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When Does Competition Foster Commitment?*

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Abstract

Consider a firm that would like to commit to a focused business strategy because focus improves efficiency and thus increases profit. We identify two general conditions under which tougher competition strengthens the firm's ability to commit to a focused strategy. Under these conditions, competition fosters commitment for two reasons: (i) competition reduces the value of the option to diversify (*the contestability effect*) and (ii) competition increases the importance of being efficient (*the efficiency effect*). We use a number of different models of imperfect competition to illustrate the applicability of our results. Our examples suggest that the contestability effect is very general. In contrast, the efficiency effect often requires further conditions, which are specific to the nature of competition in each model. In both cases, our analysis helps us predict when these effects are more likely to be observed.

Keywords: Business Strategy, Competition, Commitment.

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1. Introduction

Economic theories of business strategy often emphasize the importance of commitment. Commitment is important not only because of its competitive and entry-deterrence effects (e.g., Ghemawat, 1991) but also because it affects a firm's internal incentive structure (e.g., Rotemberg and Saloner, 1994; Van den Steen, 2005). In particular, by committing to a strategy, a firm may be able to incentivize employees to undertake strategy-specific investments in human capital or, similarly, to attract workers who possess such skills. However, such incentives can only work if employees are sufficiently confident that their investments are aligned with the firm's strategy. A natural question is then: How can firms commit to a given strategy?

This paper discusses the role of product market competition as one such commitment mechanism. We develop a framework that helps us to understand *when* more competition enhances a firm's ability to commit to a focused strategy. Our key result is the identification of two general conditions under which competitive pressure enhances a firm's ability to commit.

To understand the logic underlying our results, consider a firm that will have (or already has) an opportunity to operate in two segments (or markets): A and B. An example is a focused firm considering broadening its scope, perhaps because of growth opportunities. Alternatively, the firm could be a diversified firm considering the possibility of exiting one segment, perhaps because its management believes that the firm can be more efficient if it is focused. In either case, at some future date, the firm has to decide whether to be focused and operate only in A or to be diversified and operate in both A and B. If the firm chooses the focused strategy, its employees will have incentives to undertake investments (in human or organization capital) that are specific to segment A. However, such specific investments require employees to believe that the firm will focus on A. If the firm is unable to commit to the focused strategy, employees may not wish to undertake such investments, as strategy-specific skills are less valuable if the firm chooses the diversified strategy. This is essentially the commitment problem studied in Rotemberg and Saloner (1994).

Suppose now that we introduce competition by allowing for potential entry in segments A and/or B. Potential entry has two effects. First, entry reduces profits in B, making the diversified strategy less attractive for the incumbent firm. Second, the threat of entry provides the incumbent with entry-deterrence incentives to focus on A, as by focusing on A, the firm can make better use of the skills acquired by its workers and become more efficient (e.g., have lower costs) than the potential entrants. Both effects increase the likelihood that the incumbent will choose the focused strategy (that is, A). Thus, if competition is sufficiently strong, employees rationally choose to undertake A-specific investments.

An interesting implication of this simple model is that an incumbent's profits may increase with the threat of entry in its industry, and even a monopolist can benefit from such a threat. This apparently counter-intuitive result is easily understood once one considers the commitment effect of competition. Increased competition can eventually solve the dynamic inconsistency problem associated with the choice of business strategies. When it does, the firm may be better off due to the positive effects of competition on segment-specific investments.

We use this simple "threat-of-entry model" as our main example. This particular example illustrates the main results, but it leaves open the question of whether these ideas have broader applicability. In particular, "competition" and "competitive pressure" have different meanings in different models; thus it is natural to ask whether our analysis also applies to alternative models and notions of competition. With this issue in mind, after presenting our main example, we develop a reduced-form model in which competition is not explicitly modeled. Precisely because competition is modeled in reduced form, the model is fairly general. Within this framework, we identify two necessary and sufficient conditions that give rise to the two effects illustrated above.

The first effect is observed whenever tougher competition in segment B leads to lower profits in that segment, which then reduces the value of the option to diversify. Consequently, as competition in that segment intensifies, the firm is more likely to pursue the focused strategy. We call this the *contestability effect*. An interesting testable implication of the contestability effect is that a firm operating in one segment becomes more efficient if competition increases in other segments.

The second effect is observed whenever tougher competition in segment A makes investment in that segment more valuable. In the example above, A-specific investments reduce costs and help to deter entry. More generally, if focused firms are more efficient and thus better able to thrive under intense competition, commitment to a focused strategy may be more credible under more intense competition. We call this the *efficiency effect*. The efficiency effect requires more stringent conditions than the contestability effect. Intuitively, the efficiency effect has to contend with an opposing force: If competition sufficiently reduces profits in segment A, the firm gains little from specializing in that segment and thus any promise to focus on A has little credibility. Thus, for the efficiency effect to dominate this latter effect, competition must not have a very strong negative effect on the profits of a focused firm.

Our analysis is intentionally vague regarding the definition of "competitive pressure." After we present the main example and our main results, we discuss a number of additional examples in which competition is modeled explicitly. Using different standard models of imperfect competition, we consider four different notions of competitive pressure: (i) threat of entry (the main example), (ii) the number of rival firms in the industry, (iii) product substitutability, and (iv) mode of competition (price versus quantity competition). We demonstrate that the contestability effect holds in all models that we consider, regardless of the definition of competitive pressure. The efficiency effect is also present in all of these models, but it often requires further conditions. Our examples illustrate the characteristics of the industries where the efficiency effect is likely to be of first-order importance: (i) the presence of few incumbent rivals, (ii) high product substitutability, and (iii) a significant threat of entry.

We conclude the paper with an extension in which the firm may choose between a flexible (or ex post profit-maximizing) and a committed (or visionary) CEO. This extension allows us to link our analysis to the leadership literature (for surveys of the most recent literature, see Bolton, Brunnermeier, and Veldkamp, 2010, and Hermalin, 2012). We find that a leader's ability to commit is a less important managerial trait in highly competitive environments. The reason for this result is that competitive pressure and "vision" (in the terminology of Rotemberg and Saloner, 2000, and Van den Steen, 2005) or "resoluteness" (in the terminology of Bolton, Brunnermeier, and Veldkamp, 2013) are both alternative mechanisms for conferring credibility to a focused strategy.

A Motivating Example. Although our model is not inspired by any particular company, its components and many of its conclusions can be motivated by, and are consistent with, the case of Intel Corporation and the choices it faced in 1984-85 (see Burgelman, 1994, and Casadeus-Masanell, Yoffie, and Mattu, 2010). Before its exit from the dynamic random access memory (DRAM) business in 1985, Intel was an active player in both the market for DRAM and the market for microprocessors. Although the production of each required similar competencies (e.g., competencies in line-width reduction), DRAMs required relatively more expertise in manufacturing (e.g., low-cost production) and less expertise in product design (e.g., mastering design complexity) than microprocessors. By the early 1980s, Intel found it increasingly difficult to acquire a competitive advantage over its Japanese competitors. The situation was different for microprocessors, where it was possible to create specific capabilities in product design. By 1985, there was a clear discrepancy between Intel's official business strategy, which was to continue to support DRAMs, and the actions of middle-level managers. These individuals had already begun to change practices, to refocus, and to acquire new expertise specific to microprocessor production. According to Burgelman (1994), Andy Grove (then Intel's COO) recalled that: "By mid-1984, some middle-level managers had made the decision to adopt new process technology which inherently favored logic [microprocessor] rather than memory advances (...)." Eventually, Intel's management decided to exit the DRAM business entirely.

This is an example of how competition can provide workers with incentives to undertake strategy-specific investments. In this example, as the market for DRAMs became increasingly contested, middle-managers understood that Intel would need to refocus on microprocessors and thus began to undertake microprocessor-specific investments, even before Intel exited the DRAM market. This is an example of the contestability effect.

Another interesting observation is that Intel's official strategy was to support both products. Middle-managers, however, behaved as if Intel was likely to change its strategy. As in our model, what mattered was not the official strategy but which strategy was more likely to be implemented given the existing competitive pressures.[1]

It is more difficult to identify explicit examples of the efficiency effect. The primary empirical implication of the efficiency effect – that competition in a market tends to make incumbent firms more efficient – is a well-documented empirical fact in the industrial organization literature (see, e.g., the survey by Holmes and Schmitz, 2010, and the discussion in the next section). It is, however, difficult to isolate the exact mechanism by which this occurs. Separating the efficiency effect from other effects linking competition to productivity requires additional tests. Our analysis provides a starting point for designing such tests, as we briefly discuss in our concluding remarks. The microprocessor market at the time of the Intel case exhibited some of the characteristics of an industry in which the efficiency effect could also be found. First, we obviously need a market in which specific investments can increase profitability, and the microprocessor market had this property. Second, this was a market with few incumbent players, with relatively high product substitutability, and

[1] An objection that could be raised against this interpretation is the possibility that Intel's "official strategy," as communicated to outsiders, differed from the strategy communicated to insiders. Although we have no way of verifying this, Burgelman's (1994) narrative of the case explicitly states that Intel's top management not only supported its official strategy internally (in board meetings) but also that Intel promoted this strategy through concrete actions (e.g., it maintained a high level of funding for DRAM technology development relative to other businesses). Casadeus-Masanell, Yoffie, and Mattu's (2010) narrative of Intel's strategy similarly suggests that (at least some) managers working for Intel in the early 1980s did not receive clear signals (or regarded the signals they did receive as unclear) concerning Intel's future strategy with respect to DRAMs. Again, an inability (or lack of intent) to commit to a specific strategy required subordinates to assess the likelihood of the various options in the context of competitive pressures.

with few or no (exogenous) barriers to entry. Our analysis reveals that all of these three characteristics are associated with the prevalence of the efficiency effect.

As none of our analysis depends on a company's current market position, it equally applies to diversified firms that are considering adopting a focused approach (such as Intel) and to the common case of a focused firm that eventually decides to diversify, e.g., for growth reasons.

2. Related Literature

Our model belongs to the literature initiated by Rotemberg and Saloner (1994), who discuss the benefits of committing to a narrow business strategy in a context in which workers exert effort to produce innovations.[2] Because workers are only compensated if the innovations that they discover are implemented, a firm may wish to commit to a narrow strategy to induce effort ex ante. Rotemberg and Saloner (2000) propose that the employment of a CEO with a "vision" is a possible solution to this commitment problem. In a similar vein, Van den Steen (2005) demonstrates that the employment of a visionary CEO provides direction, improves coordination, and allows the firm to attract employees with similar beliefs, who will thus be more productive.[3]

A common element in this literature is the absence of competitive interactions; all of these papers model the firm in a quasi-monopolistic setting. Naturally, then, they do not consider the impact of product market competition on the credibility of commitment to a particular strategy. Our contribution is to embed this commitment problem in a model in which the firm may face different forms of competitive pressure.

In a broader sense, our paper is also related to the literature on the possible connections

[2] This literature is reviewed by Roberts and Saloner (2012).

[3] Other papers that focus on the personal characteristics of leaders as a means to provide credibility to proposed business strategies include Rotemberg and Saloner (1993), Blanes-i-Vidal and Möller (2007), Hart and Holmström (2010), and Bolton, Brunnermeier, and Veldkamp (2013). Alternatively, Ferreira and Rezende (2007) present a related model in which managerial career concerns operate as a commitment mechanism.

between product market competition and within-firm frictions that hamper productivity. Early concerns that lack of competition may lead to inefficiencies were expressed by Hicks (1935), who famously stated that "*the best of all monopoly profits is a quiet life*" (p.8), and Leibenstein (1966), who coined the term "X-inefficiencies" to describe the inefficiencies arising from a firm's failure to minimize costs. Modern analyses of the link between competition and internal efficiency can be found in Hart (1983), Raith (2003), Schmidt (1997), and Holmes, Levine and Schmitz (2012), among others.

To the best of our knowledge, the link between commitment and the intensity of product market competition has not been formalized before. However, the industrial organization (IO) literature addresses the question of how product market competition affects a firm's incentives to increase productivity. A comprehensive formal treatment and review of this related literature can be found in Vives (2008), who identifies the conditions under which an increase in the intensity of product market competition positively affects the value of a cost-reducing investment. Vives (2008) finds that such a link cannot be established in general and depends on the specifics of the respective model. Our approach is similar to his, in the sense that we seek general conditions under which competition fosters commitment. In particular, in Section 6, we provide examples of different models in which competition can foster commitment. Although the models that we present are specifically tailored to our question (e.g., heterogeneous firms and discrete cost reductions), and thus differ from those Vives (2008) examines, the intuition underlying some of our conditions are related to his results, as we explain in Section 6. To the best of our knowledge, the theoretical IO literature on competition and productivity does not study the relevance of commitment to specific strategies or, in particular, the impact of competition on multi-market firms, both of which are central to our analysis.[4]

Holmes and Schmitz (2010) provide an overview of empirical studies and cases that illustrate the impact of competition on productivity. Of particular interest are studies reporting

[4]Sutton (2012) also discusses the importance of developing specific capabilities in competitive environments.

that competition leads to productivity improvements within firms. Further relevant to our work are studies showing that some productivity gains can be attributed to investments in human or organization capital. An example is Schmitz (2005), who shows that an increase in competition driven by Brazilian iron ore producers led to productivity gains among US and Canadian iron ore producers in the early 1980s. He also concludes that a substantial proportion of these gains were caused by changes in work practices within firms. Although Schmitz does not provide evidence on the mechanism linking competition to productivity gains, he speculates that commitment problems may be among the reasons that such gains could not be achieved in the absence of competition (see Schmitz, 2005, p. 619).[5]

Finally, our model is also useful for understanding firm heterogeneity. There is substantial evidence that apparently similar firms display persistent differences in performance (for recent surveys, see Bloom and Van Reenen, 2010, Gibbons, 2010, and Syverson, 2011). Recent empirical evidence by Bloom, Sadun, and Van Reenen (2010) suggests that competition triggers organizational change. In our model, small variations in the strength of commitment can have drastic consequences for profitability. Absent competition, these performance differences may be persistent.

3. Setup

We describe our model in two steps. First, we explain our modeling of the organization. Then we describe the organization's external environment: its demand conditions and the structure of competition.

[5]Recent work by Backus (2014) finds that productivity improvements in the ready-mix concrete industry are directly caused by competition. Further evidence that competition can result in changes in work practices within firms can be found in Holmes and Schmitz (2001) for the US shipping industry, where the emergence of competition by railroads in the 19th century led to the adoption of more efficient work rules by unions, and in Dunne, Klimek and Schmitz (2011), who find a similar impact of competitive pressure on work rules in the U.S. cement industry in the 1980s. These cases accord with and provide plausibility to an important idea underlying the efficiency effect: workers (collectively) overcome resistance to changes in their work practices, as they expect such efforts to improve their firm's competitive situation in an increasingly competitive market.

3.1. Organization

We consider a firm, called F, that can produce two different products, A and B (also referred to as *segments* or *markets*), solely using human capital. Specifically, production requires a CEO and a worker; both are indifferent to risk. The worker can make investments in human capital (e.g., the worker can exert effort to acquire new skills, learn and adopt new work practices, etc.) that allow the firm to become more profitable in segment A (e.g., the firm can then produce A more efficiently). Such investments are specific to segment A. Following the worker's investment decision, the profit-maximizing CEO chooses a *strategy* $s \in \{A, AB\}$: The CEO decides whether the firm diversifies (denoted $s = AB$) or focuses on segment A (denoted $s = A$).[6] The firm chooses whether to produce both products simultaneously or to specialize (focus) on just one product. The profit from producing in segment A depends (among other things) on parameter $c_F \in \{\underline{c}, \overline{c}, \overline{\overline{c}}\}$, with $\underline{c} \leq \overline{c} \leq \overline{\overline{c}}$.[7] For simplicity, we refer to c_F as the (marginal) cost of production (for A), but we could more generally interpret $\{\underline{c}, \overline{c}, \overline{\overline{c}}\}$ as production at low, medium, and high costs.

Without the worker's specific investment the cost parameter is $\overline{\overline{c}}$. Specific investments reduce costs differentially, depending on the strategy chosen by the firm: If the firm chooses $s = A$, the cost parameter becomes $\underline{c}$; if it chooses $s = AB$, the cost parameter becomes $\overline{c}$. Intuitively, the worker cannot efficiently use two different sets of skills; hence the firm cannot fully exploit the worker's A-specific skills if the worker also has to produce B. For example, if the firm expands its scope by broadening its target market, the skills that were useful to the (original) focused strategy may lose some of their value. Alternative interpretations of this assumption are also possible. We could follow Rotemberg and Saloner (1994) and

[6] Focusing on B may also be a feasible choice. As we assume that the firm cannot become more efficient in B by fostering investment in B-specific skills, such a stratgy will only be optimal if profits in A are negative (and the firm shuts down production for A). For convenience of exposition the latter case will be subsumed under $s = AB$ (see also Section 3.2).

[7] Strictly speaking, the assumption that $\overline{\overline{c}}$ is greater than $\overline{c}$ is not necessary and is made only to improve the exposition. This assumption reflects the intuitive case in which specific skills cannot harm the firm, and it also rules out the trivial case where the firm never benefits from the worker's investment (see also the discussion in the next paragraph).

interpret segment-specific investments as effort to develop segment-specific ideas, which must subsequently be implemented by the firm. In that case, a diversified firm might find it more difficult to commit to implementing specific ideas, because it may have a larger set of projects from which to choose.[8]

Formally, the worker has a binary choice variable $y \in \{0, 1\}$ with

$$y = \begin{cases} 1 & \text{if the worker undertakes } A\text{-specific investments,} \\ 0 & \text{otherwise.} \end{cases}$$

For simplicity, we assume that the CEO observes y.[9] If the worker undertakes A-specific investments and the firm is focused (i.e., if $y = 1$ *and* $s = A$), the worker receives an exogenous benefit that we normalize to 1. Otherwise, the worker earns zero benefits. We assume that y is not verifiable (i.e., noncontractible); thus explicit incentive contracts that reward workers for undertaking A-specific investments are not feasible. As in Van den Steen (2005), this could be justified by the difficulty of describing the nature of such investments. We provide an additional discussion of these contractibility assumptions in Subsection 5.4.

We call the cost of A-specific investments *effort* $e \in (0, 1)$. Effort is a noncontractible cost borne by the worker. As strategy implementation decisions are made after knowing whether the worker has invested, the worker's investment decision will depend on both e and the worker's belief regarding the likelihood of the CEO implementing $s = A$. Conditional on $y = 1$, the worker believes that the focused strategy is implemented with some probability, which we denote $b \in [0, 1]$. More formally, $b \equiv \Pr(s = A \mid y = 1)$. Clearly, the worker

[8] Rotemberg and Saloner (1994) discuss two models with such features. In the first model, ideas generated in one segment can also be used in the other segment. In such a case, ex post the firm may choose to implement inferior ideas to economize on implementation costs (e.g., incentive costs). In the second model, the firm is financially constrained and can only implement a limited number of ideas (because implementation is costly). In both models, if the firm focuses on a segment, more and better ideas are implemented in that segment.

[9] The observability of y simplifies the analysis, but it is not a necessary assumption. If y is not observable, we have the same equilibrium that we describe below, as the CEO always knows y in any pure-strategy equilibrium. However, such an equilibrium would not be unique; there could be less-efficient equilibria in which investment does not occur and the CEO always chooses to diversify. Thus, our assumption of the observability of y can be alternatively interpreted as an equilibrium-selection device, which selects the most efficient equilibrium in a game in which y is not observable.

undertakes A-specific investments if and only if $b \geq e$. The belief parameter b is a measure of the *credibility of the firm's commitment to A*. A larger b means that workers are more likely to trust managers not to deviate from A, conditional on A-specific investments being undertaken.

3.2. External environment

There is ex ante uncertainty regarding which of the two segments (A or B) will have higher demand. Define the random variable $\tilde{d}$ with support $\{A, B\}$ as the *demand shock*, and let $\rho \in [0, 1]$ denote the probability that the realized value of $\tilde{d}$ is $d = A$. We interpret ρ as the probability that segment A experiences a positive demand shock that is larger than that experienced by segment B.[10]

We define competitive pressure as a random vector $\left(\tilde{C}_A, \tilde{C}_B\right)$, where $\tilde{C}_x \in \{l_x, h_x\}$ for each $x \in \{A, B\}$. $C_x = h_x$ denotes high competitive pressure in segment x; $C_x = l_x$ denotes low competitive pressure (C_x is the realization of $\tilde{C}_x$). Let $\tau_x \in [0, 1]$ denote the probability of h_x. For simplicity we assume that $\tilde{d}$, $\tilde{C}_A$ and $\tilde{C}_B$ are independently distributed. Let $\Pi_A^{C_A}(d, c_F)$ denote the firm's profit in segment A given the realized state (d, C_A) and its cost c_F. Similarly, $\Pi_B^{C_B}(d)$ denotes the firm's profit in segment B given the realized state (d, C_B). Note that c_F does not affect profits in segment B simply because we assume that the investment is specific to A. We state the assumed impact of c_F and d on the profit functions as:

Assumption 1 *The following conditions hold:*

1a. $\Pi_A^{C_A}(A, c_F) \geq \Pi_A^{C_A}(B, c_F) \geq 0$ *for all* (c_F, C_A).

1b. $\Pi_B^{C_B}(B) \geq \Pi_B^{C_B}(A) \geq 0$ *for all* C_B.

[10] Our general analysis does not require demand uncertainty; thus in some examples, we will ignore demand shocks. Demand shocks are only necessary for a commitment problem to exist in the limiting case in which firm F faces no competition (i.e., F is a monopolist). Because this is the standard case analyzed in the related literature, we assume the existence of demand shocks only to highlight the fact that, in our model, the commitment problem would exist even without competition. In the proof of Corollary 2 (in the Appendix), we present an example in which a commitment problem exists in a pure monopoly case.

1c. $\Pi_A^{C_A}(d, \underline{c}) \geq \Pi_A^{C_A}(d, \overline{c}) \geq \Pi_A^{C_A}\left(d, \overline{\overline{c}}\right)$ *for all* (d, C_A).

Assumption 1 is merely definitional. Parts 1a and 1b state that profit is (weakly) larger after a positive demand shock d. We assume non-negative profits to simplify the analysis, although this is not a necessary condition for any of our results. It is a natural assumption if the firm can (at zero cost) shut down unprofitable divisions.[11] Part 1c states that profit is (weakly) decreasing in cost. Below, we demonstrate through examples that the aforementioned assumptions (in addition to being intuitive) are compatible with standard market games and different notions/measures of competition.

3.3. Timing

The timing of events is as follows:

At period 0, the worker decides whether to invest (i.e., $y = 0$ or $y = 1$) and pays cost e if $y = 1$.

At period 1, the CEO observes y. All uncertainty is fully resolved: Both the demand shock d and the competitive pressure states C_A and C_B are realized and can be observed by all.

At period 2, the CEO decides which strategy $s \in \{A, AB\}$ to implement. This decision becomes common knowledge.

At period 3 the cost parameter c_F is determined, production takes place, products are sold in the market, and F's profit is realized.

[11] Note that if profit in segment A is negative, the diversification strategy $s = AB$ is interpreted as "shutting down A" or "not focusing on A." If $\Pi_B^{l_B}(B) < 0$, the CEO would always choose to focus on A (or to shut down operations in all segments) and a commitment problem would not exist. In this case, the equilibrium is trivial and uninteresting, but our results are still valid.

3.4. Equilibrium

Our model represents a sequential game with incomplete information, and the equilibrium concept used is Subgame Perfect Nash Equilibrium.[12] At period 0, the worker chooses y without knowing the realizations of d, C_A and C_B at period 0. At period 2, the CEO chooses s after observing (y, d, C_A, C_B). Conditional on $y = 0$, the CEO chooses $s = AB$ (because $\Pi_B^{C_B}(d) \geq 0$). Conditional on $y = 1$, the CEO's optimal choice of strategy is a function $s(d, C_A, C_B) : \{A, B\} \times \{l_A, h_A\} \times \{l_B, h_B\} \rightarrow \{A, AB\}$ such that (we assume that the CEO chooses A when indifferent):

$$s(d, C_A, C_B) = \begin{cases} A & \text{if} \quad \Pi_A^{C_A}(d, \underline{c}) \geq \Pi_A^{C_A}(d, \overline{c}) + \Pi_B^{C_B}(d), \\ AB & \text{else.} \end{cases} \tag{1}$$

The CEO's strategy if $y = 0$ is irrelevant for the worker's optimal investment decision, as in that case the worker always receives zero. The worker's optimal strategy depends on the worker's equilibrium belief b^*, which must be consistent with the CEO's optimal strategy conditional on $y = 1$:

$$b^* = \Pr[s(d, C_A, C_B) = A], \tag{2}$$

where $\Pr[x]$ denotes the probability of x. The worker's optimal decision y^* is then given by:

$$y^* = \begin{cases} 1 & \text{if } b^* \geq e, \\ 0 & \text{if } b^* < e. \end{cases} \tag{3}$$

An equilibrium is fully characterized by (b^*, y^*) and the CEO's equilibrium strategy, which is given by (1) if $y = 1$ and $s = AB$ if $y = 0$. The following proposition guarantees the existence and uniqueness of an equilibrium:

Proposition 1 *For any set of parameters* $(e, \rho, \tau_A, \tau_B)$, *a unique equilibrium exists.*

[12] Although there is incomplete information, the informed party moves last; thus subgame-perfection is a sufficient condition to guarantee sequential rationality.

4. Main Example: A Firm Facing Potential Entry

To fix ideas, here we introduce our main example. In the next two sections, we will derive general conditions for the main effects illustrated by this example and apply these conditions to other competition models.

Firm F has the ability to produce in segments A and B. Let c_F denote the constant marginal cost of producing A, with $c_F = 0$ if there is investment and the firm only produces A, and $c_F = c > 0$ otherwise. In our general notation, $\underline{c} = 0$ and $\overline{\overline{c}} = \overline{c} = c$. Furthermore, the firm's marginal cost of production in B is always c. Demand in segment x is given by the downward sloping demand function $Y(P)$ if $d \neq x$ and by $Y(P) + \delta$ if $d = x$, where $\delta > 0$ is a demand shifter that increases demand for x with probability ρ. We assume that monopoly profits (in all segments and for all possible levels of marginal costs and demand configurations) are strictly positive.

At period 2 new competitors may enter either segment. Without loss of generality, we assume that there is one potential entrant for each segment. Competition in $x \in \{A, B\}$ is low ($C_x = l_x$) if the entrant in x has marginal cost c, and it is high ($C_x = h_x$) if the potential entrant in x has zero marginal cost. Both F's CEO and the CEOs of the entrants observe the realizations of c_F, d, C_A and C_B before making their decisions. Firm F has a first-mover advantage; its CEO makes an irreversible decision of whether to focus on A or stay in/ enter both segments ($s = AB$). This is followed by the entry decisions of the competitors, who only enter segments in which they earn strictly positive payoffs.

At period 3, if there is entry and two firms operate in the same segment, firms compete on price by playing a Bertrand game. This implies that competitors only enter segments in which F either is not active or has strictly higher marginal cost. In segments without competition, a firm earns monopoly profits.

Ex post, F's profit in x if $C_x = l_x$ (i.e., if F remains a monopolist) is $\Pi_A^{l_A}(d, c_F)$ and $\Pi_B^{l_B}(d)$, with $\Pi_A^{l_A}(A, c_F) > \Pi_A^{l_A}(B, c_F) > 0$ and $\Pi_B^{l_B}(B) > \Pi_B^{l_B}(A) > 0$. If $C_A = h_A$ and there is investment ($y = 1$), F can prevent entry in A by choosing to focus ($s = A$), as then

$c_F = 0$. Thus we have $\Pi_A^{h_A}(d,0) = \Pi_A^{l_A}(d,0) > \Pi_A^{l_A}(d,c)$. Finally, if $C_x = h_x$ and cost is $c_x = c > 0$, entry in x occurs and we have $\Pi_A^{h_A}(d,c) = \Pi_B^{h_B}(d) = 0$. It is straightforward to check that Assumption 1 holds.

The next proposition fully characterizes the unique equilibrium for all possible sets of parameters for this example. Recall that $\tau_x \in [0,1]$ denotes the probability of $C_x = h_x$ (and $1 - \tau_x$ denotes the probability of $C_x = l_x$).

Proposition 2 *In the main example, for any set of parameters* $(e, \rho, \tau_A, \tau_B)$ *a unique equilibrium exists. The equilibrium belief* b^* *is weakly increasing in both* τ_A *and* τ_B. *The equilibrium is fully characterized by (3) and the following values for* b^*:

1. $b^* = 1$, if $\Pi_A^{l_A}(A,c) + \Pi_B^{l_B}(A) \leq \Pi_A^{l_A}(B,0)$;

2. $b^* = \rho + (1-\rho)(\tau_B + (1-\tau_B)\tau_A)$, if $\Pi_A^{l_A}(A,c) + \Pi_B^{l_B}(A) \in \left(\Pi_A^{l_A}(B,0), \Pi_A^{l_A}(A,0)\right]$ and $\Pi_A^{l_A}(A,c) \leq \Pi_A^{l_A}(B,0)$;

3. $b^* = \rho + (1-\rho)\tau_B$, if $\Pi_A^{l_A}(A,c) + \Pi_B^{l_B}(A) \in \left(\Pi_A^{l_A}(B,0), \Pi_A^{l_A}(A,0)\right]$ and $\Pi_A^{l_A}(A,c) > \Pi_A^{l_A}(B,0)$;

4. $b^* = \tau_B + (1-\tau_B)\tau_A$, if $\Pi_A^{l_A}(A,c) + \Pi_B^{l_B}(A) > \Pi_A^{l_A}(A,0)$ and $\Pi_A^{l_A}(A,c) \leq \Pi_A^{l_A}(B,0)$;

5. $b^* = \tau_B + \rho(1-\tau_B)\tau_A$ if $\Pi_A^{l_A}(A,c) + \Pi_B^{l_B}(A) > \Pi_A^{l_A}(A,0)$ and $\Pi_A^{l_A}(A,c) > \Pi_A^{l_A}(B,0)$.

In cases 2, 4 and 5, b^* is strictly increasing in both τ_A and τ_B.

Consider first the effect of τ_B (*competition in segment* B) on b^* (*the credibility of commitment*). This effect is easily explained by the fact that tougher competition reduces the expected profitability of segment B, and thus makes the diversified strategy less attractive. This is an example of the *contestability effect*, which we will formally define in the next section.

Next, consider the effect of τ_A on b^* (e.g., in cases 2, 4 and 5). The advantage of being focused is stronger when there is a potential entrant for A because, by being focused, F

can deter entry and protect its monopoly profits.[13] Thus, intuitively, as entry in A becomes more likely (i.e., as τ_A increases), the incumbent is more likely to focus ($s = A$) to become more efficient and deter entry in A. This is an example of the *efficiency effect*, which we will also formally define in the next section.

5. Competition and Commitment: General Results

Our main example illustrates a case in which competition (in either segment) unambiguously fosters commitment. In this section, we consider the general model as described in Section 3. Our goal is to identify general conditions that give rise to the two effects illustrated by our main example.

5.1. The Contestability Effect

In our main example, an increase in competitive pressure due to entry in segment B eliminates profits in B, which decreases the value of diversification. Tougher competition in B thus has a positive effect on the credibility of commitment b^*. Here, we demonstrate that this intuition is general: Whenever competition reduces profitability in B, an increase in the strength of competition increases commitment to $s = A$. We thus consider the following condition:

Condition 1 *For any given demand parameter d, (ex post) profit in segment B is (weakly) decreasing in the level of competition:*

$$\Pi_B^{l_B}(d) \geq \Pi_B^{h_B}(d) \text{ for all } d \in \{A, B\}. \tag{4}$$

[13]Using Fudenberg and Tirole's (1984) taxonomy of business strategies, focusing on A is a "top dog" strategy: The incumbent increases its size in market A (because marginal costs fall) and looks "tough" to potential entrants, thus effectively deterring entry.

Condition 1 is nearly as innocuous as Assumption 1; it simply states that competition reduces profits.[14] The natural definition of competition is, however, model-dependent; thus in later examples, we need to check whether this condition holds for each case that we analyze.

Under Condition 1, a focused strategy becomes more attractive when competitive pressure in B increases. The following proposition describes the effect of competitive pressure in segment B on the equilibrium credibility of commitment b^*:

Proposition 3 ***(The Contestability Effect)*** *Under Condition 1, the credibility of commitment is (weakly) increasing in the strength of competition in segment B: b^* is (weakly) increasing in τ_B.*

We call this positive effect of τ_B on the credibility of commitment the *contestability effect*. Intuitively, because increasing competition in B reduces profits in that segment, it reduces the value of diversification and thus the focused strategy becomes relatively more attractive. In other words, increasing competition in B reduces the ex ante value of the option to diversify.

5.2. The Efficiency Effect

In our main example, the threat of entry in A also enhances the credibility of a focused strategy. This happens because, without being focused, the firm could not generate profits in A when there is an efficient competitor, whereas under a focused strategy (and A-specific investments), the firm earns monopoly profits, i.e., the impact of the focused strategy on the firm's profit in A is maximal in the more competitive scenario. This intuition can be generalized. Conditional on segment-specific investments ($y = 1$), a focused strategy makes the firm more efficient (i.e., cost changes from $\bar{c}$ to $\underline{c}$). Such an efficiency improvement typically makes the firm better able to compete. If that advantage is stronger when competition is

[14] We do not impose Condition 1 on segment A because it is not necessary for the analysis that follows.

more intense, the firm is more likely to choose the focused strategy. Thus, we consider the following condition:

Condition 2 *For any given demand parameter d, improving cost efficiency (i.e., changing from $\bar{c}$ to $\underline{c}$) is more valuable under high competitive pressure:*

$$\Pi_A^{h_A}(d, \underline{c}) - \Pi_A^{h_A}(d, \bar{c}) \geq \Pi_A^{l_A}(d, \underline{c}) - \Pi_A^{l_A}(d, \bar{c}) \text{ for all } d \in \{A, B\}. \tag{5}$$

As we will illustrate below, in standard models of competition, Condition 2 is often more demanding than Condition 1. This is because high competitive pressure in A may significantly reduce $\Pi_A^{h_A}(d, \underline{c})$ and $\Pi_A^{h_A}(d, \bar{c})$. Hence, if the firm's profit is always non-negative (e.g., because it can shut down production in A), the left-hand side of (5) is very small. Condition 2 is thus more likely to hold when this *level effect* (i.e., the reduction of profit levels due to competition) is not too large. Note that level of profits in segment A under high cost is always non-negative under our (implicit) assumption that one may always quit segment A. Thus, if $\Pi_A^{h_A}(d, \underline{c}) = 0$, Condition 2 never holds strictly and only holds weakly if $\Pi_A^{l_A}(d, \underline{c})$ is also zero.

Under Condition 2, a focused strategy becomes more attractive when competitive pressure in A increases, and we obtain the following:

Proposition 4 ***(The Efficiency Effect)*** *Under Condition 2, the credibility of commitment is (weakly) increasing in the strength of competition in segment A: b^* is (weakly) increasing in τ_A.*

We call the positive effect of τ_A on the credibility of commitment the *efficiency effect*.[15]

[15] The term efficiency effect is also used in the IO literature to refer to a case in which a monopolist has stronger incentives to invest in cost-reducing innovations than does a potential entrant (see e.g., Tirole, 1988, p. 395).

5.3. The Impact of Competition on Costs and Profits

Assuming that Conditions 1 and 2 hold, we now summarize some additional results in the form of corollaries.

Because competition reduces the attractiveness of diversification, the worker is more confident of being rewarded if he/she undertakes A-specific investments:

Corollary 1 *The threat of tougher competition (i.e., an increase in τ_A or τ_B) fosters strategy-specific investments.*

Another interesting result is that competition can have a positive effect on profits. Specifically, an increase in competition may lead to a discontinuous increase in effort and thus to a discontinuous decline in costs. This occurs if competition changes b^* from just below e to just above e. In some cases, profits under sufficiently intense competition are larger than those in the absence of any competition:

Corollary 2 *The threat of tougher competition may increase F's profits. In particular, a situation in which F faces some competition can be more profitable than no competition.*

Intuitively, an increase in competition can solve the CEO's commitment problem and induce investments in a more efficient cost structure. Competition often reduces expected profits everywhere but at $b^* = e$, where profits jump upwards because of the elimination of inefficiencies.

In addition, the worker's expected payoff is zero for $b^* < e$ and $b^* - e$ for $b^* \geq e$ and is thus increasing in competition for $b^* \geq e$. Thus, *total production efficiency*, as given by the sum of the worker's and the firm's payoffs, may also strictly increase. This proves the following corollary:

Corollary 3 *The threat of tougher competition may increase the worker's surplus and total production efficiency.*

An interesting application of these results is that competition may increase productivity and profitability. These results suggest one (but not the only) channel through which competition can make firms more efficient.[16]

5.4. Contractibility Assumptions

As in the related literature, some degree of contractual incompleteness is necessary for our model to work. We have chosen the simplest possible setup to facilitate the exposition. Here, we provide a brief discussion of the key contractibility assumptions. We note, however, that many of the conclusions of our model are robust to different assumptions that allow for varying degrees of imperfect contractibility. We do not pursue such extensions here; these extensions are uninteresting and distract us from our main goal.

Commitment. Due to frictions in the contracting environment, we assume that the CEO is unable to commit to a given strategy at period 0, i.e., before the realizations of cost and demand conditions, and is thus subject to potential dynamic inconsistency problems. That is, by assumption, we exclude any kind of contractual solution that would commit the CEO to a given strategy. Commitment problems are at the core of our model; thus we are only interested in cases in which contractual solutions for these problems are not possible (or are imperfect). This assumption is standard in the related literature, which is reviewed in Section 2. This assumption is also particularly realistic in our application, as concepts of "strategy" and "strategy-specific investments" are vague and difficult to describe ex ante in formal contracts, although they might, to some extent, be observable and even easily understood by all agents.

In a similar vein, explicit contracts based on "implementation decisions" (i.e., cost reductions from $\bar{\bar{c}}$ to $\underline{c}$) are also not possible. Clearly, such contracts would allow for perfect commitment, and thus if these contracts are possible, commitment problems do not arise.

[16]The idea that a firm may use the strength of its competitors to its own advantage is known as "judo effects." See Gelman and Salop (1983) for an early example and Yoffie and Kwak (2002) for a discussion of related ideas in strategy.

Here the intuition is the same as before; concepts such as "cost-saving practices" or "productivity gains" might be observable ex post but difficult to describe ex ante.

Incentive compensation. Although explicit contracts on cost savings and strategy implementation decisions are difficult to write and enforce, the firm may indirectly achieve the same outcome by contracting on objective performance measures. For example, in the current version of the model, the problem of incentivizing segment-specific investments could be solved by offering the worker some performance-based compensation, e.g., the worker could be offered a share of the profits. In practice, however, such contracts may not be sufficient, for a number of reasons. For example, profit-sharing may be costly to the firm (i.e., profit sharing may leave rents to workers) if workers are protected by limited liability and have limited initial wealth to pay "entry fees."[17] Introducing such frictions into the model is straightforward but requires more structure and notation without providing benefits.[18]

6. Applicability and Different Notions of Competition

In this section, we consider three standard market games as subgames in period 3. In particular, we consider market games in which high competitive pressure is defined as a state such that: (i) there is a large number of competitors, (ii) product substitutability is high or (iii) firms compete on prices (Bertrand-style) rather than quantities (Cournot-style). Because we abstract from demand shocks, we drop all references to d for notational simplicity. All derived insights remain valid if we allow for demand uncertainty, as in the general framework of the previous section. In all examples that follow, it can be easily verified that Assumption 1 holds.

[17] This is a standard result in optimal contracting models under risk neutrality and limited liability (see, e.g., Laffont and Martimort, 2002).

[18] In particular, we would need to introduce yet another layer of uncertainty that would only be resolved at the end of period 3.

6.1. Number of Competitors

We model strategic interaction as Cournot competition, i.e., in each segment, firms simultaneously choose output quantities for a homogeneous good. F's marginal cost of production in A is given by $c_A \in \{\underline{c}, \overline{c}, \overline{\overline{c}}\}$, $\underline{c} < \overline{c}$; in B it is always $c_B = \overline{c}$. That is, its cost is $c_A = \underline{c}$ if $y = 1$ and $s = A$ and $c_A = \overline{c}$ otherwise. We do not make any assumptions on $\overline{\overline{c}}$. All other firms have constant marginal costs of $c \geq \underline{c}$. Cost $\overline{c}$ may be higher or lower than c, i.e., F may or may not be in a disadvantageous position in the industry.

Prices are given by a symmetric system of inverse demand functions: $P_x = \alpha - Y_x$, $x \in \{A, B\}$, where Y_x denotes total industry output in x and P_x denotes the market price. To guarantee strictly positive output levels, we require $\alpha > \max(\overline{c}, c)$. The total number of firms in x is given by $n_x \in \{\underline{n}, \overline{n}\}$ with $2 \leq \underline{n} < \overline{n}$. In state $C_x = l_x$, there are $\underline{n}$ firms in x, and in state $C_x = h_x$, there are $\overline{n}$ firms in x. To guarantee that all firms receive positive profits in equilibrium, we require the additional technical assumptions that $\overline{nc} \leq \alpha + (\overline{n} - 1)\, c$ and $c - \overline{c} < \alpha - c$.

F's equilibrium profit is given by[19]

$$\Pi_x^{C_x}(\overline{c}) = \frac{\left[\alpha - c + n_x (c - \overline{c})\right]^2}{(n_x + 1)^2} \text{ and } \Pi_A^{C_A}(\underline{c}) = \frac{\left[\alpha - c + n_A (c - \underline{c})\right]^2}{(n_A + 1)^2}.$$

It is easy to see that Condition 1 holds because $\frac{\partial \Pi_B^{C_B}(\overline{c})}{\partial n_B} < 0$. Thus, the contestability effect implies that competition in segment B fosters commitment.

To verify Condition 2, note that

$$\frac{\partial \Pi_A^{C_A}(c_A)}{\partial n_A} = -\frac{2}{(n_A + 1)^2} \underbrace{\sqrt{\Pi_A^{C_A}(c_A)}}_{\text{level effect}} \underbrace{\left[(\alpha - c) - (c - c_A)\right]}_{\text{competitive advantage effect}},$$

where c_A is either $\overline{c}$ or $\underline{c}$. Note that c_A has two opposing effects on this derivative. Low cost $c_A = \underline{c}$ reduces the *competitive advantage effect* (as defined above), which attenuates the neg-

[19]The calculation is standard and can be found in Belleflamme and Peitz (2010), p.55.

ative effect of competition on profits. However, low-cost firms also have larger profits for any given level of competition, which implies a stronger *level effect* (as defined above), which in turn amplifies the negative effect of competition on profits. Intuitively, tougher competition may have a stronger negative effect on profits for low-cost firms precisely because these firms begin at a higher profit level. Whether Condition 2 holds depends on the relative contribution of these two effects. In particular, the level effect is dominated when competition is not excessively strong. Specifically, algebra reveals that if $\overline{n} < (a-c)\,/\,[(a-c)-(c-\underline{c})-(c-\overline{c})]$, the competitive advantage effect dominates the level effect.[20] We conclude that, in this example, the efficiency effect is more likely to be of first-order importance if there are few incumbent rivals in the industry.

6.2. Product Substitutability

Here, we model strategic interaction as Cournot competition with heterogeneous goods. F faces exactly one competitor in each of the two segments. F's marginal cost of production c_x in segment $x \in \{A, B\}$ is as in the previous example, whereas each competitor has a marginal cost of production of $\overline{c}$. The price and quantity of the product of firm i in segment x are denoted p_x^i and y_x^i, respectively. The inverse demand system is given by

$$\begin{aligned} p_A^i &= \alpha - y_A^i - \sigma_A y_A^{-i}, \\ p_B^i &= \alpha - y_B^i - \sigma_B y_A^{-i}, \end{aligned} \tag{6}$$

where σ_x, $x \in \{A, B\}$, is the degree of substitutability between the goods of the two firms in each segment. We set $\sigma_x = \overline{\sigma}$ in state $C_x = h_x$ and $\sigma_x = \underline{\sigma}$ in state $C_x = l_x$, with

[20] This is similar to results in Vives (2008), who shows that increasing the number of firms tends to decrease the value of a cost reduction, as its negative impact on a firm's demand (which is similar to our level effect) dominates its positive impact on a firm's elasticity of demand (which resembles our competitive advantage effect).

$0 \leq \underline{\sigma} < \overline{\sigma} < 1$. Equilibrium profits for F are:[21]

$$\Pi_x^{C_x}(\overline{c}) = \left(\frac{\alpha - \overline{c}}{\sigma_x + 2}\right)^2 \text{ and } \Pi_A^{C_A}(\underline{c}) = \left[\frac{2(\alpha - \underline{c}) - \sigma_A(\alpha - \overline{c})}{4 - \sigma_A^2}\right]^2.$$

Again, the contestability effect holds because $\frac{\partial \Pi_B^{C_B}(\overline{c})}{\partial \sigma_B} < 0$, which implies Condition 1. To verify Condition 2, note that (after some algebra):

$$\frac{\partial}{\partial \sigma_A}\left(\Pi_A^{C_A}(\underline{c}) - \Pi_A^{C_A}(\overline{c})\right) = \frac{4(\overline{c} - \underline{c})\left[4\sigma_A(\alpha - \underline{c}) - (4 - 4\sigma_A + 3\sigma_A^2)(\alpha - \overline{c})\right]}{(4 - \sigma_A^2)^3},$$

which is positive if and only if σ_A is sufficiently large. The efficiency effect thus holds for sufficiently large $\underline{\sigma}$ because higher product substitutability is less of a problem for low-cost firms; more efficient firms find it easier to steal customers from competitors as products become more substitutable.[22] That is, as product substitutability increases, the competitive advantage effect becomes stronger and may eventually offset the level effect.

6.3. Price and Quantity Competition

Competition in prices (i.e., Bertrand competition) is typically fiercer than competition in quantities (Cournot competition).[23] Here we use the setup and notation of the previous subsection with $\sigma_A = \sigma_B = \sigma \in [0, 1)$. In state $C_x = l_x$, i.e., when firms in segment x play a Cournot game, F's equilibrium profits are

$$\Pi_x^{l_x}(\overline{c}) = \left(\frac{\alpha - \overline{c}}{\sigma + 2}\right)^2 \text{ and } \Pi_A^{l_A}(\underline{c}) = \left[\frac{2(\alpha - \underline{c}) - \sigma(\alpha - \overline{c})}{4 - \sigma^2}\right]^2.$$

[21] The calculation is very similar to that in Belleflamme and Peitz (2010), Section 3.3.2.

[22] More precisely, the effect holds if $\underline{\sigma} \geq \frac{2}{3(\alpha - \overline{c})}\left(2\alpha - \overline{c} - \underline{c} - \sqrt{2(\alpha - \overline{c})(\overline{c} - \underline{c}) + (\alpha - \underline{c})^2}\right)$. Again, our results are similar to those found in Vives (2008), who shows that higher product substitutability tends to increase the value of a cost reduction.

[23] We can interpret Cournot competition as competition in capacity-constrained markets (see Kreps and Scheinkman, 1983).

In state $C_x = h_x$ firms compete by simultaneously setting prices and the resulting demand is given by the inverse of (6). Firm F's equilibrium profits are given by

$$\Pi_x^{h_x}(\bar{c}) = \frac{(\alpha - \bar{c})^2 (1-\sigma)}{(\sigma+1)(\sigma-2)^2} \text{ and } \Pi_A^{h_A}(\underline{c}) = \frac{\left[(2-\sigma^2)(\alpha-\underline{c}) - \sigma(\alpha-\bar{c})\right]^2}{(4-\sigma^2)^2(1-\sigma^2)}.$$

Because of $\Pi_B^{h_B}(\bar{c}) - \Pi_B^{l_B}(\bar{c}) < 0$, Condition 1 and the contestability effect hold, and the credibility of commitment is enhanced by competition in B.

To verify Condition 2, note that (after some algebra)

$$\Pi_A^{h_A}(\underline{c}) - \Pi_A^{h_A}(\bar{c}) - \left[\Pi_A^{l_A}(\underline{c}) - \Pi_A^{l_A}(\bar{c})\right] = \frac{\sigma^3(\bar{c}-\underline{c})\left[\sigma(\alpha-\underline{c}) - (2-\sigma)(\alpha-\bar{c})\right]}{(1-\sigma^2)(4-\sigma^2)^2},$$

the sign of which is in principle ambiguous. Condition 2 is satisfied if the degree of product substitutability σ is sufficiently high, i.e. if $\sigma \geq 2(\alpha-\bar{c})/(2\alpha-\underline{c}-\bar{c})$.

7. Competition versus Leadership Styles

As discussed in the literature review in Section 2, certain leadership styles may improve the firm's ability to commit to a given strategy. In light of our previous results, an interesting question is how competition interacts with leadership styles.

Similar to previous papers (e.g., Rotemberg and Saloner, 2000; Bolton, Brunnermeier, and Veldkamp, 2013), we now assume that there are two possible types of CEOs, each of whom has a different leadership style $l \in \{f, v\}$: a CEO can be either *flexible* (type f) or *committed* (type v - for visionary). The CEO's leadership style is common knowledge. A flexible CEO always selects the strategy that maximizes expected profits at period 2, without any bias towards either A or AB (i.e., a flexible CEO behaves as in the previous sections). In particular, a flexible CEO cannot credibly commit to either A or AB. In contrast, a committed CEO credibly commits either to strategy $s = A$ or to strategy $s = AB$, independent of the realizations of d, C_A and C_B. Such a commitment is possible either because the CEO has biased preferences towards a specific strategy or because the CEO's beliefs concerning the profitability of a given strategy differ from the beliefs of the market (Rotemberg and Saloner, 2000; Van den Steen, 2005).

We use our main example of a monopolist facing potential entry (discussed in Section 4), and for brevity of exposition, we assume $\rho = 0$ and that the conditions for Case 2 in Proposition 2 hold. In this case, both the contestability effect and the efficiency effect are at work. Also for brevity of exposition, here we only consider the non-trivial case in which a committed leader is committed to $s = A$.

If $l = v$ (i.e., the CEO is committed to A), then the worker expects $s = A$ with probability one, in which case the worker always invests because $e < 1$. The expected profit π_v is independent of τ_A and τ_B (as $\Pi_A^{h_A}(B, 0) = \Pi_A^{l_A}(B, 0)$), thus $\pi_v = \Pi_A^{l_A}(B, 0)$. Competition has no effect on profit under a committed CEO; if the CEO credibly commits to A, no entry in A occurs.

Full commitment may not be optimal. Thus, if the shareholders of the firm could choose the style of the CEO, they would need to compare π_v with the expected profit under a flexible CEO:

$$\pi_f = \begin{cases} (\tau_A + \tau_B - \tau_A\tau_B)\,\Pi_A^{l_A}(B, 0) + (1 - \tau_B)(1 - \tau_A)\left(\Pi_A^{l_A}(B, c) + \Pi_B^{l_B}(B)\right), & \text{if } y = 1 \\ (1 - \tau_A)\,\Pi_A^{l_A}(B, c) + (1 - \tau_B)\,\Pi_B^{l_B}(B), & \text{if } y = 0 \end{cases}.$$

The optimal leadership style depends on the credibility of commitment b^*, which in turn depends on τ_A and τ_B. If b^* is sufficiently large, such that investment is always undertaken under a flexible CEO (i.e., if $b^* \geq e$), a flexible CEO is trivially superior to a committed CEO: The investment is undertaken under either CEO, but only the flexible CEO maximizes profit ex post. In contrast, if $b^* < e$, the flexible CEO cannot motivate workers to invest. The following proposition summarizes these observations:

Proposition 5 *Assume that the conditions of Case 2 of Proposition 2 hold. If $\tau_A + \tau_B - \tau_A\tau_B \geq e$, the optimal choice of leadership style is given by $l^* = f$. If $\tau_A + \tau_B - \tau_A\tau_B < e$,* *the optimal style may be either f or v, and the benefit of employing a flexible leader relative to that of employing a committed leader, $\pi_f - \pi_v$, is decreasing in both τ_A and τ_B.*

Proposition 5 provides an intuitive summary of the trade-off between commitment and flexibility and its implications for the optimality of leadership styles. Committed leaders offer full commitment. Full commitment is desirable only when (i) investment cannot be achieved without full commitment and (ii) the value of ex post adaptation is low. Investment can be achieved without full commitment if competition (i.e., τ_A, τ_B) is high, i.e. if $\tau_A + \tau_B - \tau_A \tau_B \geq e$. Thus, if competition is sufficiently strong, leadership flexibility is optimal.

For lower levels of competition ($\tau_A + \tau_B - \tau_A \tau_B < e$), either flexible or committed leadership may be optimal. Conditional on $\tau_A + \tau_B - \tau_A \tau_B < e$, $\pi_f - \pi_v$ is decreasing in both τ_A and τ_B. Thus we can have a non-monotonic relationship between competition and leadership styles. First, under very intense competition, investment without full commitment is possible, and thus flexible leadership is optimal. Second, under moderate competition, investment is not possible without a fully committed leader. Thus, if commitment is more valuable than flexibility, it is optimal to employ a committed CEO. Finally, if competition is very weak, the diversification strategy becomes more profitable, eventually making the employment of a flexible CEO optimal.

8. Concluding Remarks

There are some directions in which our model can be extended. First, our analysis similarly applies to cases in which strategy-specific investments improve profitability by increasing demand rather than by reducing costs. Second, it is possible to generalize our model to situations in which commitment also serves as a coordination device. In such an extension, to induce strategy-specific investments, competitive pressure must be stronger than that in the case of no coordination frictions.[24]

[24] Both such extensions can be found in on-line appendixes available at the authors' websites.

Our analysis provides clear predictions that could be assessed using data. The main empirical implication of the contestability effect is that, when faced with increasing competition in a given segment or market for which efficiency improvements are difficult to obtain, a multi-market firm: (i) eventually leaves that market and (ii) becomes more efficient in the remaining markets in which it operates. Furthermore, a firm operating in one market becomes more efficient if competition increases in other markets. The main empirical implication of the efficiency effect is that, when faced with increasing competition in a given market for which efficiency improvements are possible, a multi-market firm: (i) focuses more on that market (i.e., ceases operating in other markets) and (ii) becomes more efficient in the market in which competition has increased. The efficiency effect is more likely to be observed in certain industries, such as those with few exogenous barriers to entry, few incumbent rivals, and high product substitutability.

The related empirical literature, which we briefly review, reports some evidence that is consistent with such effects. However, this evidence is not unequivocal; it is only suggestive. We hope that future work will test the implications of the model more directly.

A. Appendix

Proof of Proposition 1

The uniqueness and existence of equilibrium follow directly from the fact that, for any set of parameters $(e, \rho, \tau_A, \tau_B)$, the problem can be solved recursively: The firm's optimal strategy conditional on $y = 1$ is uniquely determined by the profit functions according to (1), which then implies that belief b^* is uniquely defined by (2) and (1):

$$\begin{aligned} b^* &= \tau_A \tau_B \left(\rho \mathbf{1}\left[s\left(A, h_A, h_B\right) = A\right] + (1-\rho)\mathbf{1}\left[s\left(B, h_A, h_B\right) = A\right]\right) \\ &+ (1-\tau_A)\tau_B\left(\rho \mathbf{1}\left[s\left(A, l_A, h_B\right) = A\right] + (1-\rho)\mathbf{1}\left[s\left(B, l_A, h_B\right) = A\right]\right) \\ &+ \tau_A (1-\tau_B)\left(\rho \mathbf{1}\left[s\left(A, h_A, l_B\right) = A\right] + (1-\rho)\mathbf{1}\left[s\left(B, h_A, l_B\right) = A\right]\right) \\ &+ (1-\tau_A)(1-\tau_B)\left(\rho \mathbf{1}\left[s\left(A, l_A, l_B\right) = A\right] + (1-\rho)\mathbf{1}\left[s\left(B, l_A, l_B\right) = A\right]\right), \end{aligned} \tag{7}$$

where $\mathbf{1}[x]$ is an indicator function that equals 1 if x is true and zero otherwise. Once b^* is computed, (3) gives the worker's optimal decision y^*. The firm's optimal strategy conditional on $y = 0$ is $s = AB$.

Proof of Proposition 2.

Existence and uniqueness follow from Proposition 1. First note that (as $Y(P)$ does not depend on the segment x) we have $\Pi_A^{l_A}(A, c) + \Pi_B^{l_B}(A) = \Pi_A^{l_A}(B, c) + \Pi_B^{l_B}(B)$, $\Pi_A^{l_A}(A, 0) > \Pi_B^{l_B}(A)$ and $\Pi_A^{l_A}(A, c) = \Pi_B^{l_B}(B)$.

Case 1: if $y = 1$ the firm can guarantee a profit of at least $\Pi_A^{l_A}(B, 0) = \Pi_A^{h_A}(B, 0)$ by focusing on A. As this profit is larger than the best-case scenario under diversification ($\Pi_A^{l_A}(A, c) + \Pi_B^{l_B}(A)$), the firm always selects A over AB, which implies that $b^* = 1$.

Case 2: We first note that if $C_B = h_B$, $\Pi_B^{h_B}(d) = 0$, and the CEO chooses the focused strategy regardless of the realization of d and C_A, i.e., $s(d, C_A, h_B) = A$. If $d = A$ and $C_B = l_B$, we find that (from the conditions that define this case):

$$\begin{aligned} \Pi_A^{l_A}(A, 0) &\geq \Pi_A^{l_A}(A, c) + \Pi_B^{l_B}(A) \Rightarrow s\left(A, l_A, l_B\right) = A, \\ \Pi_A^{h_A}(A, 0) &= \Pi_A^{l_A}(A, 0) \geq \Pi_B^{l_B}(A) \Rightarrow s\left(A, h_A, l_B\right) = A, \end{aligned}$$

which implies $s = A$ with probability 1 if $d = A$. If $d = B$, we have that $s(B, C_A, h_B) = A$

as argued above, and (from the conditions that define this case):

$$\begin{aligned}\Pi_A^{l_A}(B,0) &< \Pi_A^{l_A}(A,c)+\Pi_B^{l_B}(A)=\Pi_A^{l_A}(B,c)+\Pi_B^{l_B}(B)\Rightarrow s(B,l_A,l_B)=AB,\\ \Pi_A^{h_A}(B,0) &= \Pi_A^{l_A}(B,0)\geq \Pi_A^{l_A}(A,c)=\Pi_B^{l_B}(B)\Rightarrow s(B,h_A,l_B)=A,\end{aligned}$$

which implies $s=A$ with probability $\tau_B+(1-\tau_B)\tau_A$. Thus, we have $b^*=\rho+(1-\rho)(\tau_B+(1-\tau_B)\tau_A)$.

Case 3: This is identical to Case 2, except that when $d=B$ and $(C_A,C_B)=(h_A,l_B)$, the firm now chooses $s=AB$. Thus we have $b^*=\rho+(1-\rho)\tau_B$.

Case 4: This is identical to Case 2, except that when $d=A$ and $(C_A,C_B)=(l_A,l_B)$, the firm now chooses $s=AB$. Thus, regardless of d, the probability of $s=A$ is $\tau_B+(1-\tau_B)\tau_A$ and we have $b^*=\tau_B+(1-\tau_B)\tau_A$.

Case 5: This is identical to Case 4, except that when $d=B$ and $(C_A,C_B)=(h_A,l_B)$, the firm now chooses $s=AB$. Thus, the probability of $s=A$ is $b^*=\rho[\tau_B+(1-\tau_B)\tau_A]+(1-\rho)\tau_B=\tau_B+\rho(1-\tau_B)\tau_A$.

Proof of Corollary 1

It follows immediately from the effects of τ_A and τ_B on b^* (Propositions 3 and 4) and from (3).

Proof of Corollary 2.

We construct an example that demonstrates both claims. Assume the setup of Section 4 and Case 3 of Proposition 2 with $\Pi_A^{l_A}(A,c)+\Pi_B^{l_B}(A)<\Pi_A^{l_A}(A,0)$.[25] Suppose initially that $\tau_A=\tau_B=0$ (the firm is a monopolist and faces no threat of entry). We have $b^*=\rho$, thus if $\rho<e$, F's expected profit is $\Pi_A^{l_A}(A,c)+\Pi_B^{l_B}(A)\equiv\pi^M$, that is, under monopoly and $\rho<e$, workers exert no effort and the firm always diversifies.

Holding $\tau_A=0$, our goal is to find a set of parameters e, $\tau_B>0$ and $\rho>e$ such that the

[25] For example, these assumptions hold if we have $Y(P)=\alpha-P$, $\alpha>c$, $\delta>c$ and $\alpha^2<(\alpha+\delta-c)^2+(\alpha-c)^2<(\alpha+\delta)^2$, which can always be fulfilled by choosing a sufficiently large value for δ.

firm's expected profit π^* under these parameters exceeds π^M. Let

$$\rho = \rho' \equiv \frac{\Pi_A^{l_A}(A, c) + \Pi_B^{l_B}(A) - \Pi_A^{l_A}(B, 0)}{\Pi_A^{l_A}(A, 0) - \Pi_A^{l_A}(B, 0)},$$

which is strictly less than 1 because $\Pi_A^{l_A}(A, c) + \Pi_B^{l_B}(A) < \Pi_A^{l_A}(A, 0)$. Choose any $e \in (\rho', 1)$. Let $\tau_B \in T \equiv \left(\frac{e-\rho'}{1-\rho'}, 1\right)$, i.e., we have $\rho' + (1-\rho')\tau_B \geq e$ for $\tau_B \in T$. We have that, for $\tau_B \in T$, focusing on A is optimal if $d = A$ (as $\Pi_A^{l_A}(A, 0) > \Pi_A^{l_A}(A, c) + \Pi_B^{l_B}(A)$). If $d = B$, diversification is optimal if $C_B = l_B$ (as $\Pi_A^{l_A}(B, 0) < \Pi_A^{l_A}(A, c) + \Pi_B^{l_B}(A) = \Pi_A^{l_A}(B, c) + \Pi_B^{l_B}(B)$)), and focusing on A is optimal if $C_B = h_B$ (as $\Pi_B^{h_B}(B) = 0$). Thus

$$\pi^* = \rho'\Pi_A^{l_A}(A, 0) + (1-\rho')\tau_B\Pi_A^{l_A}(B, 0) + (1-\rho')(1-\tau_B)\left(\Pi_A^{l_A}(B, c) + \Pi_B^{l_B}(B)\right).$$

Now, take the limit of π^* as τ_B goes to 1:

$$\lim_{\tau_B \to 1} \pi^* = \rho'\Pi_A^{l_A}(A, 0) + (1-\rho')\Pi_A^{l_A}(B, 0) = \Pi_A^{l_A}(A, c) + \Pi_B^{l_B}(A) = \pi^M.$$

As π^* is decreasing in $\tau_B \in T$, we have that for any $\tau_B \in T$, $\pi^* > \pi^M$.

Proof of Proposition 3

From (7), we obtain

$$\begin{aligned}
\frac{\partial b^*}{\partial \tau_B} = {} & \tau_A\rho\left(\mathbf{1}\left[s(A, h_A, h_B) = A\right] - \mathbf{1}\left[s(A, h_A, l_B) = A\right]\right) + \\
& \tau_A(1-\rho)\left(\mathbf{1}\left[s(B, h_A, h_B) = A\right] - \mathbf{1}\left[s(B, h_A, l_B) = A\right]\right) + \\
& (1-\tau_A)\rho\left(\mathbf{1}\left[s(A, l_A, h_B) = A\right] - \mathbf{1}\left[s(A, l_A, l_B) = A\right]\right) + \\
& (1-\tau_A)(1-\rho)\left(\mathbf{1}\left[s(B, l_A, h_B) = A\right] - \mathbf{1}\left[s(B, l_A, l_B) = A\right]\right).
\end{aligned}$$

Because $s(d, C_A, l_B) = A \Rightarrow \Pi_A^{C_A}(d, \overline{c}) + \Pi_B^{l_B}(d) \leq \Pi_A^{C_A}(d, \underline{c}) \Rightarrow$ (because of (4)) $\Pi_A^{C_A}(d, \overline{c}) + \Pi_B^{h_B}(d) \leq \Pi_A^{C_A}(d, \underline{c}) \Rightarrow s(d, C_A, h_B) = A$ implies $\mathbf{1}\left[s(d, C_A, h_B) = A\right] \geq \mathbf{1}\left[s(d, C_A, l_B) = A\right]$ for all $(d, C_A) \in \{A, B\} \times \{l_A, h_A\}$, we have that $\frac{\partial b^*}{\partial \tau_B}$ is always nonnegative.

Proof of Proposition 4

From (7), we obtain

$$\begin{aligned}\frac{\partial b^*}{\partial \tau_A} &= \tau_B \rho \left(\mathbf{1}\left[s\left(A, h_A, h_B\right) = A\right] - \mathbf{1}\left[s\left(A, l_A, h_B\right) = A\right]\right) + \\ &\quad \tau_B \left(1-\rho\right) \left(\mathbf{1}\left[s\left(B, h_A, h_B\right) = A\right] - \mathbf{1}\left[s\left(B, l_A, h_B\right) = A\right]\right) + \\ &\quad \left(1-\tau_B\right) \rho \left(\mathbf{1}\left[s\left(A, h_A, l_B\right) = A\right] - \mathbf{1}\left[s\left(A, l_A, l_B\right) = A\right]\right) + \\ &\quad \left(1-\tau_B\right)\left(1-\rho\right) \left(\mathbf{1}\left[s\left(B, h_A, l_B\right) = A\right] - \mathbf{1}\left[s\left(B, l_A, l_B\right) = A\right]\right).\end{aligned}$$

Because of $s\left(d, l_A, C_B\right) = A \Rightarrow \Pi_A^{l_A}\left(d, \overline{c}\right) + \Pi_B^{C_B}\left(d\right) \leq \Pi_A^{l_A}\left(d, \underline{c}\right) \Rightarrow$ (because of (5)) $\Pi_A^{h_A}\left(d, \overline{c}\right) + \Pi_B^{C_B}\left(d\right) \leq \Pi_A^{h_A}\left(d, \underline{c}\right) \Rightarrow s\left(d, h_A, C_B\right) = A$ we obtain $\mathbf{1}\left[s\left(d, h_A, C_B\right) = A\right] \geq \mathbf{1}\left[s\left(d, l_A, C_B\right) = A\right]$ for all $\left(d, C_B\right) \in \{A, B\} \times \{l_B, h_B\}$, and thus $\frac{\partial b^*}{\partial \tau_A}$ is always nonnegative.

Proof of Proposition 5.

Under a flexible CEO, we obtain $b^* = \tau_B + \left(1-\tau_B\right)\tau_A$ (see the proof Case 2 of Proposition 2). Thus, if $\tau_B + \left(1-\tau_B\right)\tau_A \geq e$, the worker chooses $y = 1$. Thus, a flexible CEO is trivially superior to a committed CEO: Investment occurs under either CEO, but the flexible CEO maximizes profit ex post, whereas the committed CEO does not.

If $\tau_B + \left(1-\tau_B\right)\tau_A < e$, the flexible CEO cannot motivate the worker to invest in A-specific skills. As $\pi_v = \Pi_A^{l_A}\left(B, 0\right) < \Pi_A^{l_A}\left(B, c\right) + \Pi_B^{l_B}\left(B\right)$, the optimal style can be either $l^* = v$ or $l^* = f$ depending on the specifications of the model. Because π_v is independent of τ_A and τ_B, $\pi_f - \pi_v$ is strictly decreasing in both τ_A and τ_B.

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