Organizational Structure and Market Competition

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Abstract

Managers need to be motivated to develop ideas and to share information regarding their potential to improve the competitive position of a firm. If the ideas are mutually exclusive, the firm needs to choose which alternative to implement. The decision structure may be either asymmetric, in which case conflict regarding which alternative to implement is always resolved in favor of one of the managers, or symmetric, in which case each manager has an equal likelihood of having his alternative implemented. Efficiency considerations often necessitate favoring one manager over the other, which in turn increases that manager's influence in the decision-making stage and leads the firm to build its strategy around that function, even if the players and market opportunities are ex ante fully symmetric. This result supports the argument that firms are typically better off by focusing their strategy on particular aspects of their business while struggling to do everything well. Increased competitiveness of a market may, however, increase the preference for a more balanced organization, while an initial comparative advantage in innovation leads to both better performance and a more balanced organization.

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keywords: innovation, cheap talk, incentives, organizational strategy

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1 Introduction

The links among the operating environment of a firm, its organizational structure and its market strategy have been extensively discussed in the management literature. One of the classic approaches to strategy is Porter's (1980) distinction between cost leadership and differentiation.[1] He argues that to be successful, a firm needs to focus its strategy on either creating value through low cost, or produce products that are of high quality and differentiated from the existing competition. Attempts to do both will end up having the firm stuck in the middle, achieving neither one of its goals and thus underperforming its competition.

Examples of companies that have been successful in pursuing either one of these strategies are many. For cost leadership, companies such as Southwest, Wal-Mart, Dell and Ikea have all enjoyed periods of success by focusing on minimizing their costs, while for differentiation, companies such as Unilever, Apple, FedEx and Bose have achieved success by focusing on the customer and providing high-quality products and/or exceptional customer service. But while companies have been successful in the pursuit of such strategies, the impossibility of achieving both has been increasingly questioned both in the academic literature and in practice. For example, Dell has attempted to increase its level of differentiation to sustain profitability while Unilever has reorganized its operations to contain its costs better. Indeed, a growing sentiment (e.g. Bartlett and Goshal, 1998 and Prahalad and Doz, 1987) is that to be survive in increasingly competitive environments, successful companies must find a way to do both.[2]

This paper revisits this question of organizational strategy and structure from the perspective of organizational economics, and makes two separate contributions. First, it constructs a tractable framework of a firm as a decision-making entity that captures some of the features of the decision-making process discussed in the managent literature at least since Simon (1947) and Cyert and March (1963), such as the need to aggregate information from different sources to reach good decisions, strategic misrepresentation of information, the resulting interpretive adjustment, and the roles of influence and authority in managing this process. Second, it tailors this framework to address the particular question of whether firms are better off focusing on cost leadership or differentiation instead of pursuing a more hybrid strategy, and how changes in the competitive landscape affect this tradeoff.

The firm I consider consists of a single CEO and two functional managers, to focus the analysis on the differentiation and cost tradeoff.[3] The functional managers need to first exert effort to generate new ideas. The first manager, who is responsible for sales and marketing, will generate an innovation that may increase the value of the product to the customers. The second manager, who is responsible for manufacturing, will generate an innovation that may decrease the marginal cost of production. In this stage, the managers have two choices. Their first choice is how much effort to exert, which will influence the expected likelihood that the innovation will succeed (if implemented), and their

[1] I leave aside the issue of scope as I will be dealing with a firm in a single line of business.

[2] Indeed, Porter himself has later qualified the claim of fundamental inconsistency (Porter, 1991).

[3] But of course, this is just a labeling assumption, so that the setting is clearly more broadly applicable. For example, the managers could be country managers of a multinational firm generating new products to suit their particular markets, or the like. Alternative interpretations of the model are discussed in section 7.

second choice is how likely it is that the innovations are technically incompatible with each other and thus cannot be included in the same product.

Once the alternatives have been generated, the firm reaches the decision-making stage. If the alternatives are mutually compatible, the CEO can simply implement both alternatives. But if the alternatives are incompatible, the CEO needs to decide which alternative to implement. The CEO thus faces a meaningful information aggregation problem, as the CEO wants to implement the alternative that is more likely to succeed, while the two managers are privately informed of the true potential of their individual alternatives. In this case, the CEO first invites recommendations from the managers regarding the quality of their alternatives (through cheap talk), after which the CEO makes her final decision.

To manage this task, the organization has two control instruments at its disposal. The first instrument is the compensation structure of the organizational participants, which can be conditioned both on divisional and firm-level performance. The second instrument is how conflict is resolved in the organization, which reflects the allocation of power or influence between the two managers. Conflict resolution is relevant when the ideas are mutually incompatible and the organizational members fail to reach a consensus on which alternative to implement. Two alternatives for conflict resolution arise in equilibrium. In a *symmetric* organization, the CEO resolves conflict democratically, with each competing alternative equally likely to be implemented. In an asymmetric organization, on the other hand, conflict is always resolved in favor of one of the managers. For example, if the sales and manufacturing managers both claim to have excellent ideas for implementation, the CEO resolves conflict in favor of the sales manager.[4]

This conflict resolution strategy is the first determinant of the relative real authority of the two managers, in terms of the likelihood that their idea is actually chosen for implementation. Clearly, favoring one manager in the case of conflict clearly increases his power relative to a balanced organization, other things constant. As a result, the more influential manager becomes both more precise in his recommendations and more motivated to generate valuable ideas, while the opposite occurs for the less influential manager. The initial conflict resolution strategy is thus amplified by making the favored manager a better and more credible source of ideas, increasing his relative influence, or what Simon (1947) called the authority of expertise.

But while the conflict resolution strategy plays a role in influencing the relative position of the managers, any idea that everybody believes to be good enough will be implemented, independent of the source of that idea. Thus, the second key element is the compensation structure of the managers, which determines their incentives to come up with ideas in the first place. This observation then implies that while an organization may be asymmetric in terms of their formal influence, the allocation of real authority may be relatively balanced. Such an outcome will arise if the favored manager is provided with relatively balanced incentives, so that he is willing to entertain all alternatives as long as they are good enough, while the less influential manager is strongly motivated through monetary means.

[4] If, on the other hand, the sales manager claims that his idea is excellent while the manufacturing manager concedes that his idea is only mediocre, then all organizational members agree that they should implement the sales manager's alternative.

The main result from the analysis of the conflict resolution strategy is that an asymmetric structure is generally preferred, even if the organization desires the same levels of effort from the two managers. The intuition behind this result is as follows. In a balanced organization, to achieve information sharing the the case of conflict, both managers need to be at least partially aligned with each other. But introducing profit-sharing is costly because it allows each manager to benefit from the implemented ideas of the other manager. In an asymmetric organization, it is important to align the favored manager with profit-maximization because of his larger influence in the decision-making stage, but it is less important to align the second manager. Thus, to motivate the less favored manager, the organization can rely on conflict as a motivational tool, thus avoiding free-riding incentives.[5] This result thus provides support for Porter's argument that a firm is generally better off focusing on either cost minimization or value maximization, while struggling to do both.

The key caveat to the above argument is, however, that it only relates to formal influence (one function has primacy), not on the equilibrium level of relative real authority, as discussed above. In particular, a manufacturing manager, who does not have a seat on the executive committee and is compensated only based on cost control, can still have considerable real authority if he feels that his opinions are listened to and his alternatives are implemented, as long as they are good enough.

To examine the more nuanced picture of relative real authority and how it is shaped by the competitive landscape, I embed this model of a firm on a Hotelling line competing against another similar firm. I then consider how both the relative efficiency of the two firms in terms of generating new innovations and the degree of substitutability between the products (both measures of competitiveness) influence the optimal organizational structure.

The results that follow from this stage of the analysis are two-fold. First, decreasing the degree of product differentiation may either increase or decrease the relative influence of the two functions. The reason for this ambiguity is the presence of two competing forces. On one hand, an increase in competitiveness may increase or decrease the *absolute* return to innovation, where a decrease in the absolute value of innovation encourages the firm to specialize on one of the functions to economize on innovation costs. This force thus encourages specialization as argued by Porter. On the other hand, an increase in competitiveness increases the convexity of the profit function and thus the *relative* importance of achieving successful innovations in both functions over a single success, which leads the firm to motivate its managers to pursue more compromise innovations that can be implemented together. This force thus highlights that competition increases the relative value of being good at both and thus supports the pursuit of more hybrid strategies, as argued by Bartlett and Goshal, among others. In equilibrium, either effect can dominate.

Second, the results highlight a potential reverse causality that will be a challenge for any empirical work attempting to correlate performance with strategy. In particular, the firm that has a comparative advantage in innovation will be both more profitable and more balanced allocation of real influence. The reason for this result comes again from the convexity of the profit function in both value and cost advantages, which implies that it is more valuable to succeed in both than it costs to fail. Therefore, a market leader, who is more likely to come up with profitable innovations, will

[5] It is, however, important to note that this result relies on the fact that the organization can freely optimize its compensation structure to manage this task only.

find investing in those innovations more valuable than another firm. And because the innovations are more valuable, the firm will pursue them in a more balanced fashion.

The reminder of the paper is organized as follows. Section 2 reviews the related literature and section 3 outlines the model. Section 4 contains some preliminary observations regarding the basic tradeoffs. Section 5 derives the equilibrium of the internal organization and section 6 considers the impact of the competitive environment on the optimal organizational structure. Section 7 contains some further observations regarding the framework and section 8 concludes.

2 Related Literature

This paper integrates aspects of several strands in the growing literature on organizational economics. The first strand is the literature on organizational focus, where the papers most closely related to the present work are Rotemberg and Saloner (1994), who show how a firm can be more profitable by focusing on a narrow set of activities, and Rotemberg and Saloner (2000), who illustrate how the firm may do even better by having a CEO that is biased in favor of one of the activities, coupled with unbiased middle management that guarantees that potentially profitable alternatives are investigated even if they don't fall under the CEO's vision. The reason for the value of organizational focus (and managerial vision) in both models is that it can increase employee incentives to come up with new ideas by increasing the likelihood that such ideas will eventually be implemented.

The present framework shares the basic organizational task of creating new ideas, and allocating influence to one manager will increase his incentives to come up with new ideas. The key qualitative difference in the approaches is that the distortion driving the value of focus in the framework of Rotemberg and Saloner is that the principal may reject an alternative because the net value of that alternative is less than the compensation promised to the agent. In most firms, however, pay is mainly conditioned on firm performance and all organizational members will earn more when the organization performs better. Thus, I allow for performance-based contracts for all parties and eliminate the potential distortion in the ex post implementation decision. Another key difference is that asymmetric influence arises in the present model as an equilibrium outcome simply through endogenous adjustments in the equilibrium information structure, and does not require either a biased CEO or the elimination of a particular activity from the organization.

Organizational focus is analyzed also in Dessein, Galeotti and Santos (2012), who consider a team-theoretic setting where the precision of information transmission is limited by the attention allocated to agents. Allocating more attention to one agent allows that agent to be more adaptive in his decisions because the attention given improves how well the rest of the organization is coordinated with that decision. The story is thus informational instead of motivational, as in Rotemberg and Saloner framework. The present model also contains a similar mechanism, in that the favored function will be more influential in the final decision, which induces more precise sharing of private information, other things constant. In the current setting, however, this mechanism arises from the strategic interaction between the agents instead of exogenous limits on attention. Further, the communication equilibrium exhibits an important complementarity between the two sources of information, in that improving the quality of one source also improves the quality of the other source.

Finally, organizational focus, broadly interpreted, is also discussed in Van den Steen (2005). In his framework, managerial vision leads to both sorting, in that employees who agree with the manager's vision self-select to the firm, and incentive effects, where workers aligned with the manager's vision work harder because they find it more likely that their projects will be implemented and ultimately succeed. His setting, however, relies on differing priors while the present framework is framed in a common-priors framework.

The second relevant strand examines the benefits of conflict (in organizations and other settings). Here, the papers closest to the present setting are Dewatripont and Tirole (1999) and Rotemberg and Saloner (1995), in that in all papers, multiple agents provide information for a single decision that needs to be made by the organization. The key differences are two-fold. First, I allow for output-based contracts, whereas Dewatripont and Tirole allow compensation to depend only on the decision made, while Rotemberg and Saloner take the compensation structure to arise through interaction with the labor market, which is directly outside the control of the firm. Second, I allow for the information acquired to be soft, which limits the benefits of conflict between the agents as a motivational tool. Some conflict will, however, be maintained in equilibrium because of its motivational benefits. Indeed, in contrast to Rotemberg and Saloner, if information was verifiable in the present setting, a balanced organization will typically be optimal.[6] However, once we introduce strategic communication, asymmetric treatment of the managers arises as an additional tool for motivating idea generation.[7] Papers that touch upon the motivational issues of information acquisition in committees include Li (2001), Persico (2004) and Gerardi and Yariv (2008), which all highlight how shared preferences lead to free-riding in information acquisition, and how the committee structure and the decision rule can be manipulated to balance this tension. They, however, assume shared goals and focus on commitment to decision rules, whereas I assume ex post incentive-compatible decision-making but with preferences manipulated through the compensation structure of the agents.

Third, the strategic communication stage is related to the large literature on cheap talk that has followed Crawford and Sobel (1982). The basic framework itself is adapted from Rantakari (2012, 2013), but which focus on very different questions (effects of uncertain agent bias and the decision-maker's ability to engage in independent ex post evaluation of the alternatives, respectively) and take the extent of conflict between the agents as exogenous. Other related papers are Li, Rosen and Suen (2001), Wolinsky (2002) and Krishna and Morgan (2001), in that the goal is to aggregate the information of different parties to reach a single decision. Li, Rosen and Suen analyze a collective choice problem analogous to the present one, but with correlated information and focusing on a two-element partition. In Wolinsky, the agents have independent pieces of information, as here, but in his framework the experts share preferences with each other, allowing them to share information with each other truthfully, while in my setting the agents' preferences are in conflict both with each

[6] The fact that compensation is endogenous, there can never be excessive conflict, which is what focus manages in their paper.

[7] For motivating the acquisition of two pieces of information for a single decision, see also Gromb and Martimort (2007).

other and the principal. The independence of the pieces of information is also the key difference to Krishna and Morgan, which prevents the principal from cross-checking the recommendations, which is at the heart of their model.[8] Multiple sources of information are also at the heart of the coordinated adaptation framework of Alonso, Dessein and Matouschek (2008) and Rantakari (2008), but the key difference to their setting is that the value of one source of information is independent of the information regarding the other dimension, so that there is no interaction between the sources of information, which is at the core of the present framework. Also, by focusing only on the strategic communication stage, this strand takes the preferences of the agents as exogenous and assumes the presence of conflict, whereas here the extent of conflict arises as an equilibrium outcome.

Fourth, the basic tension in the framework is the tension between motivating idea generation and then to share that information, and the question is how compensation contracts and the organizational structure manage that conflict. Papers that have considered such multitasking frameworks with similar basic tensions and the joint effect of incentives and the organizational structure on that tension Athey and Roberts (2001), Friebel and Raith (2010), Dessein, Garicano and Gertner (2010) and Rantakari (2011). In Athey and Roberts, the tension is between effort provision and project choice, in Friebel and Raith the tension is between generating valuable investment opportunities and then being truthful regarding their value, in Dessein, Garicano and Gertner the tension is between productive effort and a synergy implementation choice, and in Rantakari the tension is between motivating information acquisition and then sharing that information truthfully. The present framework examines the tension between motivating idea generation and then sharing information regarding the value of those ideas, similar to Friebel and Raith, but focuses on the role of conflict resolution and the competitive implications of the organizational design.

Finally, as one of the goals of this paper is to begin replacing the black box of a firm in industrial organizations with a model of an organization and analyze the consequences of firm organization to market outcomes, this paper is related to Alonso, Dessein and Matouschek (2012) and Gibbons, Holden and Powell (2012), among others. The models themselves are, however, quite different, with Gibbons, Holden and Powell considering a property-rights model of the firm, so that only asset ownership is ex ante contractible, while Alonso, Dessein and Matouschek consider a problem of coordinated adaptation with exogenous conflict. In contrast, here a key determinant for the equilibrium comparative statics is the endogeneity of the compensation contracts and thus the incentives of the organizational participants.

3 Model

The firm I consider consists of three players, a CEO (she) and two managers (he). For concreteness, I will associate the two managers with sales (s) and manufacturing (m). The two managers need to first exert effort to generate ideas that can improve the competitive position of the firm. By their

[8] See also Battaglini (2002) on information aggregation with multiple fully informed senders and multidimensional decisions.

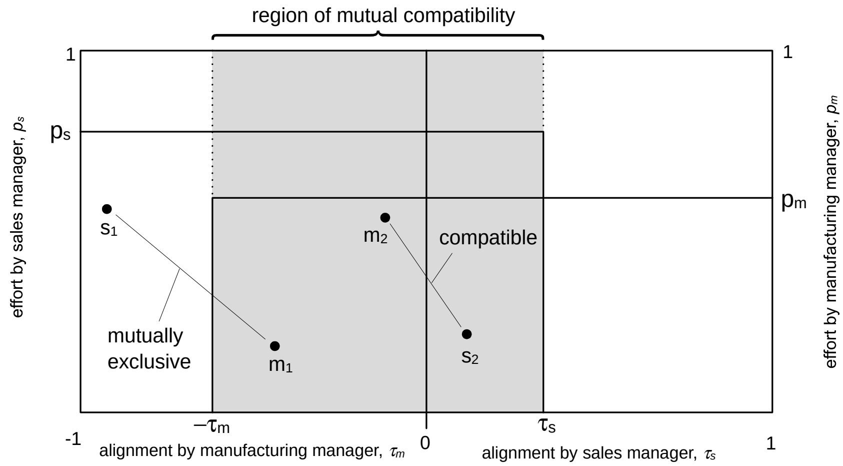

Figure 1: The structure of the idea generation process

proximity to the customers, I assume that the sales manager is able to generate an innovation that may increase the value of the product to the customers, while the manufacturing manager is able to generate an innovation that will lower the cost of producing the product in question.

Each innovation generated is characterized by two parameters that are influenced by the respective managers. The first is the likelihood that the innovation, if implemented, will actually be successful. This likelihood is ex ante uncertain but influenced by managerial effort. In particular, I assume that by exerting effort p_i, the likelihood of success is drawn from the uniform distribution on $[0, p_i]$. The second parameter is whether the two ideas are mutually compatible. This element captures the idea that, depending on the particular innovations, it may be possible to integrate them both in the same product and thus achieve the benefits of a more attractive product at a lower cost, or they may be mutually incompatible, in which case the firm needs to choose which innovation to implement.[9]

To capture this compromise in a parsimonious way, I assume that each manager chooses a degree of compromise $\tau_i \in [0,1]$, with the likelihood that the ideas are mutually compatible given by $\left(\frac{\tau_m+\tau_s}{2}\right)$. The key tradeoff in the idea generation stage is that compromise is costly. In other words, increasing the likelihood of mutual compatibility increases cost of generating ideas. I capture this by assuming that the cost of idea generation is given by $C(\tau_i, p_i)$, where $\frac{\partial^2 C(\tau_i,p_i)}{\partial \tau_i \partial p_i} \geq 0$ and which satisfies all the other usual conditions, in particular that $\lim_{x\to 0} \frac{\partial C(\tau_i,p_i)}{\partial x} = 0$ and $\lim_{\to 1} \frac{\partial C(\tau_i,p_i)}{\partial x} \to \infty$ for $x \in \{\tau_i, p_i\}$.

A simple framework for this idea generation structure is as follows and illustrated in figure 1. The type of innovation generated by the sales manager is uniformly distributed on $[-1, \tau_s]$, while the type of innovation generated by the manufacturing manager is uniformly distributed on $[-\tau_m, 1]$. The realized ideas are mutually compatible if the realized type of both ideas falls on the overlapping part of the supports. Each manager chooses their effort level, p_i, which determines the expected

[9] Because the managers are fundamentally in charge of the idea generation, I assume that they can also control the likelihood that their idea is compatible with the other idea.

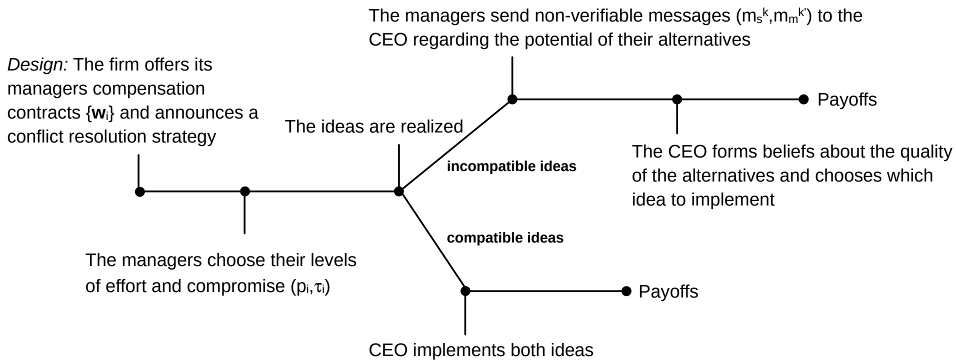

Figure 2: Sequence of events

success probability of their idea, and the degree of compromise, τ_i. If both of the realized innovations fall in the region of mutual compatibility (such as (s_2, m_2)), the CEO can integrate both innovations into a single product, while if one or both of the ideas fall outside this region (such as (s_1, m_1)), the CEO needs to choose which alternative to implement.

Once the alternatives have been generated, all organizational participants learn whether the innovations are mutually compatible or not. This assumption reflects the observation that, once generated, all organizational members would prefer to integrate the innovations to maximize the value realized, and it is prevented only when the ideas are truly incompatible. The realized potential of the ideas is, however, private information to the manager who generated the idea. This assumption reflects the idea that the manager who generated the new innovation will be in the best position to evaluate its true potential due to his expertise and may have incentives to misrepresent that information.

Next, the CEO must decide which alternative(s) to implement. For simplicity, I assume that the implementation is free, so that when the ideas are mutually compatible, the CEO will implement both and the payoffs are realized. If the ideas are incompatible, then the CEO faces an information aggregation problem to decide which alternative to implement. To this end, she elicits cheap talk messages from the two managers regarding the quality of their alternatives, forms beliefs regarding which alternative is better and then makes the final choice. I assume that the implementation decision must be ex post incentive compatible, so that if the CEO believes that one alternative is better, she will implement that alternative. But when the CEO does not know, then the alternatives remain in conflict and the CEO needs to decide on a tie-breaking rule. In equilibrium, two alternatives present themselves. In a *balanced* organization, the conflict is resolved with a coin flip, with each of the competing alternatives having an equal likelihood of implementation. In an *asymmetric* organization, conflict is always resolved in favor of one of the managers. Finally, once the implementation decision is made, the organizational profits are realized and compensation payments are made. This sequence of events is summarized in figure 2.

Payoffs: The remaining element is to describe to payoffs to the firm and to the managers. Given that each innovation either succeeds or fails, we can write the profit levels of the firm as

$$\pi_i(R_G, C_G) > \pi_i(R_G, C_B) = \pi_i(R_B, C_G) > \pi_i(R_B, C_B),$$

where the subscript $\{G, B\}$ reflects whether the innovation was successful or not in the revenue and cost dimensions. For simplicity, I assume that the value of a single success is the same independent of the function, so to simplify the notation further, I let these three realized profit levels to be $\pi_i^H > \pi_i^M > \pi_i^L$. These profit functions will arise as a part of the competitive equilibrium derived in section 6, so I will not make any additional assumptions on their relative magnitude, except that successes are weakly complementary: $\pi_i^H + \pi_i^L - 2\pi_i^M \geq 0$.

The organizational participants are solely motivated by their monetary compensation, and they are protected by limited liability with the outside option normalized to zero. Given that the CEO plays only a limited role in the analysis, I will simply assume that the goal of the CEO is to maximize gross profits. For the functional managers, the compensation contract consists of four different wages based on the combination of successes and failures across the two functions. Let $w_{G,G,i}$ denote the pay to manager i in case of success in both functions, and $w_{G,B,i}$ and $w_{B,G,i}$ denote the payments in the case of a success in own and the other function, respectively. Given limited liability, $w_{B,B,i} = 0$ in equilibrium, so that the managers receive no compensation in the case of mutual failure.

Design: The goal of organizational design is then to choose the six wages $(\mathbf{w}_s, \mathbf{w}_m)$ and the conflict resolution strategy to maximize expected net profits $E(\pi_i - w_s - w_m)$ subject to the PBNE of the game described above.

4 Preliminaries

Before considering the solution to the organizational outlined above, it is instructive to consider the first-best solution, which would arise if the firm could perform the idea generation directly. To understand the equilibrium performance of the firm, we can consider it in two stages. First, if the ideas are compatible, both ideas can be implemented and, given that the expected success probability of each idea is then $E(p_i) = \frac{p_i}{2}$, we can write the expected performance of the organization as

$$\Pi^C(p_s, p_m) = \tfrac{1}{4}\left(p_s p_m\left(\Delta\pi^H - 2\Delta\pi^M\right) + 2(p_s + p_m)\Delta\pi^M\right) + \pi^L,$$

where $\Delta\pi^M = \pi^M - \pi^L$ and $\Delta\pi^H = \pi^H - \pi^L$. Note that this component is symmetric in its arguments and exhibits complementarity in efforts as long as the profit function is weakly convex, as assumed. Second, if the ideas are incompatible, the organization chooses to implement the better of the two ideas. Assuming that $p_s \geq p_m$ to identify the dimension that the firm works (weakly) harder to improve, we get that the expected payoff in this case is given by

$$\Pi^{IC}(p_s, p_m) = \tfrac{1}{2}\left(p_s + \tfrac{1}{3}\tfrac{p_m^2}{p_s}\right)\Delta\pi^M + \pi^L.$$

In other words, when only one alternative can be implemented, only one function can succeed.

Note that in the case of incompatibility, the two efforts are strategic subsitutes. In other words, the more the firm invests in developing an innovation that is attractive for the customers, the less likely it becomes that the cost-reducing innovation will be implemented, and vice versa.

Given the expected profit levels following compatible and incompatible innovations, we can then write the expected payoff to the organization as

$$\Pi = \left(\frac{\tau_s+\tau_m}{2}\right)\Pi^C\left(p_s,p_m\right) + \left(1-\frac{\tau_s+\tau_m}{2}\right)\Pi^{IC}\left(p_s,p_m\right) - C\left(\tau_s,p_s\right) - C\left(\tau_m,p_m\right),$$

from where it is then straightforward to take the first-order conditions for the effort and compatibility choices. First, considering the effort levels, we have that they solve

$$p_s : \left(\frac{\tau_s+\tau_m}{2}\right)\frac{\partial\Pi^C(p_s,p_m)}{\partial p_s} + \left(1-\frac{\tau_s+\tau_m}{2}\right)\left[\frac{1}{2}\left(1-\frac{1}{3}\left(\frac{p_m}{p_s}\right)^2\right)\right]\left(\pi^M-\pi^L\right) = \frac{\partial C(\tau_s,p_s)}{\partial p_s}$$
$$p_m : \left(\frac{\tau_s+\tau_m}{2}\right)\frac{\partial\Pi^C(p_s,p_m)}{\partial p_m} + \left(1-\frac{\tau_s+\tau_m}{2}\right)\frac{1}{3}\frac{p_m}{p_s}\left(\pi^M-\pi^L\right) = \frac{\partial C(\tau_m,p_m)}{\partial p_m},$$

while for the compatibility, we have that

$$\tau_i : \frac{1}{2}\left[\Pi^c\left(p_s,p_m\right) - \Pi^{IC}\left(p_s,p_m\right)\right] = \frac{\partial C(\tau_i,p_i)}{\partial \tau_i}.$$

Two observations follow. First, since the marginal return to compatibility is the same across the tasks, while the marginal cost is increasing in the equilibrium effort level, we have that $\tau_s = \tau_m$ if $p_s = p_m$ and $\tau_s < \tau_m$ if $p_s > p_m$. Intuitively, if the organization wants to have equal effort levels in the two tasks, then it is also optimal to split the level of compromise evenly between the two tasks to minimize total effort costs. On the other hand, if $p_s > p_m$, so that the firm invests more in one of the tasks, then compromise is relatively more costly for that tasks and thus it is optimal for the organization to accommodate investment in that task by disproportionately placing the costs of compromise on the other task.

The remaining question is then what the optimal effort levels will be. As discussed above, if the ideas are mutually compatible, the effort levels are (weak) complements and this supports equal effort levels. If the ideas are in conflict, then the effort levels are imperfect substitutes. The question of whether the maximum will then be asymmetric or symmetric will depend on the convexity of the cost function. If the cost function is convex enough, then the optimal effort levels will be symmetric even if the ideas are in conflict with probability one. On the other hand, if the cost function is flat enough, then the optimum will exhibit an asymmetry. Finally, note that since the value of the complementarity is increasing in the baseline effort level, symmetric effort levels are more likely to be optimal when the cost of effort is small.

An illustration of the optimal information acquisition and compromise is provided in figure 3, which uses as parameterization $C\left(\tau,p\right) = c\left(1-\left(\tau+\ln\left(1-\tau\right)\right)\right)\left(p+\ln(1-p)\right)$, which guarantees an interior solution for the maximization problem for both choices. As discussed, when the cost of information is suffiently low, then the optimal strategy is to be balanced and choose a high level of compromise to utilize on the opportunity to obtain mutual success. As information becomes more expensive, the effort levels decrease and so does the value of compromise, so the firm economizes

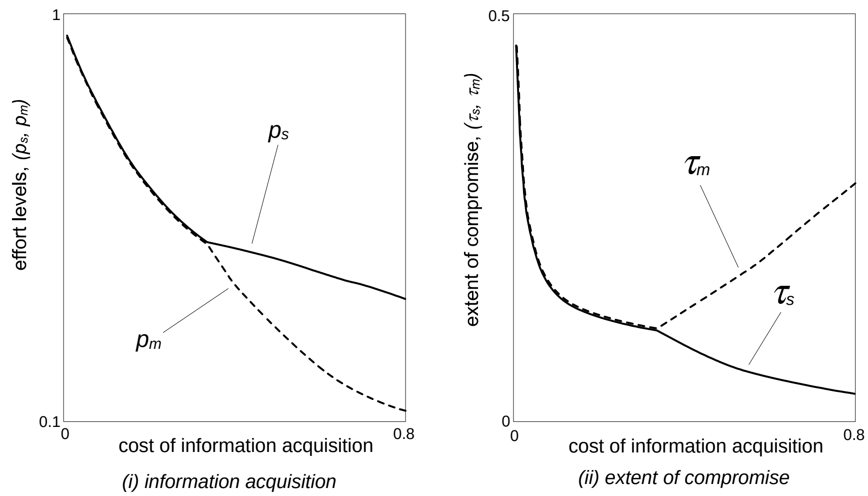

Figure 3: An illustration of the first-best outcome, $g = 1$.

on idea generation costs by reducing the level of compatibility. Finally, when information becomes sufficiently costly, the firm starts to focus increasingly only on one of the tasks. The effort levels diverge, and to support this divergence, the organization continues to reduce the compatibility of the favored task while increasing the compatibility of the other task. In other words, an increase in the cost of information takes the organization from a balanced one to one that is increasingly focused on one of the functions. This basic pattern is retained even once we introduce the strategic behavior by the organizational participants.

5 Organization

Having outlined the basic production technology itself, we can now consider the solution to the agency problem itself, which follows through backward induction. We thus begin with the decision-making stage, which is at the heart of the present framework. In this stage, the managers have generated their alternatives and make strategic recommendations to the CEO. Having solved the decision-making stage, we can then consider the incentives to generate the alternatives and how organizational performance will depend on the compensation structure and the conflict resolution strategy adopted by the firm. In the next section, we will embed this organization to compete against another similar firm on a Hotelling line and consider how changes in the competitiveness of the market impacts the equilibrium structure of the firm.

5.1 Communication and decision-making

Having exerted the efforts (p_s, p_m) , the managers learn the potential of their ideas, which I will denote by (θ_s, θ_m) . If the ideas are mutually compatible, the CEO will simply implement both alternatives and the expected payoffs are realized. If the ideas are incompatible, however, the CEO needs to make a decision which of the two alternatives to implement. It is this decision that is at the heart of the present model.

In this stage of the game, the CEO elicits recommendations from the managers to aggregate information and then chooses which recommendation to follow. To model this communication game, I follow Crawford and Sobel (1982) and the literature that has followed by assuming that each manager has access to a countably infinite set of messages $\{m^k\}$ that they can send to the CEO. Having received the messages $m_s^{k'}$ and m_m^k from the two managers, the CEO forms beliefs $E\left(\theta_s|m_s^{k'}\right)$ and $E\left(\theta_m|m_m^k\right)$ regarding the viability of the two alternatives and makes the final choice, with $d \in \{s, m\}$. I take k to index the strength of the claim in favor of each of the alternatives, so that $E\left(\theta_s|m_s^k\right) > E\left(\theta_s|m_s^{k'}\right)$ if $k > k'$, while, as we will see, the comparison across the managers will arise as a part of the equilibrium. I also assume that the decision rule of the CEO must be ex post incentive compatible, so that if $E\left(\theta_s|m_s^{k'}\right) > E\left(\theta_m|m_m^k\right)$, she will implement the sales manager's alternative and vice versa. Below we will return to what the CEO can do in the case of $E\left(\theta_s|m_s^{k'}\right) = E\left(\theta_m|m_m^k\right)$.

Given the interpretation of the messages and the resulting decision rule of the CEO, we can then write the expected compensation of manager s, conditional on the message m_s^k as

$$EU_s = \theta_s E\left[\Pr(d = s|m_s^k, m_m^{k'})\right] w_{G,B,s} + E\left[\Pr(d = m|m_s^k, m_m^{k'})\right] E\left(\theta_m|d = m\right) w_{B,G,s},$$

where $w_{G,B,s}$ and $w_{B,G,s}$ are the wages paid to the manager in the case of success in his own function and success in the other function, respectively. In short, the manager believes that his innovation will succeed with probability θ_s, the chosen message induces an expected acceptance probability of $E\left[\Pr(d = s|m_s^k, m_m^{k'})\right]$, and the manager receives in the case of a success a wage $w_{G,B,s}$. Similarly, with expected probability $E\left[\Pr(d = m|m_s^k, m_m^{k'})\right]$, the CEO will implement the other manager's alternative, which succeeds with expected probability $E\left(\theta_m|d = m\right)$ and the manager receives a wage $w_{B,G,s}$. The manager will then choose his message to solve $m_s^k = \max_{m^k} EU_s$.

Given this basic structure for decision-making and communication, the equilibrium communication strategy takes a familiar partition structure, where each message m_i^k only reveals that the beliefs are within a given interval: $m_i^k \to \theta_i \in [\theta_i^{k-1}, \theta_i^k]$. This partition structure follows directly from the supermodularity of the manager's expected payoff in the strength of his belief θ_s and the probability of acceptance. The stronger his belief that the innovation will yield a good outcome, the more valuable inducing acceptance becomes.[10] The thresholds of the partition are then given by the familiar indifference condition, where the type θ_i^k is just indifferent between sending the messages m_i^k and m_i^{k+1}.

[10] This structure is elaborated more in Rantakari (2012,2013).

Without even considering the indifference condition itself, from the manager's expected payoff it is clear that the first key determinant for the precision of communication is the difference between the wages $w_{G,B,s}$ and $w_{B,G,s}$. If $w_{B,G,s} = 0$, so that the manager is paid only when his function performs well, no informative communication is possible because his payoff will always be weakly higher if his alternative is implemented, and he will thus always claim his alternative is as good as possible. However, once $w_{B,G,s} > 0$, the manager may be willing to concede the debate to the other manager if his alternative is sufficiently bad. As $(w_{G,B,s} - w_{B,G,s})$ decreases, the manager becomes increasingly forthcoming with his private information.

This effect of alignment on the precision of cheap talk is familiar from all models of cheap talk. But the second key element, which is how the CEO resolves any remaining conflict in the organization, is to my knowledge unique to this framework. In particular, while the requirement of incentive compatibility implies that the manager will follow the alternative for which stronger evidence is presented, when $E\left(\theta_s|m_s^{k'}\right) = E\left(\theta_m|m_m^k\right)$, the CEO is indifferent between the two alternatives and can implement different tie-breaking rules. I will call the organization *symmetric* if the CEO breaks ties democratically, with each manager having an equal likelihood for having their alternative implemented. I will call an organization *asymmetric* if the CEO systematically breaks ties in favor of one of the managers.

The nature of the resulting communication equilibria is illustrated in figure 4. Panel (i) illustrates the communication equilibrium under a symmetric organization. If the messages sent don't match, then the alternative for which a manager makes a stronger case for implementation is chosen. Essentially, the organization reaches a consensus, with the other manager conceding that the other alternative is truly better.[11] If the messages match, so that the managers remain in conflict over which alternative to implement, the CEO chooses either alternative with equal probability.

Note that for this structure to be an equilibrium, it must indeed be the case that $E\left(\theta_s|m_s^k\right) = E\left(\theta_m|m_m^k\right)$ for all k. To achieve this, in addition to the democratic tie-breaking rule, the compensation structure of the managers must be symmetric as well. This is required for two reasons. First, suppose that the extent of alignment between the managers was different. Then, suppose that the CEO expects the thresholds to be the same, $\theta_m^k = \theta_s^k \ \forall k$. But if the less biased manager is indifferent at this threshold, the more biased manager will strictly prefer sending the higher message, negating the equilibrium.[12] Second, suppose that the supports p_m and p_s will be different due to different incentives to acquire information. Then, it is again clearly impossible to construct a partition for which $E\left(\theta_s|m_s^k\right) = E\left(\theta_m|m_m^k\right)$ for all k.[13] But when the agents are symmetric in terms of their expected payoffs, and they are treated symmetrically in the case of conflict, we can construct an equilibrium where the assumption holds.

Instead of breaking ties in a balanced fashion, the CEO might just as well favor one of the

[11] By revealed preference, the other manager could have sent a stronger claim in favor of their alternative and chose not to. Thus, all organizational participants prefer the chosen alternative.

[12] It may be possible to find a sequence of mixing probabilities that will restore a balanced equilibrium, but that equilibrium requires favoring the more biased manager, which will be detrimental to information transmission. See Rantakari (2012) for additional discussion.

[13] Indeed, the fact that one alternative will be strictly preferred over the other for some pair of "equal" messages makes constructing an equilibrium with some balance impossible. The reason is that the asymmetric treatment of that message induces different thresholds for sending that message, which then negates the ability of achieve $E\left(\theta_s|m_s^k\right) = E\left(\theta_m|m_m^k\right)$ for the lower messages as well.

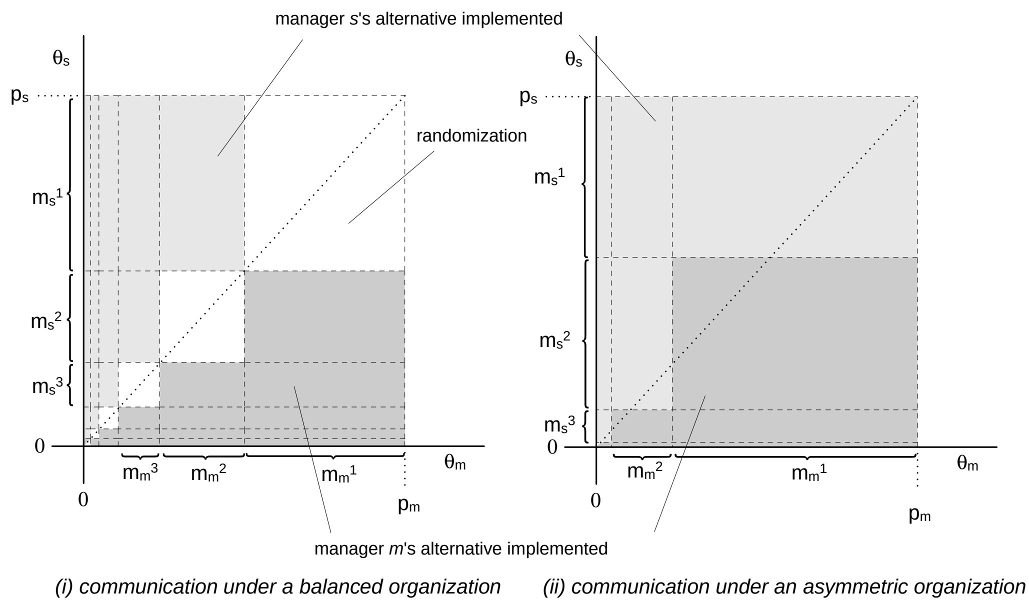

Figure 4: Communication equilibria under alternative decision-making structures

managers, since her beliefs are such that she is indifferent between the two alternatives. So suppose that the CEO begins to favor the sales manager. The implication of this change in balance is that, since the sales manager now knows that he will be more influential in the final decision, he becomes more conservative in his recommendations, increasing the precision of his communication. Correspondingly, the manufacturing manager, who is now less influential in the final decision, becomes less conservative in his recommendations. Starting from the symmetric equilibrium, such favoritism then makes the sales manager a strictly more credible source of information, so that $E\left(\theta_s|m_s^k\right) > E\left(\theta_m|m_m^k\right)$ and the only resulting incentive-compatible response to the CEO is to pick the sales manager's recommendation in the case of conflicting messages. This is the reason why an asymmetric allocation of influence is self-confirming in the present model: by favoring one of the functions, that function becomes a more credible source of information, confirming the initial favoritism. This communication equilibrium is illustrated in panel (ii).

Deriving the equilibrium of the two communication games is then just a simple exercise in algebra. The only additional observation is that the communication game itself has naturally multiple equilibria, of which the babbling equilibrium in which no information is transmitted is one. But because both the senders and the receiver prefer maximal information transmission in their relationship, I will follow the standard approach in the literature and focus on the most informative partition of each of the cheap talk games. These partitions are summarized in the following proposition:

Proposition 1 ***Communication equilibria in the organization:***

Suppose that $p_s = p_m = \overline{p}$, so that both symmetric and asymmetric communication equilibria exist. Then, *(i) Under the symmetric structure, the thresholds of the most informative partition are given by*

$\theta^n = \alpha(x)^{n-1}\,\overline{p}$, *with* $n \in \{1, ..., \infty\}$,

where $\alpha(x) = \frac{x}{1+\sqrt{1-x^2}}$, *with* $x = \frac{w_{B,G,i}}{w_{G,B,i}} \in [0,1]$, *the degree of incentive alignment between the managers.*

(ii) Under the asymmetric structure, the thresholds of the most informative partition are given, for the favored and non-favored managers, respectively, by

$\theta_s^n = \alpha(y)^{n-2}\left(\frac{1+\alpha(y)}{2}\right) x_s p_m$ *and* $\theta_m^n = \alpha(y)^{n-1}\, p_m$,

where $\alpha(y) = \frac{y}{\left(1+\sqrt{1-y}\right)^2}$, *with* $y = x_s x_m = \frac{w_{B,G,s}}{w_{G,B,s}}\frac{w_{B,G,m}}{w_{G,B,m}}$ *the degree of incentive alignment between the managers.*

(iii) Suppose that $x_s = x_m = x$. *Then, the thresholds in the asymmetric communication equilibrium relate to the thresholds of the symmetric communication equilibrium through* $\theta_m^n = \alpha(x)^{2n-2}\,\overline{p}$ *and* $\theta_s^n = \alpha(x)^{2n-3}\,\overline{p}$ $\forall n \geq 2$ $(\theta_s^1 = \theta_m^1 = \theta^1 = \overline{p})$.

Proof. See Appendix A.1 ■

This proposition formalizes the intuitive discussion of the communication equilibria from above. The key determinant for the precision of communication, in both the symmetric and asymmetric cases, is the extent to which the managers are aligned with each other, as measured by $x_i = \frac{w_{G,B,i}}{w_{B,G,i}}$ as the ratio in the compensation between success in the own function and success by the other manager, respectively. As $x_s, x_m \to 1$, the managers' interests become perfectly aligned and communication becomes perfect, while as $x_s, x_m \to 0$, the managers come to care only about their functions and no information flow is possible. This precision is captured by the function $\alpha(.) \in [0,1]$, with $\alpha(.) \to 1$ implying perfect communication.

Part (ii) of the proposition contains the key insights regarding how the two managers' incentives to share information interact, with the relative conflict $y = x_s x_m$ as the key determinant. The reason why the bias of the other manager also enters as the determinant for the precision of communication between the manager and the CEO is that the incentives to exaggerate arise not only from the desire to have one's idea implemented, but also from preventing the other manager's idea from being implemented. If the other manager becomes more aggressive in his communication strategy, in that he makes strong claims in favor of even mediocre projects, the first manager will counter this by increasing his own degree of exaggeration. This complementarity between the communication strategies of the two managers leads to two observations.

First, part (iii) of the proposition completes the discussion for the adjustment that occurs once we move from a symmetric to an asymmetric communication structure while maintaining a symmetric compensation structure. Above, we already suggested the first effect of asymmetric influence, with the favored manager becoming more precise in his recommendations while the other manager becoming less precise. But then, the complementarity implies that the fact that the less influential manager is now less forthcoming with his private information, the favored manager will also be less forthcoming. The proposition shows that the equilibrium adjustment is such that the asymmetric structure ends up exactly replicating the the symmetric communication equilibrium in terms of the information content of the partition, but with the favored manager as the more reliable source of information.

Second, and more importantly for the present analysis, using an asymmetric compensation structure we can actually improve the overall flow of information. In particular, increasing x_s and decreasing x_m while holding $y = x_s x_m$ constant improves the flow of information by holding the communication strategy of the less influential manager constant while improving the precision of communication by the more influential manager. It is this benefit of asymmetric compensation structures that is the key ingredient behind the preference for an asymmetric organization in equilibrium.

5.2 Information acquisition and compromise

Having derived the equilibrium of the communication game following incompatible ideas, we can now consider the incentives of the managers to acquire information and the extent to which they will pursue ideas that can be compatible with each other.

If the ideas are mutually compatible, the CEO will implement them both and the payoff to manager s (and symmetrically for manager m) is thus

$$EU_s^C(\mathbf{p}, \mathbf{w}_i) = \tfrac{1}{4}\left(p_s p_m \left(w_{G,G,s} - w_{G,B,s} - w_{B,G,s}\right) + 2p_s w_{G,B,s} + 2p_m w_{B,G,s}\right)$$
$$= \tfrac{1}{4}\left(p_s p_m \left(w_{G,G,s} - (1 + x_s)\, w_{G,B,s}\right) + 2\left(p_s + x_s p_m\right) w_{G,B,s}\right),$$

which occurs with probability $\left(\frac{\tau_s+\tau_m}{2}\right)$. With the complementary probability, the ideas are incompatible and the CEO will make the choice according to the communication game described above. The resulting success probabilities are given by the following proposition:

Proposition 2 ***Ex ante success probabilities for incompatible ideas:***

(i) Under a symmetric structure, the ex ante success probability for each each function is given by

$$\tfrac{1}{2}\left(\tfrac{1+x}{2+x}\right)\overline{\overline{p}}$$

(ii) Under an asymmetric structure, the ex ante success probabilities are given, for the favored and non-favored functions, respectively, by

$$\tfrac{1}{2}\left[p_s - \tfrac{x_s^2}{4-x_s x_m}\tfrac{p_m^2}{p_s}\right] \qquad \textit{and} \qquad \tfrac{x_s}{4-x_s x_m}\tfrac{p_m^2}{p_s}$$

Proof. See Appendix A.2.1 ■

To understand the logic behind these expressions, consider first the symmetric structure. Suppose that there is no communication. Then, the final choice is fully random, with an expected value of $\frac{\overline{p}}{2}$, and each is chosen with probability $\frac{1}{2}$. Conversely, if communication is perfect, then the better idea is chosen with probability one, with an expected value of $\frac{2\overline{p}}{3}$, and each idea is ex ante equally likely to be chosen. It is this increase in expected success probability from $\frac{\overline{p}}{2}$ to $\frac{2\overline{p}}{3}$ that the organization manages through the extent of alignment x.

Under an asymmetric structure, the logic is similar, except that now if there is no communication, it is manager s's alternative that is chosen with probability one. Therefore, with no alignment, his success probability is $\frac{p_s}{2}$, while the other manager has no chance of having his alternative accepted. Now, increasing the extent of alignment reduces the likelihood that the favored manager will have his alternative implemented while increasing that likelihood for the less influential manager. After all, it is only through informative communication that the more influential manager will ever concede and allow for the implementation of the other manager's alternative. Indeed, for all $p_s \geq p_m$, it is the case that the favored manager's expected success probability is higher, while the probabilities converge as $p_s, p_m \to p$ and $x_s, x_m \to 1$. Combining these probabilities with the expected compensation in the case of compatible ideas, we have that the expected compensation of each of the managers is, in the case of a symmetric structure, given by

$$\left(\frac{\tau_i+\tau_j}{2}\right) EU_i^C\left(\overline{p}, \mathbf{w}\right) + \left(1 - \left(\frac{\tau_i+\tau_j}{2}\right)\right)\left(\frac{(1+x)^2}{2(2+x)}\right)\overline{\overline{p}}w_{G,B},$$

while under the asymmetric structure, the expected compensation for the favored and the less influential manager are given by

$$\left(\frac{\tau_s+\tau_m}{2}\right) EU_s^C\left(\mathbf{p}, \mathbf{w}_s\right) + \left(1 - \left(\frac{\tau_s+\tau_m}{2}\right)\right)\frac{p_s}{2}\left(1 + \frac{1}{4-x_s x_m}\left(\frac{x_s p_m}{p_s}\right)^2\right) w_{G,B,s}$$

$$\left(\frac{\tau_s+\tau_m}{2}\right) EU_m^C\left(\mathbf{p}, \mathbf{w}_m\right) + \left(1 - \left(\frac{\tau_s+\tau_m}{2}\right)\right)\frac{p_s}{2}\left[x_m + \frac{x_s(2-x_m x_s)}{(4-x_s x_m)}\left(\frac{p_m}{p_s}\right)^2\right] w_{G,B,m},$$

from where it follows immediately that the managerial incentives to compromise are given by the following proposition:

Proposition 3 ***Value of compromise:***

(i) For the symmetric structure, the level of compromise solves

$$\tau : \frac{1}{2}\left(EU_i^C\left(\overline{p}, \mathbf{w}\right) - \frac{(1+x)^2}{2(2+x)}\overline{p}w_{G,B}\right) = \frac{\partial C(\tau, \overline{p})}{\partial \tau}$$

(ii) For the asymmetric structure, the levels of compromise solve (for the favored and the less influential manager, respectively)

$$\tau_s : \frac{1}{2}\left(EU_s^C\left(p_m, \mathbf{w}_s\right) - \frac{p_s}{2}\left(1 + \frac{1}{4 - x_s x_m}\left(\frac{x_s p_m}{p_s}\right)^2\right) w_{G,B,s}\right) = \frac{\partial C(\tau_s, p_s)}{\partial \tau_s}$$

$$\tau_m : \frac{1}{2}\left(EU_m^C\left(p_s, \mathbf{w}_m\right) - \frac{p_s}{2}\left[x_m + \frac{x_s(2 - x_m x_s)}{(4 - x_s x_m)}\left(\frac{p_m}{p_s}\right)^2\right] w_{G,B,m}\right) = \frac{\partial C(\tau_m, p_m)}{\partial \tau_m}$$

Logically, the marginal value of compromise for each manager is simply the difference in the expected compensation when both ideas can be implemented simultaneously and when they cannot. Thus, the value of compromise is naturally increasing for each manager in the reward they receive in the case of mutual success, $w_{G,G,i}$, which they can only earn when the ideas are mutually compatible. Similarly, in the case of an asymmetric structure, the value of compromise is decreasing in the alignment of the opposing agent, x_j, as that increases the payoff in the case of conflicting alternatives but has no impact on the payoff in the case of mutually compatible ideas. Finally, under the asymmetric structure, the value of compromise is generally higher for the less influential manager as he is particularly disadvantaged in the case of conflicting ideas. For the rest of the parameters, the comparative statics are generally ambiguous, as they influence the expected compensation in both outcomes.

The last component we need for the equilibrium is the managerial incentives to exert effort. The additional challenge in this stage is the unobservability of effort, so we need to take into account the implications of any unobserved deviations from the expected level of effort for the communication equilibrium. The resulting first-order conditions are given by the following proposition:

Proposition 4 ***Value of effort:***

Let $\Gamma_i\left(p_j, \mathbf{w}_i\right) = \frac{1}{4}\left(p_j\left(w_{G,G,i} - (1 + x_i)\, w_{G,B,i}\right) + 2w_{G,B,i}\right)$, *the marginal value of effort by manager i when the alternatives are compatible. Then,*

(i) Under the symmetric structure, the level of effort solves

$$\overline{p} : \left(\frac{\tau_s + \tau_m}{2}\right)\Gamma_i\left(\overline{p}, \mathbf{w}_i\right) + \left(1 - \frac{(\tau_s + \tau_m)}{2}\right)\frac{1}{2}\left(\frac{1 + x}{2 + x}\right) w_{G,B} = \frac{\partial C(\tau, \overline{p})}{\partial \overline{p}}$$

(ii) Under the asymmetric structure, the levels of effort solve (for the favored and less influential manager, respectively)

$$p_s : \left(\frac{\tau_s + \tau_m}{2}\right)\Gamma_s\left(p_m, \mathbf{w}_s\right) + \left(1 - \frac{(\tau_s + \tau_m)}{2}\right)\frac{1}{2}\left[1 - \frac{1}{4 - x_s x_m}\left(\frac{x_s p_m}{p_s}\right)^2\right] w_{G,B,s} = \frac{\partial C(\tau_s, p_s)}{\partial p_s}$$

$$p_m : \left(\frac{\tau_s + \tau_m}{2}\right)\Gamma_m\left(p_s, \mathbf{w}_m\right) + \left(1 - \frac{(\tau_s + \tau_m)}{2}\right)\left[\frac{1}{4 - x_s x_m}\right]\frac{x_s p_m}{p_s} w_{G,B,m} = \frac{\partial C(\tau_m, p_m)}{\partial p_m}.$$

Proof. See Appendix A.2.2 ■

When the alternatives are mutually compatible, there is no conflict in decision-making and thus the conditional value of effort is similar across the managers and decision structures. But again, when the alternatives are in conflict, then the decision structure clearly matters.

Under the symmetric structure, the marginal value of effort in the case of conflict is given by $\frac{1}{2}\left(\frac{1+x}{2+x}\right)w_{G,B}$. Incentives are thus naturally increasing in $w_{G,B}$, the wage the manager expects to earn in the case of success, but also in $x = \frac{w_{B,G}}{w_{G,B}}$, the degree of alignment between the managers. The reason why alignment has a positive effect on incentives is as follows. On one hand, increasing alignment increases free-riding incentives by increasing the expected payment in the absence of effort. On the other hand, alignment increases the quality of decision-making by allowing the CEO to make more informed choices between the two alternatives, which in turn increases the expected success probabilities. It is exactly this effect that is captured in proposition 2 by the increase in the ex ante success probability for each function when moving from no communication to perfect alignment. In the present setting, this increase in the use of information that is achieved by alignment dominates the free-riding incentives and thus, on net, alignment actually increases the motivation of the managers.[14]

Under the asymmetric structure, the logic is similar but now the expressions take into account the difference in the relative position of the two managers. Thus, paralleling proposition 2, the incentives of the less influential manager are increasing in alignment because it is only through alignment that his alternative will ever be implemented, while alignment hurts the motivation of the more influential manager for the same reason.

In addition to the role of alignment, the asymmetric structure also highlights the role of the levels of effort, (p_s, p_m). In particular, for the less influential manager, the value of information is proportional to $\frac{x_s p_m}{p_s}$ and is thus convex in p_m. If p_m is small, then it is unlikely that manager m's alternative will ever be better, even if communication was perfect. And because the alternative will rarely be implemented, it is not worth creating in the first place. As p_m increases, the more likely it becomes that the alternative will actually be better, and thus increasing its value. The second observation is that the component depends on x_s. The reason is that under the asymmetric structure, the favored manager essentially determines when the other alternative is implemented. If x_s is zero, the favored manager will always implement his own alternative, and thus it is not worth for the other manager to work at all. As x_s increases, the more accommodating the more influential manager becomes, and thus the higher the value of effort. Indeed, technically this effect shows up as a simple scaling of the less favored manager's effort as $x_s p_m$. For the favored manager, the value of effort is decreasing in $\left(\frac{x_s p_m}{p_s}\right)^2$, highlighting the converse of the effect on the less influential manager. However, since $\left(\frac{x_s p_m}{p_s}\right)^2 < \left(\frac{x_s p_m}{p_s}\right)$, the motivating benefit of balanced efforts outweighs the demotivating effect.

5.3 Organizational design

Having derived the optimal managerial responses in the game, from the communication equilibrium to the incentives to exert effort and to compromise, we can now consider the organizational design problem, which consists of the choice between the symmetric and asymmetric decision structures and the compensation contracts offered to the managers.

[14] This result would clearly not hold if there was no problem of strategic communication.

With respect to the choice of the decision structure, we obtain the main result of the framework, as it pertains to the internal organization of the firm:

Proposition 5 ***Choice of decision structure:***

The asymmetric decision structure always dominates the symmetric decision structure

Proof. See Appendix A.3 ■

The proof itself is a simple replication argument: take any symmetric $(\overline{p}, \tau)$ that is induced by the symmetric decision structure and the compensation contract $(w_{G,G}, w_{G,B}, w_{B,G})$. Then, we can always find an asymmetric decision structure and compensation contracts that replicate $(\overline{p}, \tau)$ at a total cost that is lower than the cost under the symmetric structure.

To understand the basic logic behind this result, consider the expected organizational payoff in the case of conflicting ideas, which is when the decision structure is relevant. Under the symmetric structure, we have that the expected organizational payoff (gross of wages) is given by

$$\left(\frac{1+x}{2+x}\right) \overline{p} \Delta \pi^M,$$

while the expected organizational payoff in the case of an asymmetric structure is given by

$$\frac{p_s}{2} \left(1 + \frac{x_s(2-x_s)}{4-y} \left(\frac{p_m}{p_s}\right)^2\right) \Delta \pi^M,$$

where $y = x_s x_m$. Now, suppose that it is actually optimal for the firm to induce the level of effort $\overline{p}$. Then, the two structures achieve the same level of performance if

$$\left(\frac{1+x}{2+x}\right) = \frac{1}{2} \left(1 + \frac{x_s(2-x_s)}{4-y}\right) \rightarrow y = 4 - \frac{x_s}{x} (2 - x_s)(2 + x).$$

In other words, the asymmetric organization is able to maintain the same level of performance as the symmetric organization by increasing the alignment of the favored manager, x_s, while decreasing the alignment between the managers, $x_s x_m$. In other words, under the asymmetric structure the firm can choose $x_s > x$ and $x_m < x$ so that the expected performance remains the same while $x_s x_m < x^2$, so that the relative conflict between the managers is actually higher than under the symmetric structure. This result follows from the complementarity between the communication precisions of the managers. And because under the asymmetric decision structure the degree of conflict can be higher, the free-riding incentives and thus the wage bill will be lower, even if the firm desires to induce symmetric effort levels.

A related observation that follows from this result is that even if the organization is asymmetric, in the sense that formally one function has primacy when it comes to conflict, the allocation of real influence, as captured by the likelihood that the ideas originating from a given manager are actually implemented, may vary from highly asymmetric to very balanced. It is just that the balance is managed mainly through x_s, which controls how receptive the favored manager is to ideas originating from the other function, and $\frac{p_m}{p_s}$, the asymmetry in the effort levels, as induced by the rest of the compensation contracts.

6 Effects of competition

Having derived the solution to the organizational problem for given profit levels $\Delta\pi^H, \Delta\pi^M$ and π^L, we can now consider how the optimal organizational structure is influenced by the competitive environment of the firm. To this end, I embed the model of innovation desribed above in the horizontal differentiation model of Hotelling. Suppose that there is a mass K of customers, uniformly distributed on a line segment of length one. Two firms are located at the end points of the line, with the value for a customer located at x from purchasing from firm 0 is $v_0 - tx - p_0$, while the net value from purchasing from firm 1 is $v_1 - t(1-x) - p_1$. Each firm may produce either a low- or high-quality product, with $v_H > v_L$ and may have either a high or low marginal cost of production, with $c_H > c_L$. Further, assume that innovations are of the same size, so that $\Delta v = v_H - v_L = \Delta c = c_H - c_L$.

In the model, each firm chooses simultaneously their market price p_0 and p_1, after which profits are realized. For simplicity, I assume that when choosing their price, the firms know whether the innovations have been successful or not.[15] Then, standard analysis reveals that, given the realized value and cost profile, the profits of the firm are given by

$$\pi_i = \frac{K}{2t}\left(\frac{(\Delta v + \Delta c)}{3} + t\right)^2,$$

where Δv and Δc are the value and cost advantages of the firm against its rival. Let $\Delta = \Delta v = \Delta c$ the size of the innovation, and assume that profits are always non-negative (each firm produces a positive quantity). Then, letting p_j^H and p_j^M denote the probability that the competitor succeeds in both or one dimension, we get that

$$\Delta\pi_i^M = K\left[\frac{\Delta}{3} + \frac{\Delta^2}{18t}\left(1 - 2\left(p_j^M + 2p_j^H\right)\right)\right] \text{ and } \Delta\pi_i^H = K\left(\frac{2\Delta}{3} + \frac{4\Delta^2}{18t}\left(1 - \left(p_j^M + 2p_j^H\right)\right)\right),$$

which then implies that the relative complementarity of a joint success is given by

$$\gamma = \frac{\left(\Delta\pi^H - 2\Delta\pi^M\right)}{\Delta\pi^M} = \frac{2\Delta}{\left[6t + \Delta\left(1 - 2\left[p_j^M + 2p_j^H\right]\right)\right]}.$$

From these expressions we then obtain immediately the following proposition regarding the impact of competition on the value of innovation:

[15] Presumably, even if the firms are initially uncertain about the quality of their product and the quality of their competitors product, learning from realized demand will allow the firms to adjust their pricing quickly. Similar logic would hold even if the prices were chosen under uncertainty, but that would simply add additional layers to the analysis.

Proposition 6 ***Implications of the competitive environment for the value of innovation:***

(i) A decrease in product differentiation (an increase in competitiveness) increases the value of a single success as long as $1 \geq 2\left(p_j^M + 2p_j^H\right)$ *and increases the value of a joint success as long as* $1 \geq \left(p_j^M + 2p_j^H\right)$ *. A decrease in product differentiation always increases the relative importance of a joint success.*

(ii) An increase in the efficiency of a competitor (an increase in competitiveness) reduces the value of both single and joint success, while increasing the relative importance of a joint success

From the proposition, it is then clear that the impact of changes in the competitiveness of the market have generally an ambiguous effect on the value of innovation and thus the resulting organizational structure. In particular, if the rival is not particularly efficient, then a reduction in t increases the value of both single and joint successes, leading to an unambiguous increase in the value of innovation, which in turn leads to higher and more balanced levels of effort. However, as the rival becomes more efficient, then the impact of t on the value of innovation will change. The key, however, is that the value of a single success decreases faster than the value of a joint success, so that the organization may increase the real balance in the organization even when the absolute value of innovation goes down, because the absolute and relative importance of a joint success is still increasing. Eventually, however, the optimal response becomes generally to specialize. In short, the impact of the competitiveness of the environment has an ambiguous impact on the organization, where an increase in competitiveness can lead the organization either towards more balance or towards specialization, depending on the particular setting.

The second observation that follows from the proposition is that because the value of innovation depends on the efficiency of the rival, any initial differences in the efficiency of the two firms in terms of innovation will trickle down to effort levels, performance and organizational structure. In particular, an increase in the efficiency of the rival, by reducing the value of both single and joint success, will generally lead the firm to specialize and scale back on innovation, which in turn increases the value of innovation to the rival, leading that firm to pursue a more balanced strategy with higher levels of innovation. This result suggests that even if performance and hybrid strategies may be positively correlated, a balanced strategy is not causing good performance. Instead, it is the initial comparative advantage in innovation that leads the firm to be able to be both more profitable and more balanced.

These results are illustrated in figure 5 for a particular parameterization of the model, where I vary the degree of product differentiation, t, and the innovation costs of firm 0.[16] The main panel is panel (ii), which measures the relative real authority of the two managers, in terms of the relative

[16] The cost function used is parameterized as $cG(\tau)C(p)$, where $G(\tau) = 1 - g(\tau + \ln(1-\tau))$ and $C(p) = \left(p^2 + \ln\left(1-p^2\right)\right)$, which guarantees an interior solution. For computational simplicity, the wage contract has been simplified to (w_i, β_i), where w_i is the reward for successful innovation while β_i is the share of firm profits, so that $w_{G,B,i} = w_i + \beta_i \Delta\pi^M$ and $w_{B,G,i} = \beta_i \Delta\pi^M$. This linearized managerial compensation so that $w_{G,G,i} - w_{G,B,i} - w_{B,G,i} = \beta_i\left(\Delta\pi^H - 2\Delta\pi^M\right)$, proportional to the convexity of the profit function. This prevents the compensation contract from being excessively convex, but has no implications for the basic mechanics of the model.

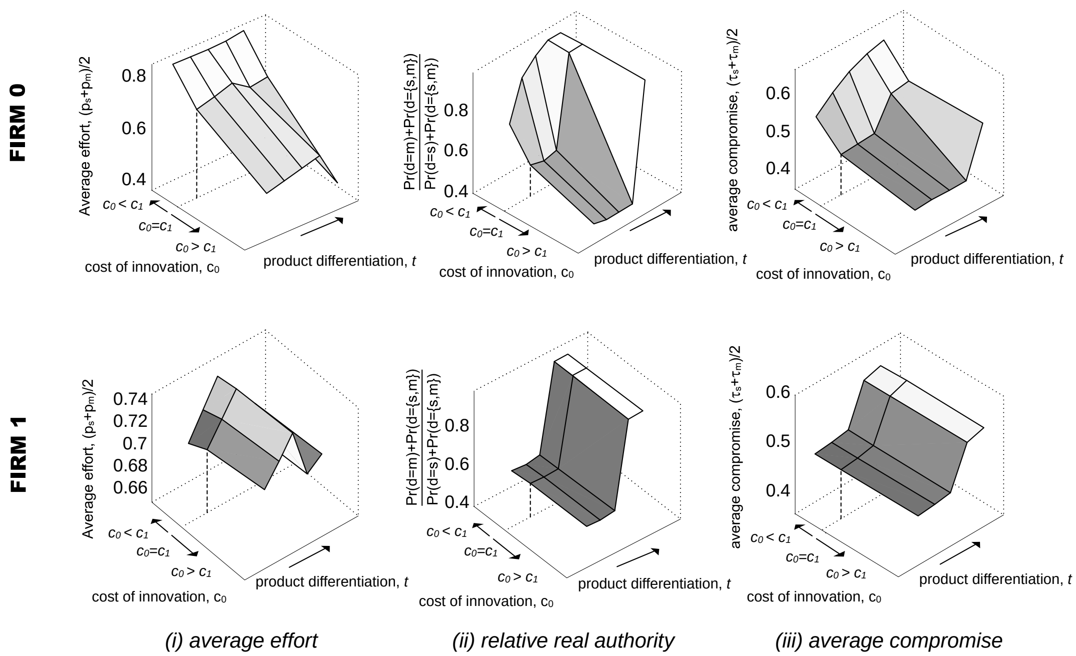

Figure 5: Equilibrium organizational structure in the Hotelling model

likelihood that the manager's alternative is implemented.[17] Looking at the equilibrium outcome for firm 0 illustrates then both of the main results. First, a comparative advantage in innovation leads to both higher average effort and more balanced real authority, together with relatively higher profitability than firm 0, while the converse occurs when firm zero has a comparative disadvantage. Second, decreasing the degree of product differentiation has an ambiguous impact on the relative balance, even if in the present formulation the tendency is to increase specialization. However, for sufficiently low levels of differentiation (and high-enough cost) we see an increase in balance for both firms 0 and 1.

7 Discussion and extensions

The present analysis was framed in terms of idea generation with an endogenous probability of compatibility, to tailor the setting for the analysis of Porter's strategies of cost leadership and differentiation. But the basic framework, with the choice between competing alternatives, is clearly more broadly applicable. In this section, I will briefly discuss some potential further applications of the framework and some other observations.

Competition revisited: The analysis has illustrated how we can construct a meaningful and tractable model of a firm and consider how the competitive environment shapes the internal organization of that firm. However, the paper has clearly only taken some first steps in this direction.

[17] One could consider other measures as well, but the relative likelihood of implementation seems a natural measure.

First, I have only considered a particular competitive model, with symmetric value for both value-increasing and cost-reducing innovations. In other models, there is an inherent asymmetry between these two, and the extent of competitiveness can influence their relative importance, with resulting organizational implications. For example, in a vertical differentiation model, the value of cost-reducing and value-enhancing innovations will depend on the location of the firm. Second, because of the asymmetry in the optimal organizational structure, the firm may endogenously seek a market position that will take advantage of that asymmetry, further enforcing the initial asymmetry in real influence. Third, I have simplified the setting considerably by assuming that the value of the innovation itself is fixed. In practice, another margin that is relevant is the tradeoff between the magnitude of an innovation and the likelihood that the innovation will be successful, which is relevant because the expected profits are not linear in the magnitude of the innovation. For space limitations, such considerations are left for future work, even if they appear clearly relevant in practice.

Applications and modifications of the basic framework: As mentioned above, the model was tailored to consider the cost versus differentiation tradeoff, with competing functional managers providing innovations for implementation, with an endogenous probability of compatibility. But at the core of the framework is the simple choice between two competing alternatives. With minor modifications, the framework could instead consider the evaluation of two pre-existing alternatives with different payoff consequences to organizational participants, or the generation of alternatives with direct payoff externalities across managers. Such modifications would allow us to apply the framework to consider a multi-regional firm, where managers are in charge of their regions and need to generate or evaluate product alternatives, marketing strategies or the like to suit their particular regions, or a multi-product firm, where the firm needs to worry about positive or negative payoff externalities across the product lines. Alternatively, we could apply the framework at a smaller scale to consider which job candidate to hire, where to build a new factory, and so on. The key elements of the framework are simply that (i) the organization needs to make a choice between competing alternatives, (ii) these alternatives have different payoff consequences to the organizational participants, and that (iii) the information about these payoff consequences is dispersed inside the organization. For example, the two functional managers of the present framework could be evaluating different product alternatives for their revenue and cost consequences.

The challenge of balance: Proposition 5 suggests that a democratic treatment of managers may be undesirable. Instead, real balance is best achieved through an asymmetric treatment of the managers. However, it is worth noting that this result depends on the fact that the compensation of the managers can be fully tailored to manage this particular decision-making task. Indeed, the converse is also true: if managerial compensation is exogenously restricted to be symmetric, then achieving symmetric effort levels is always cheaper through the symmetric structure. But while balance through symmetry may be desirable when compensation contracts are not as flexible as assumed in the analysis, the analysis also suggests that such balance may be difficult to achieve. The reason follows from sections 5.1 and 5.2, which discuss how any deviation from the democratic resolution of conflict becomes self-sustaining by increasing the credibility and motivation of one of the managers while decreasing the credibility and motivation of the other.

This observation may provide at least some explanation why, for example, matrix organizations can be so hard to sustain. In particular, even if the organizational structure is formally a matrix, the real influence wielded by different dimensions often tilts in favor of one of the dimensions, as with ABB. This tilting may occur not only with the relationship of the managers with the headquarters, but also, if we take Herbert Simon's view of authority, in the relationship between the managers and their common subordinate. In short, when the managers make conflicting demands on the subordinate, the subordinate needs to choose which instruction to follow and any deviation from balance will lead the subordinate to favor one of the superiors, leading to an asymmetric allocation of real influence. Further, if the real influence in the organization has become asymmetric but the organization continues to compensate its managers symmetrically in the formal spirit of a hybrid structure, then it may perform worse than if it accepted the reality of asymmetric allocation of real authority and tailored its compensation contracts to accommodate that reality.

The managerial firm: The final observation is that the organizational structure that results from proposition 5 resembles a managerial firm, where ownership is separated from the active management of the firm. In particular, in the asymmetric structure, the CEO is redundant in that the CEO might just as well delegate the decision right to the favored manager. Then, from the symmetric initial conditions we have a firm with one agent who is mainly compensated based on firm-level performance and responsible for decision-making, while the second agent is compensated mainly based on his individual performance but whose ideas are still listened to as long as they are good enough. Two observations result from this structure. First, the firm has only one "leader." The reason is that using a more democratic structure would be more expensive because for a balanced structure to work, everybody needs to be sufficiently aligned with each other. Second, the "leader" is not a residual claimant but also a salaried employee of the company. The reason is that if the leader was a residual claimant, then, as highlighted by Rotemberg and Saloner (1994,2000), he would begin to discriminate against the other manager's innovations, demotivating him from generating valuable ideas.

8 Conclusion

This paper has examined how to optimally motivate innovative activity inside a firm when the managers need to both generate ideas and then share information regarding the viability of those ideas, and how the optimal organizational structure is affected by the competitive environment of a firm. The main contributions of this paper are two-fold. First, it constructed a tractable framework of an organization as a decision-making entity that contains many of the features discussed in the management literature, such as the need to aggregate dispersed information, strategic misrepresentation of that information by the informed parties and the interpretative adjustment of the decision-maker in return. While applied here in the context of innovation in a functional organization, the framework could potentially be applied to analyze any setting where (i) a decision-maker needs to choose between competing alternatives that have differential payoff consequences to the organizational participants, and (ii) the organizational participants are differentially informed regarding the payoff consequences of those different alternatives, such as which job candidate to hire, which product to produce, where to build a new factory, and the like.

The key organizational design choice, in addition to the compensation structure of the managers, was the choice of conflict resolution strategy, which determined how the organization chose which alternative to implement in the case of disagreement. This structure could be either symmetric, where each manager had an equal likelihood of having their alternative chosen, or asymmetric, where conflict was always resolved in favor of one of the managers. Favoring one manager gave him more influence and made him both more motivated to generate ideas and a more reliable source of information regarding those ideas, while the opposite occurred to the manager who lost influence relative to the symmetric case.

The main result of this part of the analysis was that, as long as managerial compensation could be structured freely to optimize performance in this particular task, the asymmetric structure dominated the symmetric structure, even when the organization wanted to induce same levels of effort by the two managers. The reason for this result was that to benefit from the ideas under the symmetric structure, each manager needed to be sufficiently aligned with each other to achieve high levels of information sharing, which was costly to the organization because it generated significant incentives for the managers to free-ride on each other's efforts. In contrast, under the asymmetric structure, it was important to align the interests of the more influential manager with the goals of the firm, but the firm could rely on disagreement to provide incentives for the other manager. In particular, the organization could achieve the same quality of decision-making with higher relative conflict between the managers under the asymmetric structure, thus allowing the organization to economize on its compensation costs.

Having considered the optimal internal organization, I then extended the analysis to consider the implications of the competitiveness of the environment on the internal organization of the firm. After all, even if the optimal formal decision-making structure always favored one of the managers, the allocation of real influence depended also on the compensation structure of the managers, which influenced both how receptive the more influential manager was to ideas generated by the other manager and how motivated each of the managers was to generate innovations in the first place. Here, the analysis revealed that increases in the competitiveness of the market could lead to either increased specialization, supporting the argument of Porter (1980), among others, that firms are generally better off specializing on a particular area, or increased balance, supporting the more recent arguments of Bartlett and Goshal (1998), among others, that increased competition increases the need for hybrid strategies where the firm excels in multiple areas. The reason why both arguments were supported was that an increase in competitiveness always increased the relative value of succeeding in both dimensions, supporting a balanced strategy, but could decrease the absolute value of success, supporting specialization to economize on innovation costs.

The second result regarding the relationship between the competitive environment and strategy was that performance and a balanced strategy could be positively correlated in equilibrium, but a balanced strategy in itself did not cause better performance. Instead, both were caused by an initial comparative advantage in innovation: the initial advantage in innovation led the firm to induce higher levels of innovative effort relative to the other firm, which in turn increased the value of innovation and the value of a more balanced strategy. This observation poses an empirical challenge to any work that is attempting to isolate the role of strategy for organizational performance.

References

[1] Alonso, R. W. Dessein and N. Matouschek (2008), "When Does Coordination Require Centralization?," 98(1) *American Economic Review* 145-79

[2] Alonso, R., W. Dessein and N. Matouschek (2012), "When Does Adaptation Require Decentralization?" working paper, USC Marshall, Columbia University and Kellogg

[3] Athey, Susan and John Roberts. 2001. "Organizational Design: Decision Rights and Incentive Contracts," 91(2) *The American Economic Review* 200-5

[4] Chen, Ying, Naviv Kartik and Joel Sobel. 2008. "Selecting Cheap-Talk Equilibria," 76 *Econometrica* 117-36

[5] Crawford, V. and J. Sobel (1982), "Strategic Information Transmission," *Econometrica*, 50, 1431-1451

[6] Dessein, W., A. Galeotti and T. Santos (2012), "Rational Inattention and Organizational Focus," working paper, Columbia University and University of Essex

[7] Dessein, Wouter, Luis Garicano and Robert Gertner. 2010. "Organizing for Synergies," 2(4) *American Economic Journal: Microeconomics* 77-114

[8] Friebel, Guido and Michael Raith. 2010. "Resource Allocation and Organizational Form," 2(2) *American Economic Journal: Microeconomics* 1-33

[9] Gerardi, D. and L. Yariv (2008), "Information Acquisition in Committees," *Games and Economic Behavior*, 62, 436-459

[10] Gromb, D. and D. Martimort (2007), "Collusion and the Organization of Delegated Expertise," Journal of Economic Theory, 137(1), pp.271-299

[11] Krishna, V. and J. Morgan (2001), "A Model of Expertise," *The Quarterly Journal of Economics*, 116(2), 747-775

[12] Li, H. (2001), "A Theory of Conservatism," *Journal of Political Economy*, 109(3), pp. 617-636

[13] Li, H., S. Rosen and W. Suen (2001), "Conflicts and Common Interests in Committees," *American Economic Review*, 91, 1478-97

[14] Persico, N. (2004), "Committee Design with Endogenous Information," *Review of Economic Studies* 71(1), pp. 165-94.

[15] Porter, M. (1980), *Competitive Strategy: Techniques for Analying Industries and Competitors*, Free Press, New York

[16] Porter, M. (1991), "Towards a Dynamic Theory of Strategy," Strategic Management Journal, 12, pp.95-117

[17] Rantakari, H. (2008), "Governing Adaptation," 75 *Review of Economic Studies* 1257-85

[18] Rantakari, H. (2011), "Organizational Design and Environmental Volatility," The Journal of Law, Economics, and Organization, forthcoming

[19] Rantakari, H. (2012), "A Simple Model of Project Selection with Strategic Communication and Uncertain Preferences," working paper, USC Marshall

[20] Rantakari, H. (2013), "Project Selection with Strategic Communication and Further Investigations," working paper, USC Marshall

[21] Rotemberg, J. and G. Saloner (1994), "Benefits of Narrow Business Strategies," The American Economic Review, 84(5), pp.1330-1349

[22] Rotemberg, J. and G. Saloner (1995), "Overt Interfuctional Conflict (and Its Reduction Through Business Strategy)," The RAND Journal of Economics, 26(4), pp.630-653

[23] Rotemberg, J. and G. Saloner (2000), "Visionaries, Managers, and Strategic Direction," The RAND Journal of Economics, 31(4), pp.693-716

[24] Van den Steen, E. (2005), "Organizational Beliefs and Managerial Vision," The Journal of Law, Economics, and Organization, 21(1), pp.256-283

[25] Wolinsky, A. (2002), "Eliciting Information from Multiple Experts," *Games and Economic Behavior*, 41, 141-160

A Proofs and derivations

A.1 Communication equilibria (proposition 1)

A.1.1 symmetric equilibrium

Suppose that the CEO expects $p_s^e = p_m^e = \overline{p}$ and these beliefs are correct (which will be established in the next step). Then, for manager s, we can write the indifference condition for sending message m_s^k and message m_s^{k+1} as

$$\Pr\left(m_m^k\right)\left[\tfrac{1}{2}\left(\theta_s w_{G,B,s}\right) + \tfrac{1}{2}\left(E\left(\theta_m | m_m^k\right) w_{B,G,s}\right)\right] + \Pr\left(m_m^{k-1}\right)\left(\theta_s w_{G,B,s}\right) =$$
$$\Pr\left(m_m^k\right)\left[\left(E\left(\theta_m | m_m^k\right) w_{B,G,s}\right)\right] + \Pr\left(m_m^{k-1}\right)\left(\tfrac{1}{2}\left(\theta_s w_{G,B,s}\right) + \tfrac{1}{2}\left(E\left(\theta_m | m_m^{k-1}\right) w_{B,G,s}\right)\right).$$

The first line is the relevant part of the payoff from sending the higher message. With probability $\Pr\left(m_m^k\right)$, the other manager sends the same message, in which case the CEO randomizes, while with probability $\Pr\left(m_m^{k-1}\right)$, the other manager sends a message just below, in which case the alternative is accepted with probability one. The second line is the relevant part from sending the lower message, where if the other manager sends the higher message, it is now that alternative which is chosen, while a lower message by the other manager as well leads to randomization. Note that other messages by the other manager are irrelevant to this choice, because the choice will not change the final outcome.

Next, we can rerrange this expression to

$$\Pr\left(m_m^k\right)\left[\left(\theta_s w_{G,B,s}\right) - \left(E\left(\theta_m | m_m^k\right) w_{B,G,s}\right)\right] = \Pr\left(m_m^{k-1}\right)\left(\left(E\left(\theta_m | m_m^{k-1}\right) w_{B,G,s}\right) - \left(\theta_s w_{G,B,s}\right)\right),$$

and then imposing symmetry and utilizing the properties of the uniform distribution we get

$$\left(\theta^{k+1} - \theta^k\right)\left[\left(\theta^k w_{G,B,s}\right) - \frac{\left(\theta^{k+1}+\theta^k\right)}{2} w_{B,G,s}\right] = \left(\theta^k - \theta^{k-1}\right)\left(\frac{\left(\theta^k+\theta^{k-1}\right)}{2} w_{B,G,s} - \left(\theta^k w_{G,B,s}\right)\right),$$

which we can then rearrange to

$$2\left(\frac{w_{G,B,s} - w_{B,G,s}}{w_{B,G,s}}\right)\theta^k = \left[\theta^{k+1} - 2\theta^k + \theta^{k-1}\right],$$

and finally to

$$\Delta^{k+1} = \Delta^k + 4\left(\frac{w_{G,B,s} - w_{B,G,s}}{2 w_{B,G,s}}\right)\theta^k.$$

The difference equation thus takes the form

$$\Delta^{k+1} = \Delta^k + \frac{4}{\varphi}\theta^k,$$

the solution to which is derived, among others, in Rantakari (2008), where the most informative partition is given by

$$\theta^n = \alpha(\varphi)^{n-1}\overline{\theta},$$

where $\alpha(\varphi) = \frac{\varphi}{\left(1+\sqrt{1+\varphi}\right)^2}$ measures the precision of communication and $\overline{\theta}$ is the upper bound on the distribution. In this symmetric case,

$$\varphi_{sym} = \frac{2w_{B,G,s}}{w_{G,B,s}-w_{B,G,s}} = \frac{2x}{1-x}, \text{ where } x = \frac{w_{B,G,s}}{w_{G,B,s}}.$$

A.1.2 Asymmetric equilibrium

For the asymmetric equilibrium, suppose that in the case of matching messages, the CEO follows manager s. Then, by sending a message m_s^k, the manager ensures the implementation of his preferred alternative while sending the lower message leads to the implementation of the other alternative. Thus, at the threshold it must be that

$$\theta_s^k w_{G,B,s} = E\left(\theta_C | m_j^k\right) w_{B,G,s} \Leftrightarrow \theta_s^k = E\left(\theta_C | m_j^k\right) x_s.$$

For the non-favored manager, the logic is similar but his message is replacing m_s^{k-1}, so his indifference condition is given by

$$\theta_m^k = E\left(\theta_s | m_s^{k-1}\right) x_m.$$

But using the properties of the equilibrium and the uniform distribution we have that

$$\theta_m^k = \frac{\theta_s^k + \theta_s^{k-1}}{2} x_m,$$

and substituting from the favored manager's indifference condition, we get

$$\Delta_m^{k+1} = \Delta_m^k + 4\theta_m^k \frac{(1-x_s x_m)}{x_s x_m},$$

which thus takes the same structure as above, but with the parameter $\varphi_{asy} = \frac{x_s x_m}{(1-x_s x_m)}$. Then, since the thresholds for the less influential manager are given by

$$\theta_m^n = \alpha\left(\varphi_{asy}\right)^{n-1} p_m,$$

we have that the thresholds for the more influential manager are given by

$$\theta_s^n = \left(\frac{\alpha\left(\varphi_{asy}\right)^{n-1} + \alpha\left(\varphi_{asy}\right)^n}{2}\right) p_m x_s = \alpha\left(\varphi_{asy}\right)^{n-1} \left(\frac{1+\alpha\left(\varphi_{asy}\right)}{2}\right) x_s p_m$$

A.2 Information acquisition and compromise

A.2.1 expected success probabilities in the case of conflict (proposition 2)

Start with the symmetric structure. Conditional on message m_m sent by the other manager, the success probability of manager s's alternative is

$$\Pr(m_s > m_m)E\left(\theta_s|m_s > m_m\right) + \Pr(m_s = m_m)\tfrac{1}{2}E\left(\theta_s|m_s = m_m\right).$$

Then, adding over all the messages sent by manager m and utilizing the properties of the uniform distribution, we have

$$\sum \tfrac{\theta^{k+1}-\theta^k}{\overline{p}}\left[\left(\tfrac{\overline{p}-\theta^{k+1}}{\overline{p}}\right)\left(\tfrac{\overline{p}+\theta^{k+1}}{2}\right)+\tfrac{\left(\theta^{k+1}-\theta^k\right)}{2\overline{p}}\tfrac{\left(\theta^{k+1}+\theta^k\right)}{2}\right].$$

But from the communication equilibrium, we know that

$$\theta^{k+1} = \alpha^{n-1}\overline{p},$$

so we can write the expression as

$$\sum\nolimits_{n=1}^{\infty}\alpha^{n-1}\left(1-\alpha\right)\left[\left(\tfrac{1-\alpha^{n-1}}{}\right)\left(\tfrac{1+\alpha^{n-1}}{2}\right)\overline{p}+\tfrac{\left(\alpha^{n-1}-\alpha^n\right)}{2}\tfrac{\left(\alpha^{n-1}+\alpha^n\right)}{2}\overline{p}\right],$$

which then simplifies to

$$\sum\nolimits_{n=1}^{\infty}\alpha^{n-1}\left(1-\alpha\right)\left[2-\alpha^{2(n-1)}\left(1+\alpha^2\right)\right]\tfrac{\overline{p}}{4}.$$

Taking the summation gives us

$$\tfrac{\overline{p}}{2}-\tfrac{\left(1+\alpha^2\right)}{1+\alpha+\alpha^2}\tfrac{\overline{\overline{p}}}{4}=\tfrac{(1+\alpha)^2}{1+\alpha+\alpha^2}\tfrac{\overline{\overline{p}}}{4}.$$

But as shown in Rantakari (2008), among others, we can further simplify

$$\tfrac{(1+\alpha)^2}{1+\alpha+\alpha^2}=\tfrac{4(1+\varphi)}{4+3\varphi},$$

and since $\varphi_b = \frac{2w_{B,G}}{w_{G,B}-w_{B,G}} = \frac{2x}{1-x}$, the expression simplifies to $\frac{1}{2}\left(\frac{1+x}{2+x}\right)\overline{\overline{p}}$, which is then the ex ante expected success probability for manager s's function, which is then also the success probability for manager m's function.

The same steps allow us to derive the probabilities under an asymmetric structure. The probability that manager s's alternative is implemented, given the message of the manufacturing manager, is

$$\Pr(m_s^k \geq m_m^k) E\left(\theta_s | m_s^k \geq m_m^k\right) = \left(\frac{p_s - \theta_s^k}{p_s}\right)\left(\frac{p_s + \theta_s^k}{p_s}\right),$$

and summing over the messages of the manufacturing manager gives

$$\sum_k \left(\frac{\theta_m^{k+1} - \theta_m^k}{p_m}\right)\left(\frac{p_s - \theta_s^k}{p_s}\right)\left(\frac{p_s + \theta_s^k}{p_s}\right) = \sum \alpha^{n-1}(1-\alpha)\left(\frac{p_s^2 - \left(\theta_s^k\right)^2}{2p_s}\right).$$

Next, we have that

$$\theta_s^k = E\left(\theta_m | m_m^k\right) x_s = \frac{\alpha^{n-1}(1+\alpha) p_m x_s}{2},$$

so that $\sum \alpha^{n-1}(1-\alpha)\left(\frac{p_s^2 - \left(\theta_s^k\right)^2}{2p_s}\right) = \left[\frac{p_s}{2} - \frac{(p_m x_s)^2}{2p_s}\left(\frac{1+\varphi_{asy}}{4+3\varphi_{asy}}\right)\right].$

Finally, $\left(\frac{1+\varphi_{asy}}{4+3\varphi_{asy}}\right) = \frac{1}{4 - x_s x_m}$, so the expected success probability is

$$\frac{1}{2}\left[p_s - \frac{x_s^2}{4 - x_s x_m}\frac{p_m^2}{p_s}\right].$$

Similarly, for the other manager, we have that

$$\sum_k \left(\frac{\theta_m^{k+1} - \theta_m^k}{p_m}\right)\left(\frac{\theta_s^k}{p_s}\right)\frac{\left(\theta_m^{k+1} + \theta_m^k\right)}{2} = \left(\frac{p_m x_s}{p_m}\right)\frac{(1-\alpha)(1+\alpha)^2 p_m}{4(1-\alpha^3)}$$
$$= \frac{\left(1+\varphi_f\right) x_s}{4+3\varphi_f}\frac{p_m^2}{p_s} = \frac{x_s}{4 - x_s x_m}\frac{p_m^2}{p_s}.$$

A.2.2 Perceived value of effort (proposition 4)

When the ideas are mutually compatible, the unobservability of effort has no consequences for the perceived value of information, as the alternative is implemented independent of the realized value. However, when the alternatives are in conflict, we need to consider the consequences of any unexpected deviations in the level of effort for the communication equilibrium.

To this end, note that the upper bound of the belief distribution played no role in the derivation of the indifference condition. Thus, the thresholds following an unexpected deviation remain the same. But from the manager's perspective, two things change. First, the likelihood that he will end up sending any of the messages changes, reducing the likelihood of any but the maximal interior message. Second, when the manager's alternative is chosen, the expected payoff conditional on the maximal message changes as well.

Let us begin again with the symmetric organization, and consider the probability that the other manager's idea is implemented and succeeds, from the perspective of manager m. From above, recall that this probability was given, in equilibrium, by

$$\sum \Pr\left(m_m^k\right)\left[\left(\frac{\overline{p}^e - \theta^{k+1}}{\overline{p}^e}\right)\left(\frac{\overline{p}^e + \theta^{k+1}}{2}\right) + \frac{\left(\theta^{k+1} - \theta^k\right)}{2\overline{p}^e}\frac{\left(\theta^{k+1} + \theta^k\right)}{2}\right].$$

Note that since the expression in brackets is the success probability of the other manager's idea, it is unaffected by the level of effort by manager m, as the interior thresholds are determined by the *expected* levels of effort: $\theta^n = \alpha (x)^{n-1} \overline{p}^e$. For $\Pr\left(m_m^k\right)$, on the other hand, we have

$$\Pr\left(m_m^k\right) = \frac{\theta^{k+1}-\theta^k}{p_m} = \frac{\alpha^{n-1}(1-\alpha)\overline{p}^e}{p_m}$$

for all interior messages, while for the maximal message we have

$$\frac{p_m-\alpha\overline{p}^e}{p_m} = \frac{p_m-\overline{p}^e}{p_m} + \frac{(1-\alpha)\overline{p}^e}{p_m}.$$

Finally, noting that the expression in brackets equals $\frac{\left(1-\alpha^2\right)}{4}\overline{p}^e$ for the maximal message, we have that the perceived value is given by

$$\sum \frac{\alpha^{n-1}(1-\alpha)\overline{p}^e}{p_m} \left[\left(\frac{\overline{p}^e-\theta^{k+1}}{\overline{p}^e}\right)\left(\frac{\overline{p}^e+\theta^{k+1}}{2}\right) + \frac{\left(\theta^{k+1}-\theta^k\right)}{2\overline{p}^e}\frac{\left(\theta^{k+1}+\theta^k\right)}{2}\right] + \frac{(1-\alpha)\overline{p}^e}{p_m}\left[\frac{\left(1-\alpha^2\right)}{4}\right]\overline{p}^e.$$

Now, the first part is identical to the true value, with the exception of the scaling $\frac{\overline{p}^e}{p_m}$, so

$$\sum \frac{\alpha^{n-1}(1-\alpha)\overline{p}^e}{p_m} \left[\left(\frac{\overline{p}^e-\theta^{k+1}}{\overline{p}^e}\right)\left(\frac{\overline{p}^e+\theta^{k+1}}{2}\right) + \frac{\left(\theta^{k+1}-\theta^k\right)}{2\overline{p}^e}\frac{\left(\theta^{k+1}+\theta^k\right)}{2}\right] = \frac{\overline{p}^e}{p_m}\left(\frac{1+\varphi}{4+3\varphi}\right)\overline{p}^e,$$

so the perceived probability of success by the other manager is given by

$$\left[\frac{\overline{p}^e}{p_m}\left(\frac{1+\varphi}{4+3\varphi}\right) + \frac{\left(p_m-\overline{p}^e\right)}{p_m}\left[\frac{\left(1-\alpha^2\right)}{4}\right]\right]\overline{p}^e.$$

Similarly, we can solve for the perceived success probability of own task. First, recall from above that we could write this as

$$\sum \Pr\left(m_m^k\right)\left[\frac{\left(\theta^{k+1}-\theta^k\right)}{2\overline{p}^e}\frac{\left(\theta^{k+1}+\theta^k\right)}{2} + \frac{\theta^k}{\overline{p}^e}\left(\frac{\theta^{k+1}+\theta^k}{2}\right)\right].$$

Now, the difference is that while $\frac{\left(\theta^{k+1}-\theta^k\right)}{2\overline{p}^e}$ and $\frac{\theta^k}{\overline{p}^e}$ are determined by the communication strategy of the other manager, $\frac{\left(\theta^{k+1}+\theta^k\right)}{2}$ is determined by manager m. Now, while he will conform to the expectations for all interior messages, for the maximal message we have that $\left(\frac{\theta^{k+1}+\theta^k}{2}\right) = \left(\frac{p_m-\overline{p}^e}{2}\right) + \frac{(1+\alpha)\overline{p}^e}{2}$. Thus, we can expand the sum to be equal to

$$\sum \Pr\left(m_m^k\right)\left[\frac{\left(\theta^{k+1}+\theta^k\right)}{2\overline{p}^e}\right]\left(\frac{\theta^{k+1}+\theta^k}{2}\right) =$$
$$\sum_{n=1}^{\infty} \frac{\alpha^{n-1}(1-\alpha)\overline{p}^e}{p_m}\left[\frac{\alpha^{2(n-1)}(1+\alpha)^2\left(\overline{p}^e\right)^2}{4\overline{p}^e}\right] + \left[\frac{(1+\alpha)}{2}\right]\left[\frac{(1-\alpha)\overline{p}^e}{p_m}\left(\frac{p_m-\overline{p}^e}{2}\right) + \frac{\left(p_m-\overline{p}^e\right)}{p_m}\left[\left(\frac{p_m-\overline{p}^e}{2}\right) + \frac{(1+\alpha)\overline{p}^e}{2}\right]\right].$$

Now, when it comes to the first-order condition, $\frac{\left(p_m-\overline{p}^e\right)^2}{2p_m}$ has only a second-order effect and thus does not show up, while

$$\sum_{n=1}^{\infty} \frac{\alpha^{n-1}(1-\alpha)\overline{p}^e}{p_m}\left[\frac{\alpha^{2(n-1)}(1+\alpha)^2\overline{p}^e}{4\overline{p}^e}\right] = \left(\frac{1+\varphi}{4+3\varphi}\right)\frac{\left(\overline{p}^e\right)^2}{p_m}$$

from above, and finally

$$\frac{(1-\alpha)\overline{p}^e}{p_m}\left(\frac{p_m-\overline{p}^e}{2}\right)+\frac{(p_m-\overline{p}^e)}{p_m}\frac{(1+\alpha)\overline{p}^e}{2}=\left(\frac{p_m-\overline{p}^e}{p_m}\right)\overline{p}^e,$$

so the (relevant) perceived probability of success in own function is given by

$$\left(\frac{1+\varphi}{4+3\varphi}\right)\frac{(\overline{p}^e)^2}{p_m}+\frac{(1+\alpha)}{2}\left(\frac{p_m-\overline{p}^e}{p_m}\right)\overline{p}^e.$$

The perceived payoff in the case of conflict is then

$$\left(\left[\left(\frac{1+\varphi}{4+3\varphi}\right)\frac{\overline{p}^e}{p_m}+\frac{(1+\alpha)}{2}\left(\frac{p_m-\overline{p}^e}{p_m}\right)\right]w_{G,B}+\left[\frac{\overline{p}^e}{p_m}\left(\frac{1+\varphi}{4+3\varphi}\right)+\frac{(p_m-\overline{p}^e)}{p_m}\left[\frac{(1-\alpha^2)}{4}\right]\right]w_{B,G}\right)\overline{p}^e,$$

resulting in a marginal value of effort of (differentiating and setting $p_m=\overline{p}^e$)

$$\left(\frac{(1+\alpha)}{2}-\left(\frac{1+\varphi}{4+3\varphi}\right)\right)w_{G,B}+\left(\frac{(1-\alpha^2)}{4}-\left(\frac{1+\varphi}{4+3\varphi}\right)\right)w_{B,G}.$$

But recall that $\left(\frac{1+\varphi}{4+3\varphi}\right)=\frac{(1-\alpha)(1+\alpha)^2}{4(1-\alpha)^3}=\frac{(1+\alpha)^2}{4(1+\alpha+\alpha^2)}$, we can further rearrange the above to yield

$$\left(\frac{1}{4}\frac{(1+\alpha)\left(1+\alpha+2\alpha^2\right)}{(1+\alpha+\alpha^2)}\right)w_{G,B}-\left(\frac{\alpha(1+\alpha)\left(1+\alpha^2\right)}{4(1+\alpha+\alpha^2)}\right)w_{B,G}.$$

Now, for the final simplification, we can write the above as

$$\frac{(1+\alpha)}{4}\left[\left(\frac{\left(1+\alpha+2\alpha^2\right)}{(1+\alpha+\alpha^2)}\right)-\left(\frac{\alpha\left(1+\alpha^2\right)}{(1+\alpha+\alpha^2)}\right)x\right]w_{G,B},$$

and recalling from earlier that $\alpha=\frac{x}{\left(1+\sqrt{1-x^2}\right)}$, we have $\left(1+\alpha+\alpha^2\right)=\frac{x+2}{\left(1+\sqrt{1-x^2}\right)}$, while $\left(1+\alpha^2\right)x=\frac{2x}{\left(1+\sqrt{1-x^2}\right)}$, so we can rewrite

$$\left(\frac{\left(1+\alpha+2\alpha^2\right)}{(1+\alpha+\alpha^2)}\right)-\left(\frac{\alpha\left(1+\alpha^2\right)}{(1+\alpha+\alpha^2)}\right)x=1+\alpha\left[\frac{\alpha}{(1+\alpha+\alpha^2)}-\left(\frac{\left(1+\alpha^2\right)}{(1+\alpha+\alpha^2)}\right)x\right]$$
$$=1+\alpha\left[\frac{x}{\left(1+\sqrt{1-x^2}\right)}\frac{\left(1+\sqrt{1-x^2}\right)}{x+2}-\frac{2x}{\left(1+\sqrt{1-x^2}\right)}\frac{\left(1+\sqrt{1-x^2}\right)}{x+2}\right]=1-\alpha\left[\frac{x}{x+2}\right],$$

so that $(1+\alpha)\left(1-\alpha\left[\frac{x}{x+2}\right]\right)=\left(\frac{\left(1+\sqrt{1-x^2}+x\right)\left((2+x)\left(1+\sqrt{1-x^2}\right)-x^2\right)}{(2+x)\left(1+\sqrt{1-x^2}\right)^2}\right)$.

But finally, $\left(1+\sqrt{1-x^2}+x\right)\left((2+x)\left(1+\sqrt{1-x^2}\right)-x^2\right)=2\left(1+x\right)\left(2-x^2+2\sqrt{1-x^2}\right)$
$=2\left(1+x\right)\left(1+\sqrt{1-x^2}\right)^2$,

so $\left(\frac{\left(1+\sqrt{1-x^2}+x\right)\left((2+x)\left(1+\sqrt{1-x^2}\right)-x^2\right)}{(2+x)\left(1+\sqrt{1-x^2}\right)^2}\right)=\frac{2(1+x)}{(2+x)}$,

giving the marginal value of effort in the case of conflict simply as $\frac{(1+x)}{2(2+x)}w_{G,B}$.

The next step is to repeat the analysis for the asymmetric case. For the favored manager, the solution follows directly from the true value of effort. The reason is that since the favored manager is able to guarantee the implementation of his alternative by sending the strongest claim in its favor, the final decision will reflect the true upper bound of his beliefs, not the expectation of the upper bound. Thus, for the favored manager, we have that the expected payoff in the case of conflict is

$$\frac{1}{2}\left[p_s - \frac{x_s^2}{4-x_s x_m}\frac{p_m^2}{p_s}\right] w_{G,B,s} + \frac{x_s}{4-x_s x_m}\frac{p_m^2}{p_s} w_{B,G,s},$$

which gives us the marginal value of effort as

$$\frac{1}{2}\left[1 - \frac{x_s^2}{4-x_s x_m}\frac{p_m^2}{p_s^2}\right] w_{G,B,s}.$$

For the other manager, we need to repeat the exercise from above. Starting with the impact on the success probability of the other manager, we have

$$\sum \Pr\left(m_m^k\right)\left(\frac{p_s-\theta_s^k}{p_s}\right)\left(\frac{p_s+\theta_R^k}{2}\right),$$

so the deviation component for the largest message is

$$\left(\frac{p_m-p_m^e}{p_m}\right)\left(\frac{p_s^2-\left(\theta_s^k\right)^2}{p_s}\right),$$

but since $\theta_s^k = E\left(\theta_m | m_j^k\right) x_s = \frac{\alpha^{n-1}(1+\alpha)p_m^e x_s}{2}$, we have

$$\left(\frac{p_m-p_m^e}{p_m}\right)\left(\left(\frac{p_s}{2}\right) - \left(\frac{(1+\alpha)^2(p_m^e x_s)^2}{8p_s}\right)\right),$$

while the rest sums up, as before, to

$$\frac{p_m^e}{p_m}\left(\left[\frac{p_s}{2} - \frac{(p_m^e x_s)^2}{2p_s}\left(\frac{\left(1+\varphi_{asy}\right)}{4+3\varphi_{asy}}\right)\right]\right).$$

Thus, the ex ante perceived success probability of the other manager is

$$\frac{p_m^e}{p_m}\left(\left[\frac{p_s}{2} - \frac{(p_m^e x_s)^2}{2p_s}\left(\frac{\left(1+\varphi_{asy}\right)}{4+3\varphi_{asy}}\right)\right]\right) + \left(\frac{p_m-p_m^e}{p_m}\right)\left(\left(\frac{p_s}{2}\right) - \left(\frac{(1+\alpha)^2(p_m^e x_s)^2}{8p_s}\right)\right),$$

which gives us the marginal impact of

$$\left[\frac{4\left(1+\varphi_{asy}\right)}{4+3\varphi_{asy}} - (1+\alpha)^2\right]\frac{(x_s)^2}{8}\frac{p_m}{p_s}.$$

Same steps lead us to the value of own success, except that now again the largest element is also affected, for which we have now the additional component

$$\left(\frac{\theta_s^k}{p_s}\right)\left[\left(\frac{p_m-p_m^e}{p_m}\right)\frac{\left(\theta_m^{k+1}+\theta_m^k\right)}{2} + \left(\frac{\theta_m^{k+1}-\theta_m^k}{p_m}\right)\frac{(p_m-p_m^e)}{2}\right] = \left(\frac{\theta_s^k}{p_s}\right)\left(\frac{p_m-p_m^e}{p_m}\right)\left[\theta_m^{k+1}\right] = \left(\frac{\theta_s^k}{p_s}\right)\left(\frac{p_m-p_m^e}{p_m}\right)p_m^e,$$

while $\theta_s^1 = \frac{(1+\alpha)p_m^e x_s}{2}$, so we have $\left(\frac{p_m-p_m^e}{p_m}\right)\left(\frac{(1+\alpha)x_s(p_m^e)^2}{2p_s}\right)$ and thus the perceived probability of success in own function is

$$\left[\left(\frac{p_m^e}{p_m}\right)\left(\frac{(1+\varphi_{asy})x_s}{4+3\varphi_{asy}}\right)+\left(\frac{p_m-p_m^e}{p_m}\right)\left(\frac{(1+\alpha)x_s}{2}\right)\right]\frac{(p_m^e)^2}{p_s},$$

and so the marginal effect is given by

$$\left[2\left(1+\alpha\right)-\frac{4\left(1+\varphi_{asy}\right)}{4+3\varphi_{asy}}\right]\frac{x_s p_m}{4p_s}.$$

Thus, as above, we can construct the marginal value of effort as

$$\left[2\left(1+\alpha\right)-\frac{4\left(1+\varphi_{asy}\right)}{4+3\varphi_{asy}}\right]\frac{x_s p_m}{4p_s}w_{G,B,m}+\left[\frac{4\left(1+\varphi_{asy}\right)}{4+3\varphi_{asy}}-\left(1+\alpha\right)^2\right]\frac{(x_s)^2}{8}\frac{p_m}{p_s}w_{B,G,m}.$$

Next, recall that $\frac{\left(1+\varphi_{asy}\right)}{4+3\varphi_{asy}}=\frac{1}{4-y}$, while $(1+\alpha)=\frac{2}{1+\sqrt{1-y}}$, we have

$$\left[2\left[2\left(1+\alpha\right)-\frac{4\left(1+\varphi_{asy}\right)}{4+3\varphi_{asy}}\right]+\left[\frac{4\left(1+\varphi_{asy}\right)}{4+3\varphi_{asy}}-\left(1+\alpha\right)^2\right]x_s x_m\right]\frac{x_s}{8}\frac{p_m}{p_s}w_{G,B,m}$$
$$=\left[\frac{8}{1+\sqrt{1-y}}-\frac{8}{4-y}+\left[\frac{4}{4-y}-\frac{4}{\left(1+\sqrt{1-y}\right)^2}\right]y\right]\frac{x_s}{8}\frac{p_m}{p_s}w_{G,B,m}.$$

But $\frac{8}{1+\sqrt{1-y}}-\frac{4y}{\left(1+\sqrt{1-y}\right)^2}=4$ and $\frac{8}{4-y}-\frac{4y}{4-y}=\frac{4(2-y)}{4-y}$,

so we get

$$\left[1-\frac{(2-y)}{4-y}\right]\frac{4x_s}{8}\frac{p_m}{p_s}w_{G,B,m}=\left[\frac{x_s}{4-x_s x_m}\right]\frac{p_m}{p_s}w_{G,B,m}.$$

A.3 Proposition 5

To establish the superiority of the asymmetric structure, I will use a replication argument. Take any $(\overline{p},\tau)$ induced by the symmetric structure and the resulting $(\Delta w_{G,G}=w_{G,G}-(1+x)\,w_{G,B},w_{G,B},x)$ and show that we can induce the same levels of effort, compromise and organizational performance under an asymmetric structure with a smaller total wage bill.

For compromise, we can use proposition 3 to establish that the marginal value of compromise under the symmetric structure is

$$\frac{\overline{p}}{4}\left(\frac{1}{2}\overline{p}\Delta w_{G,G,i}+\left(\frac{(1+x)}{(2+x)}\right)w_{G,B}\right),$$

while under the asymmetric structure, the equivalent values are

$$\frac{\overline{p}}{4}\left[\frac{1}{2}\overline{p}\left(\Delta w_{G,G,s}\right)+\left[x_s-\frac{x_s^2}{4-y}\right]w_{G,B,s}\right]\qquad \textit{and}\qquad \frac{\overline{p}}{4}\left[\frac{1}{2}\overline{p}\left(\Delta w_{G,G,m}\right)+\left(1-\frac{x_s(2-y)}{(4-y)}\right)w_{G,B,m}\right].$$

With respect to the effort levels, we can use proposition 4 to establish that the marginal value of effort under the symmetric structure is

$$\frac{\tau}{4}\overline{p}\left(\Delta w_{G,G}\right)+\frac{1}{2}\left(\frac{1+x+\tau}{2+x}\right)w_{G,B},$$

while under the asymmetric structure, the corresponding values are

$$\frac{\tau}{4}\overline{p}\left(\Delta w_{G,G,s}\right)+\frac{1}{2}\left(\tau+(1-\tau)\left[1-\frac{x_s^2}{4-y}\right]\right)w_{G,B,s} \text{ and } \frac{\tau}{4}\overline{p}\left(\Delta w_{G,G,m}\right)+\frac{1}{2}\left(\tau+(1-\tau)\left[\frac{2x_s}{4-y}\right]\right)w_{G,B,m}.$$

Thus, to replicate the symmetric incentives for the favored manager, we have that

$$\frac{\tau}{4}\overline{p}\left(\Delta w_{G,G}\right)+\frac{1}{2}\left(\frac{1+x+\tau}{2+x}\right)w_{G,B}=\frac{\tau}{4}\overline{p}\left(\Delta w_{G,G,s}\right)+\frac{1}{2}\left(\tau+(1-\tau)\left[1-\frac{x_s^2}{4-y}\right]\right)w_{G,B,s}$$

and

$$\frac{\overline{p}}{4}\left(\frac{1}{2}\overline{p}\Delta w_{G,G}+\left(\frac{(1+x)}{(2+x)}\right)w_{G,B}\right)=\frac{\overline{p}}{4}\left[\frac{1}{2}\overline{p}\left(\Delta w_{G,G,s}\right)+\left[x_s-\frac{x_s^2}{4-y}\right]w_{G,B,s}\right],$$

which we can rearrange to give

$$\frac{1}{2}\overline{p}\left[\Delta w_{G,G}-\Delta w_{G,G,s}\right]=\left(\left[x_s-\frac{x_s^2}{4-y}\right]w_{G,B,s}-\left(\frac{(1+x)}{(2+x)}\right)w_{G,B}\right)$$
$$\frac{1}{2}\overline{p}\left[\Delta w_{G,G}-\Delta w_{G,G,s}\right]=\frac{1}{\tau}\left[\left(\tau+(1-\tau)\left[1-\frac{x_s^2}{4-y}\right]\right)w_{G,B,s}-\left(\frac{1+x+\tau}{2+x}\right)w_{G,B}\right],$$

and so we have that

$$\left(\frac{1+x+\tau}{2+x}\right)w_{G,B}-\tau\left(\frac{(1+x)}{(2+x)}\right)w_{G,B}=\left(\tau+(1-\tau)\left[1-\frac{x_s^2}{4-y}\right]\right)w_{G,B,s}-\tau\left[x_s-\frac{x_s^2}{4-y}\right]w_{G,B,s},$$

which then rearranges to

$$w_{G,B,s}=\frac{(1+x(1-\tau))}{(2+x)\left[1-\tau x_s-(1-2\tau)\frac{x_s^2}{4-y}\right]}w_{G,B},$$

which then also implies that

$$\Delta w_{G,G,s}=\Delta w_{G,G}-\frac{2}{\overline{p}}\left(\left[x_s-\frac{x_s^2}{4-y}\right]w_{G,B,s}-\left(\frac{(1+x)}{(2+x)}\right)w_{G,B}\right)$$
$$=\Delta w_{G,G}-\frac{2}{\overline{p}}\left(\frac{(1+x(1-\tau))}{\left[1-\tau x_s-(1-2\tau)\frac{x_s^2}{4-y}\right]}-(1+x)\right)\frac{w_{G,B}}{(2+x)}.$$

Repeating the same exercise for the less influential manager, we have that

$$\frac{\overline{p}}{4}\left(\frac{1}{2}\overline{p}\Delta w_{G,G,i}+\left(\frac{(1+x)}{(2+x)}\right)w_{G,B}\right)=\frac{\overline{p}}{4}\left[\frac{1}{2}\overline{p}\left(\Delta w_{G,G,m}\right)+\left(1-\frac{x_s(2-y)}{(4-y)}\right)w_{G,B,m}\right]$$

and

$$\frac{\tau}{4}\overline{p}\left(\Delta w_{G,G}\right)+\frac{1}{2}\left(\frac{1+x+\tau}{2+x}\right)w_{G,B}=\frac{\tau}{4}\overline{p}\left(\Delta w_{G,G,m}\right)+\frac{1}{2}\left(\tau+(1-\tau)\left[\frac{2x_s}{4-y}\right]\right)w_{G,B,m},$$

which then rearrange to give

$$w_{G,B,m} = \frac{(1+x(1-\tau))(4-y)}{(2+x)x_s[2-y\tau]} w_{G,B}$$

and

$$\Delta w_{G,G,m} = \Delta w_{G,G} - \frac{2}{\overline{p}} \left[\left(1 - \frac{x_s(2-y)}{(4-y)}\right) w_{G,B,m} - \left(\frac{(1+x)}{(2+x)}\right) w_{G,B} \right]$$
$$= \Delta w_{G,G} - \frac{2}{\overline{p}} \left[\frac{(1+x(1-\tau))}{[2-y\tau]} \left(\frac{(4-y)-x_s(2-y)}{x_s} \right) - ((1+x)) \right] \frac{w_{G,B}}{(2+x)}.$$

Next, we need to consider the total wage bill. Under the symmetric structure, we have that the expected compensation of the managers equals

$$\tau \frac{\overline{p}^2}{2} \Delta w_{G,G} + \tau (1+x) w_{G,B} + (1-\tau) \frac{(1+x)^2}{(2+x)} w_{G,B} = \tau \frac{\overline{p}^2}{2} \Delta w_{G,G} + (1+x) \left[\frac{(1+x+\tau)}{(2+x)} \right] w_{G,B},$$

while under the asymmetric structure, the expected compensation of the managers is given by

$$\tau \frac{\overline{p}^2}{4} (\Delta w_{G,G,s} + \Delta w_{G,G,m}) + \tau \frac{\overline{p}}{2} (1+x_s) w_{G,B,s} + \tau \frac{\overline{p}}{2} (1+x_m) w_{G,B,m}$$
$$+ \overline{p} \frac{1}{2} \left[1 + \frac{x_s^2}{4-y} \right] w_{G,B,s} + \frac{\overline{p}}{2} \left[x_m + x_s \left(\frac{2-y}{4-y} \right) \right] w_{G,B,m}.$$

Substituting in for $\Delta w_{G,G,s}$ and $\Delta w_{G,G,m}$ gives

$$\tau \frac{\overline{p}^2}{4} (\Delta w_{G,G} + \Delta w_{G,G}) - \tau \frac{\overline{p}}{2} \left(1 - \frac{x_s(2-y)}{(4-y)}\right) w_{G,B,m} - \tau \frac{\overline{p}}{2} \left[x_s - \frac{x_s^2}{4-y} \right] w_{G,B,s}$$
$$+ \tau \frac{\overline{p}}{2} (1+x_s) w_{G,B,s} + \tau \frac{\overline{p}}{2} (1+x_m) w_{G,B,m}$$
$$+ (1-\tau) \overline{p} \frac{1}{2} \left[1 + \frac{x_s^2}{4-y} \right] w_{G,B,s} + (1-\tau) \frac{\overline{p}}{2} \left[x_m + x_s \left(\frac{2-y}{4-y} \right) \right] w_{G,B,m} + 2\tau \frac{\overline{p}}{2} \left(\frac{(1+x)}{(2+x)} \right) w_{G,B}.$$

Next, grouping the coefficients, we have that

$$\tau \frac{\overline{p}}{2} (1+x_s) w_{G,B,s} - \tau \frac{\overline{p}}{2} \left(\left[x_s - \frac{x_s^2}{4-y} \right] w_{G,B,s} \right) + (1-\tau) \overline{p} \left[\frac{1}{2} \left[1 + \frac{x_s^2}{4-y} \right] \right] w_{G,B,s}$$
$$= \frac{1}{2} \left[1 + \frac{x_s^2}{4-y} \right] \overline{p} w_{G,B,s}$$

and that

$$\tau \frac{\overline{p}}{2} (1+x_m) w_{G,B,m} - \tau \frac{\overline{p}}{2} \left[\left(1 - \frac{x_s(2-y)}{(4-y)}\right) w_{G,B,m} \right] + (1-\tau) \frac{\overline{p}}{2} \left[x_m + x_s \left(\frac{2-y}{4-y} \right) \right] w_{G,B,m}$$
$$= \frac{\overline{p}}{2} \left[x_m + x_s \left(\frac{2-y}{4-y} \right) \right] w_{G,B,m},$$

so the total wage bill simplifies to

$$\tau \frac{\overline{p}^2}{4} (\Delta w_{G,G} + \Delta w_{G,G}) + \frac{\overline{p}}{2} \left[1 + \frac{x_s^2}{4-y} \right] w_{G,B,s} + \frac{\overline{p}}{2} \left(x_m + x_s \left(\frac{2-y}{4-y} \right) \right) w_{G,B,m} + \tau \overline{p} \left(\frac{(1+x)}{(2+x)} \right) w_{G,B}.$$

Finally, substituting in for $w_{G,B,s}$ and $w_{G,B,m}$ we get

$$\tau \frac{\overline{p}^2}{2} (\Delta w_{G,G}) + \frac{1}{2} \left[1 + \frac{x_s^2}{4-y} \right] \overline{p} \frac{(1+x(1-\tau))}{(2+x)\left[1 - \tau x_s - (1-2\tau)\frac{x_s^2}{4-y}\right]} w_{G,B}$$

$$+\frac{\overline{p}}{2}\left(\left[x_m + x_s\left(\frac{2-y}{4-y}\right)\right]\right)\frac{(1+x(1-\tau))(4-y)}{(2+x)x_s[2-y\tau]}w_{G,B} + 2\tau\frac{\overline{p}}{2}\left(\frac{(1+x)}{(2+x)}\right)w_{G,B},$$

which finally simplifies to

$$\frac{\tau\overline{p}^2\Delta w_{G,G}}{2} + \left[\frac{(1+x(1-\tau))}{2}\left(\frac{\left[(4-y)+x_s^2\right]}{[(1-\tau x_s)(4-y)-(1-2\tau)x_s^2]} + \left(\frac{y(4-y)+x_s^2(2-y)}{x_s^2[2-y\tau]}\right)\right) + \tau\left(1+x\right)\right]\frac{\overline{p}w_{G,B}}{(2+x)}.$$

Thus, the wage bill under the asymmetric structure is smaller as long as

$$\frac{\tau\overline{p}^2\Delta w_{G,G}}{2} + \left(\frac{1+x+\tau}{2+x}\right)(1+x)\,\overline{p}w_{G,B} \geq$$
$$\frac{\tau\overline{p}^2\Delta w_{G,G}}{2} + \left[\frac{(1+x(1-\tau))}{2}\left(\frac{\left[(4-y)+x_s^2\right]}{[(1-\tau x_s)(4-y)-(1-2\tau)x_s^2]} + \left(\frac{y(4-y)+x_s^2(2-y)}{x_s^2[2-y\tau]}\right)\right) + \tau\left(1+x\right)\right]\frac{\overline{p}w_{G,B}}{(2+x)},$$

which we can simplify to

$$(1+x)^2 \geq \frac{(1+x(1-\tau))}{2}\left(\frac{\left[(4-y)+x_s^2\right]}{[(1-\tau x_s)(4-y)-(1-2\tau)x_s^2]} + \left(\frac{y(4-y)+x_s^2(2-y)}{x_s^2[2-y\tau]}\right)\right).$$

The final constraint is that the performance under conflict must be the same. This result is achieved whenever

$$\left(\frac{1}{2} + \frac{x_s(2-x_s)}{2(4-y)}\right) = \left(\frac{1+x}{2+x}\right) \to y = 4 - \frac{x_s(2-x_s)(2+x)}{x},$$

with $x_s \in [x, x_s^{\max}]$, where $x_s^{\max} = \frac{(2+x)-\sqrt{\max(0,4-4x-3x^2)}}{(2+x)}$ is the highest level of alignment that is compatible with a given x ($y = 0$). For example, $x_s = 1$ and $x_m = 0$ is equivalent to $x = 2/3$. While establishing the rest of the result analytically is infeasible, it is straightforward to verify numerically that for all x, τ, there exists $x_s \in [x, x_s^{\max}]$ that achieves a lower cost. The converse, however, is also true, which is that for $x_s = x$, the cost under the asymmetric structure is always higher.