1 - s_f)}{(1 - s_f)s_f} \right] 2\Delta_L \quad (22)$$

The communication constraint under functional control equals

$$\frac{(1 - s_f)(1 - s_{bu})}{s_f s_{bu}} \geq \frac{2\Delta_L}{\Delta_L + \Delta_H} \quad (CC)$$

and can be rewritten as

$$\frac{1 - s_{bu}}{s_f} 2\Delta_H \geq \frac{2s_{bu}s_f - (1 - s_f)(1 - s_{bu})}{(1 - s_f)s_f} 2\Delta_L$$

Since $1 - s_{bu} < s_f$ and $K > 2\Delta_H$, it follows that the LHS of the above expression is smaller than the LHS of (22).

■

Proposition 6. *Incentive strength as measured by $s_f^*/(1 - s_{bu}^*)$ is strictly increasing in K and v , and decreasing in Δ_L . It does not depend on Δ_H . Moreover, $s_f^*/(1 - s_{bu}^*) > 1$.*

Proof: We can rewrite profits under functional initiative with win-win synergies, denoted as π^{fi} , as a function of ℓ and s_{bu} :

$$\pi^{fi} = \pi_i^{fi}(\ell) + \pi_e^{fi}(\ell, s_{bu})$$

where

$$\pi_e^{fi}(\ell, s_{bu}) = \left\{ s_{bu}(2 - s_{bu}) + \frac{(1 - s_{bu})}{\ell} \left(2 - \frac{(1 - s_{bu})}{\ell} \right) \right\} v$$

and

$$\frac{\partial \pi_i^{fi}(\ell)}{\partial \ell} = \frac{1}{2} [1 - \ell] \frac{\gamma^{fi}}{K} > 0$$

with $\gamma^{fi} = E(\Delta_L)^2$. The acceptance constraint AC

$$\left[\frac{s_{bu}}{1 - s_f} - \frac{1 - s_f}{s_{bu}} \right] < \frac{K}{2\Delta_L}$$

can be rewritten as

$$\left[\frac{1 - \ell s_f}{1 - s_f} - \ell \right] < \frac{K}{2\Delta_L}$$

Note that if AC is binding, then it must be that $\ell < 1$. If the acceptance constraint is non-binding, then we find the following first order conditions

$$\frac{1}{2} [1 - \ell] \frac{\gamma^{fi}}{K} - 2s_f^2 \ell v = 0 \quad (23)$$

$$2 [(1 - s_f) - s_f \ell^2] v = 0, \quad (24)$$

which are equivalent to the first order conditions (6) and (7), with $\gamma = \gamma^{fi} = E(\Delta_L)^2$. It follows again that $0 < \ell < 1$ and $1/\ell, s_f$ and s_{bu} are increasing in v, K , but decreasing in γ . If the acceptance constraint is binding, then abusing notation, we can rewrite profits as a function of ℓ :

$$\pi^{fi} \equiv \pi^{fi}(\ell, s_f(\ell)) = \pi_i^{fi}(\ell) + \pi_e^{fi}(\ell, s_f(\ell))$$

where

$$s_f(\ell) = \frac{\ell + \frac{K}{2\Delta_L} - 2}{\frac{K}{2\Delta_L} - \ell}$$

and

$$\pi_e^{fi}(\ell, s_f(\ell)) = \{(1 - s_f^2(\ell)\ell^2) + s_f(\ell)(2 - s_f(\ell))\} v$$

This yields the following first order condition with respect to ℓ

$$\frac{d\pi^{fi}(s_f(\ell), \ell)}{d\ell} = \frac{1}{2} [1 - \ell] \frac{\gamma}{K} - 2s_f^2\ell v + 2v [(1 - s_f(\ell)) - s_f(\ell)\ell^2] \frac{2\left(\frac{K}{2\Delta_L} - 1\right)}{\left(\frac{K}{2\Delta_L} - \ell\right)^2} = 0$$

It follows that ℓ is decreasing in v , and thus also $s_f(\ell)$ is decreasing in v . Moreover, since it must be that $\ell + \frac{K}{2\Delta_L} - 2 > 0$, we have that

$$\frac{2\left(\frac{K}{2\Delta_L} - 1\right)}{\left(\frac{K}{2\Delta_L} - \ell\right)^2}$$

is decreasing in $\frac{K}{2\Delta_L}$. It follows that ℓ is also decreasing in K and increasing in Δ_L . The impact on $s_f(\ell)$ is ambiguous.

Proposition 7 *Let s_f^c and s_{bu}^c be the optimal incentives under functional control with communication and s_f^{fi} and s_{bu}^{fi} the optimal incentives under functional initiative with Δ_L cooperation, then $s_f^{fi}/(1 - s_{bu}^{fi}) > s_f^c/(1 - s_{bu}^c)$.*

Proof: Assume first that the business unit manager's incentive constraint is binding in both cases (communication constraint under functional control and acceptance constraint under functional initiative). The decision-making distortion ℓ^c under functional control then must satisfy the following first order condition:

$$\frac{d\pi(\ell, s_f^c(\ell))}{d\ell} = \frac{1}{2} [1 - \ell] \frac{\gamma}{K} - 2(s_f^c(\ell))^2\ell v + 2v [(1 - s_f^c(\ell)) - s_f^c(\ell)\ell^2] \frac{1}{\ell^2} \frac{2}{\frac{\Delta_H}{\Delta_L} - 1} = 0 \quad (25)$$

Note that since $s_f^c(\ell)$ is increasing in ℓ , we have that

$$\frac{d\pi(\ell, s_f^c(\ell))}{d\ell^2} < 0$$

Similarly, the decision-making distortion ℓ^{fi} under functional initiative must satisfy

$$\frac{d\pi^{fi}(\ell, s_f^{fi}(\ell))}{d\ell} = \frac{1}{2} \left[1 - \ell \right] \frac{\gamma}{K} - 2(s_f^{fi}(\ell))^2 \ell v + 2v \left[(1 - s_f^{fi}(\ell)) - s_f^{fi}(\ell) \ell^2 \right] \frac{2 \left(\frac{K}{2\Delta_L} - 1 \right)}{\left(\frac{K}{2\Delta_L} - \ell \right)^2} = 0$$

Note that

$$\frac{1}{\ell^2} \frac{2}{\frac{\Delta_H}{\Delta_L} - 1} > \frac{2 \left(\frac{K}{2\Delta_L} - 1 \right)}{\left(\frac{K}{2\Delta_L} - \ell \right)^2}$$

Indeed, this inequality will be satisfied whenever

$$\left(\frac{K}{2\Delta_L} - \ell \right)^2 > \left(\frac{\ell K}{2\Delta_L} - \ell \right) \left(\frac{\ell 2\Delta_H}{2\Delta_L} - \ell \right)$$

which is always verified whenever $\ell < 1$. Let ℓ^{fi} be a solution to the first order condition under functional initiative. Note further that since $\frac{K}{2\Delta_L} > \frac{\ell\Delta_H}{\Delta_L}$, we have that $s_f^c(\ell) < s_f^{fi}(\ell)$ for a given ℓ . It thus follows that

$$\frac{d\pi(s_f^c(\ell^{fi}), \ell^{fi})}{d\ell} = \frac{1}{2} \left[1 - \ell^{fi} \right] \frac{\gamma}{K} - 2(s_f^c(\ell^{fi}))^2 \ell^{fi} v + 2v \left[(1 - s_f^c(\ell^{fi})) - (s_f^c(\ell^{fi}))(\ell^{fi})^2 \right] \frac{1}{(\ell^{fi})^2} \frac{2}{\frac{\Delta_H}{\Delta_L} - 1} > 0 \quad (26)$$

from which it must be that

$$\ell^c(\gamma) > \ell^{fi}(\gamma) \quad (27)$$

Since $\ell^P(\gamma)$ is increasing in γ , and $\gamma^{fi} < \gamma^c$, we have that

$$\ell^c(\gamma^c) > \ell^{fi}(\gamma^c) > \ell^{fi}(\gamma^{fi}) \quad (28)$$

Secondly, assume that the incentive constraint is non-binding under both functional control and functional initiative. Denoting by $\tilde{\ell}^c$ and $\tilde{\ell}^{fi}$ the optimized values of ℓ if one ignores incentive constraints, then from an inspection of the first order conditions, it follows directly that

$$\tilde{\ell}^c > \tilde{\ell}^{fi}$$

Next, assume that only the incentive constraint is binding under functional control, then since $\ell^c > \tilde{\ell}^c$, this follows directly from $\tilde{\ell}^c > \tilde{\ell}^{fi}$.

Finally, assume that only under functional initiative, the incentive constraint is binding, that is $\ell = \ell^{fi} > \tilde{\ell}^{fi}$ under functional initiative and $\ell = \tilde{\ell}^c = \ell^c$ under functional control with communication.. Since $\gamma^{fi} = 2\Delta_L^2 < \gamma^{nc} = 2\bar{\Delta}^2$, and $\tilde{\ell}^c(\gamma)$ and $\ell^c(\gamma)$ are increasing in y , it follows that

$$\ell^c = \tilde{\ell}^c(\gamma^c) = \ell^c(\gamma^c) > \ell^c(\gamma^{fi}) \geq \tilde{\ell}^c(\gamma^{fi}) \quad (29)$$

Note further that, since the first order conditions are identical except for the value of γ ,

we have $\tilde{\ell}^c(\gamma^{fi}) = \tilde{\ell}^{fi}(\gamma^{fi}) = \tilde{\ell}^{fi}$ and $\tilde{s}_f^c(\gamma^{fi}) = \tilde{s}_f^{fi}(\gamma^{fi}) = \tilde{s}_f^{fi}$, where $\tilde{\ell}^c$, $\tilde{\ell}^{fi}$, \tilde{s}_f^c and \tilde{s}_f^{fi} refer to variables which are optimized ignoring any communication or acceptance constraint. However, we know $\tilde{\ell}^{fi}$ and \tilde{s}_f^{fi} violated the acceptance constraint under functional initiative. From lemma 4, $\tilde{\ell}^c(\gamma^{fi}) = \tilde{\ell}^{fi}$ and $\tilde{s}_f^c(\gamma^{fi}) = \tilde{s}_f^{fi}$ then also must violate the communication constraint under functional control. But if $\tilde{\ell}^c(\gamma^{fi}) = \tilde{\ell}^{fi}(\gamma^{fi})$ and $\tilde{s}_f^c(\gamma^{fi}) = \tilde{s}_f^{fi}(\gamma^{fi})$ violate both the communication and the acceptance constraint, then inequality (27) holds, that is $\ell^c(\gamma^{fi}) > \ell^{fi}(\gamma^{fi})$, where ℓ^c and ℓ^{fi} refer to variables which are optimized subject to respectively the communication and acceptance constraint. From (29), it then follows that

$$\ell^c = \ell^c(\gamma^c) > \ell^c(\gamma^{fi}) > \ell^{fi}(\gamma^{fi}) = \ell^{fi}$$

In other words, we always have $\ell^c > \ell^{fi}$.

QED

It will be useful to first proof proposition 9:

Proposition 8: *There exists a \tilde{v} such that functional control is preferred over functional initiative whenever $0 < v < \tilde{v}$. If $K \leq 2\Delta_H + (\Delta_H - \Delta_L)/2$, this preference is always strict.*

Proof: From proposition 5, to show that there exists a \tilde{v} such that functional control is preferred over functional initiative whenever $0 < v < \tilde{v}$, we only need to show that there exists a \tilde{v} such that functional control is preferred over functional initiative with win-win synergies whenever $0 < v < \tilde{v}$. Since under functional initiative with win-win synergies, standardization is only implemented if both $\Delta_1 = \Delta_2 = \Delta_L$, and given that $k > \Delta_H + \Delta_L$ with probability $K - (\Delta_H + \Delta_L) > 0$, functional initiative with win-win synergies yields profits π^{fi} which are strictly smaller than first-best profits π^{FB} . In contrast, under functional control, $\lim_{v \rightarrow 0} \pi^c = \pi^{FB}$. Indeed, $\lim_{v \rightarrow 0} s_f^c = s_{bu}^c = 1/2$ in which case $k_{ij} = k_{fb}$ and the communication constraint is always satisfied. Since profits under functional control are continuous in v , it follows that there exists a $\tilde{v} > 0$ such that for $v < \tilde{v}$, functional control strictly dominates functional initiative with win-win synergies.

We conclude by showing that whenever $K \leq 2\Delta_H + (\Delta_H - \Delta_L)/2$, functional control strictly dominates functional initiative for $0 < v < \tilde{v}$. Since we have already shown that functional control then strictly dominates functional initiative with win-win synergies, we only need to show that that functional control also dominates "informal" functional control, that is functional initiative where both Δ_H and Δ_L managers cooperate. As argued in the main text, the optimization problem under "informal" functional control is identical to the optimization problem under formal functional control, except for an additional acceptance constraint given by

$$\frac{1 - s_f}{2} \left(\frac{K}{2} + \frac{k_{LH}}{2} \right) > s_{bu} \Delta_H \quad (30)$$

which indicates that a Δ_H manager must be willing to accomodate a standardization effort

knowing that the functional manager initiates a standardization effort whenever $k > k_{LH}$.²⁰ Let s_f^* and s_{bu}^* be the solution to the optimization problem without this acceptance constraint, functional control then strictly dominates "informal" functional control whenever s_f^* and s_{bu}^* violate (30). Substituting k_{LH} and s_{bu}^* and s_f^* , we can rewrite (30) as

$$\frac{1}{2} \left(\frac{K}{2} + \frac{s_f^*}{1 - s_{bu}^*} \frac{\Delta_L + \Delta_H}{2} \right) > \frac{s_{bu}^*}{1 - s_f^*} \Delta_H \quad (31)$$

Since from proposition 2, $(1 - s_{bu}^*)/s_f^* \leq 1$ and hence also $s_{bu}^*/(1 - s_f^*) \geq 1$, it follows that a necessary condition for (30) to be satisfied is that

$$\frac{1}{2} \left(\frac{K}{2} + \frac{\Delta_L + \Delta_H}{2} \right) > \Delta_H \quad (32)$$

which is always violated whenever $K \leq 2\Delta_H + (\Delta_H - \Delta_L)/2$. QED.

Proposition 9: (i) *An increase in v may result in a shift from Functional Control with communication (standardization contingent on k , Δ_1 and Δ_2) to Functional Initiative (with standardization only if $\Delta_1 = \Delta_2 = \Delta_L$, win-win synergies), but never the other way around*
(ii) *An increase in v may result in a shift from Functional Control with communication (standardization contingent on k , Δ_1 and Δ_2) to Functional Control without communication (standardization contingent only on cost savings k) but never the othe way around.*

Proof: Part (ii) follows immediately from Propostion 1. We now prove (i). Applying envelope theorem, we have that

$$\begin{aligned} \frac{d\pi^{fi}(v, s_f^{fi}, s_{bu}^{fi}, \lambda^{fi})}{dv} &= \frac{\partial \pi^{fi}(v, s_f^{fi}, s_{bu}^{fi}, \lambda^{fi})}{\partial v} \\ &= s_{bu}^{fi} [2 - s_{bu}^{fi}] + s_f^{fi} (2 - s_f^{fi}) \end{aligned}$$

where (s_f^{fi}, s_{bu}^{fi}) are the optimal shares under functional initiative with communication and $\lambda^{fi} \geq 0$ is strictly positive if and only if the acceptance constraint is binding. Similarly, we have that

$$\frac{d\pi^c(v, s_f^c, s_{bu}^c, \lambda^c)}{dv} = s_{bu}^c [2 - s_{bu}^c] + s_f^c (2 - s_f^c)$$

where (s_f^c, s_{bu}^c) are the optimal shares under functional control with communication and $\lambda^c \geq 0$ is strictly positive if and only if the communication constraint is binding. Assume now that

$$s_{bu}^{fi} [2 - s_{bu}^{fi}] + s_f^{fi} (2 - s_f^{fi}) \leq s_{bu}^c [2 - s_{bu}^c] + s_f^c (2 - s_f^c)$$

²⁰The functional manager use this cut-off rule both in a pooling equilibrium and in a separating equilibrium where the other manager is a Δ_L type. If this acceptance constraint is satisfied, then a Δ_H manager will also be willing to cooperate when the other business unit manager is revealed to be a Δ_H type, and the functional manager initiates a standardization effort whenever $k > k_{HH}$.

then

$$\pi_e^{fi}(s_{bu}^{fi}, s_f^{fi}) \leq \pi_e^{fi}(s_{bu}^c, s_f^c)$$

and since $(1 - s_{bu}^{fi})/s_f^{fi} < (1 - s_{bu}^c)/s_f^c$, also

$$\pi_i^{fi}(s_{bu}^{fi}, s_f^{fi}) < \pi_i^{fi}(s_{bu}^c, s_f^c)$$

Moreover, if (s_{bu}^c, s_f^c) satisfy the communication constraint under functional control, then they also satisfy the acceptance constraint under functional initiative. Hence, $\pi^{fi}(s_{bu}^{fi}, s_f^{fi}) < \pi^{fi}(s_{bu}^c, s_f^c)$, which is impossible given that (s_{bu}^{fi}, s_f^{fi}) are the optimal shares under functional initiative. It follows that we must have that

$$s_{bu}^{fi} [2 - s_{bu}^{fi}] + s_f^{fi} (2 - s_f^{fi}) > s_{bu}^c [2 - s_{bu}^c] + s_f^c (2 - s_f^c)$$

and thus $d\pi^{fi}/dv > d\pi^c/dv$.