Commitment, Firm and Industry Effects in Strategic Divisionalization

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Abstract

We modify the canonical two-stage game of strategic divisionalization by adding an initial stage to allow firms to credibly commit to whether they will create additional divisions or not. This generates a unique equilibrium prediction consistent with the key stylised fact that often only one of the mother firms alone creates independent divisions. Examples include GM versus Ford for national markets and many cases of franchising in local markets (e.g., McDonald's vs Burger King). A key implication for organization theory is that the adoption of the M versus the U-form is part of a strategic whole necessarily involving all competitors, rather than just intra-firm managerial and informational considerations as in the received theory.

Key words: M-form vs U-form, organizational form, franchising, strategic endogenous organizational heterogeneity, organizational preemption.

1 Introduction

In business strategy and organization theory on one hand, and in industrial organization on the other, divisionalization refers to one of the most important long-run strategic decisions of a firm, namely, one mother firm can create multiple divisions that have some extent of autonomy over the lower-end operating decisions (e.g., pricing and output decisions), and in this regard compete with each other as they compete with other firms or their divisions in the same market. Probably the most well-known example in this context is the automobile giant, General Motors, which owns a number of divisions including Chevrolet, Buick, Pontiac, GMC, Oldsmobile, etc. Starting first as a holding company, General Motors has a long and well-known history of divisional autonomy. The long-time president, chairman and CEO of General Motors, Alfred Sloan, was a devoted follower of this tradition and a strong advocate of the policy that while the top executives would serve only in an advisory capacity to the divisions, the operating decisions would remain "absolutely" in the hands of the division managers (see *pp.50-87* in Freeland, 2001).[1]

Experts in organization theory and industrial organization (i.e., the strategists and the economists) view the divisionalization problem mostly via quite different lenses. Roughly speaking, in the former fields the organization's structure choices are usually weighed against various internal factors that govern the organization's information flow, managerial capacity, incentive controls, etc., while the organization is treated as a complex hierarchical system that has a unilateral contact with an abstracted, mostly non-competitive environment (as an information or task feeder). For industrial organization in contrast, firms are usually treated as black boxes with its structural complexity highly abstracted, and the study revolves around firms' strategic interactions in a competitive environment. Each way of abstraction tackles one side of the problem and has its unique merits, but one can hardly deny that both the firm-internal, non-competitive characteristics, and the competitive environmental dynamics play an important role in shaping the organization's structure. This paper starts to tackle with the divisionalization problem using an IO approach while integrating with organization theory through a fixed divisionalization cost.

Strategic divisionalization is a staple subject in industrial organization. However, IO economists usually look past intra-firm organizational aspects to focus instead on market share and other industry-level effects: Even with induced self-competition or cannibalization effects (the *competition effect*), the incentive to divisionalize is to increase the mother firm's overall market share and its total profit by creating additional competing units (the

[1] Despite of some back-and-forth debate in the top management over the degree of decentralization within the firm, divisional interdependence largely remained in the boundary of policy decisions (e.g., engineering, designing decisions).

business-stealing effect). In short, divisionalization is simply seen as the converse operation to a horizontal merger or acquisition.[2] The formal study of divisionalization in a game-theoretic framework traces back to Schwartz and Thompson (1986), which justify the divisionalization move as an entry deterrence tool to forestall potential entry and maintain monopoly status. The dominant model for strategic divisionalization is a two-stage game wherein firms choose the number of divisions in the first stage and then let all the divisions thus created compete in Cournot fashion in a homogeneous-good industry in the second stage. Assuming costless divisionalization and linear demand and production costs, Corchon (1991) and Polasky (1992) showed that each firm would create an infinite number of divisions, thus giving rise to perfect competition and zero profit in the equilibrium.

However, although many firms do divisionalize, nothing akin to perfect competition (or excessive divisionalization) has ever been observed in the real world. Following Corchon (1991) and Polasky (1992), efforts were made to modify the theory to explain why divisionalizing firms would create a finite number of divisions in the equilibrium. Introducing a unit cost of creating each additional division, Baye et al. (1996) derived a unique equilibrium with finitely many divisions, thus circumventing the self-defeating perfect competition trap. Other works avoid the perfect competition outcome by introducing product differentiation in a stylized way (Yuan, 1999; Ziss, 1998). Despite a sizable literature in this field, intra-firm divisionalization as one of the key strategies in the complex process of endogenous determination of market structure has remained less than fully understood. A key observation, not covered in the extant literature, is that in some global markets, some firms, often a single one, do while others do not. A prototypical example is the automobile industry. As mentioned earlier, General Motors had several non-luxury divisions early on, while its long-time rival Ford remained in a more centralized form.[3] This is the key stylised fact that motivates our study: firms differ in their degree of divisionalization, and in the GM vs. Ford case, only one firm divisionalizes.

[2]See Faulí-Oller and Sandonis (2018) for a thorough survey on horizontal mergers.

[3]Ford did own several subsidiaries including Mercury, Lincoln and Troller. However, Mercury was discontinued in 2010, while Lincoln targets more towards the luxury car market and Troller the off-road vehicle market. More importantly, we don't find evidence that suggests divisional autonomy among Ford's subsidiaries. Therefore, the scope of intra-firm divisional competition is limited. In contrast, GM is well-known for its divisional autonomy, namely the vast authority given to their division managers (Alonso et al., 2008; Baye et al., 1996).

A key feature to the divisionalization problem discussed at hand is divisional autonomy (up to operating decisions). We study divisional competition in this paper, focus on the underlying incentives and the endogenous organizational structure thus given rise to, although the organizational pros and cons of divisionalization will be incorporated simply in a fixed divisionalization cost. Therefore, a typical conglomerate company may own many subsidiaries, but if the subsidiaries operate in different market sectors (e.g., GE Healthcare, GE Aviation and GE Power) or if they collaborate on one task line (e.g., designing, financing, sourcing), it is beyond the scope of this paper.

In this regard, one may say franchising is another field akin to our subject (Baye et al., 1996). Franchised units can be established contiguous to each other, "steal" sales of each other and the company-owned units. In fact, the issue of encroachment has gained a lot of prominence in the United States over the last decade (Kalnins and Lafontaine, 2004). Most franchisees are allowed some autonomy over their units. McDonald's claims that ninety percent of their restaurants are "independently owned and operated by franchisees, who have the ability to set their own prices".[4] Franchising is a common practice for restaurant chains, retail mega-stores, electronics, office supplies, hairdresser salons, tax services, etc., but the degree of franchising differs across firms. In the United States, McDonald's has absolutely more franchised units than Burger King, but on top of that, McDonald's also tends to give only 1-2 units per franchisee while Burger King, in contrast, has many very large franchisees that could own more than 10 stores clustered in just a few geographical markets (Kalnins and Lafontaine, 2004). That said, McDonald's seems to be the more "divisionalized" chain in a local market with a higher degree of divisional competition. In practice, McDonald's uses a combination of owner-operators and ex post rent to motivate franchisees to self-regulate and behave competitively, and tightly controls the ability of franchisees to acquire new stores based on their current performance (Kaufmann and Lafontaine, 1994).

This paper contributes to organization theory in business and strategic divisionalization in IO by bridging them. To organization theory, where firms' structure decision is usually weighed against firm-specific characteristics and non-competitive environmental dynamics, this paper adds a new dimension of strategic dependence on this key decision, thus bringing

[4]The claim is made on their website, https://www.mcdonalds.com/us/en-us/faq/business.html.

market competition to the fore of organization design problem. To IO, we amend the basic two-stage game model of strategic divisionalization in a plausible way to yield equilibrium outcomes consistent with the GM vs. Ford stylised fact with the absence of perfect competition. Moreover, our model gives rise to asymmetric organization form choices even when all firms are ex ante symmetric.

In what follows, we start from a general model where divisionalization entails both fixed costs in the preparation stages and variable costs per additional division created. The fixed cost connects to classical organization theory and represents the firm's natural proclivity toward U-form (centralized) or M-form (divisionalized). We add an initial stage to the basic two-stage divisionalization game wherein each firm credibly announces and commits to whether it will divisionalize in the following stages, thus shedding light on strategic commitment which fits with a long-standing approach in business strategy (Ghemawat, 1991) and industrial organization (Shapiro, 1989). The general model shows that asymmetric structure choices can arise as a Nash equilibrium outcome in an ex-ante perfectly symmetric industry: some firms choose M-form and others remain as U-form, while the number of M-form firms depends on the magnitude of fixed divisionalization cost.

In the second model we consider a special case where the variable divisionalization cost is zero.[5] We show that except when the fixed cost is too large (thus no firm divisionalizes), the equilibrium predicts one firm to divisionalize and others not. Thus by adding the initial commitment stage we neatly eliminate perfect competition which would otherwise arise without the additional stage and give rise to an equilibrium outcome corresponding to the GM vs. Ford stylized fact, though some caveats will be discussed at the end of Section 4.1. In the third and last model, we consider a duopoly asymmetric in their divisionalization (fixed) costs, who thus differ in their internal proclivity towards M-form and U-form, for a full comparison with the classic organization theory. Compared with organization theory which emphasizes on the firm-internal characteristics and non-competitive environmental dynamics, we show that by incorporating the third factor, namely the competitive market dynamics to the problem, the two theories' predictions can be in full, or partial agreement,

[5]This assumption is commonly adopted by most IO divisionalization papers. One can argue that it is especially relevant for holding companies.

or in full conflict, depending on the fixed divisionalization cost.

The remainder of this paper is organized as follows. Section 2 has a brief literature review on divisionalization of business strategy and organization theory. Section 3 introduces the model setup, connects with classical organization theory, and then presents the general three-stage divisionalization game with strictly positive fixed and variable costs. Section 4 considers two extensions: a model without variable divisionalization cost, and an asymmetric duopoly model for a full comparison with organization theory. Section 5 concludes.

2 Literature Review

While strategic divisionalization is a relatively succinct literature strand in IO (with the important works already covered in the Introduction), the volume on organizational form choices becomes large in business strategy and organization theory literature.

In business strategy, this issue came to the fore early on with important work contrasting the pros and cons of the U-form (unitary or single-divisional firm) and the M-form (multi-divisional firm) by Chandler (1962, 1990) and Williamson (1975). This early work argued with great insight that a number of different factors, such as the nature of managerial hierarchies and contracts, the management of informational flows, the size of the firm, and notions of economies of scale and scope, give rise to the complex trade-offs that determine the final decision of the firm on this key long-term commitment. This pioneering work found formalized expression with significant delay upon the emergence of modern incentive theory in economics (e.g., Maskin et al., 2000).[6] For the firm's organizational structure in general, early works tend to owe structural differentiation across organizations to various imperatives, such as the environment, technology, information imperative, etc. (Keats and O'Neill, 2005).

The modern organizational economics literature emphasizes various trade-offs embedded in firms' structure choices: coordination vs. adaption, specialization vs. communication, efficiency vs. incentives, etc. Coordination requires a certain degree of synchronization that is

[6]As noted by several authors, including Maskin et al. (2000), the complex trade-offs that underpin the optimal organization of a firm are similar to their analogs in a planned economy, e.g., the Soviet Union or China. Likewise, one might add historically large empires, and the most obvious examples of an M-form in this context are the West and East-Roman empires first formed in 285 AD out of a unitary empire, and then re-formed again for good in 395 AD (upon a lapse back to a U-form for some decades in between).

facilitated by centralization (or a more unitary structure) while adaption to local conditions is facilitated by decentralization (or a more divisionalized structure). Dessein and Santos (2006) endogenize the organization's choice of adaptiveness using a team-theoretic model to solve an organizational design problem of how to divide labor to take up tasks and how much the labor should tailor his primary action to his local information in an uncertain business environment, and the follow-up work by Alonso et al. (2008) shows that decentralization can be optimal even when coordination is very important. In other works, the cost of communication via the exchange of information across divisions is weighed against the benefit of specialization via divisionalization when examining the organization's hierarchical efficiency, while the organization is sometimes deemed as an information processor (Bolton and Dewatripont, 1994; Patacconi, 2009) and sometimes a knowledge-based hierarchy (Garicano, 2000). Lastly, various incentive problems, such as eliciting truthful divisional communication (Friebel and Raith, 2010), dealing with the possibility of shading (Hart and Holmstrom, 2010), protecting the source of organizational rents (Rajan and Zingales, 2001), are incorporated into the organization design problem. Using agent-based simulation, Rivkin and Siggelkow (2003) synthesize the above studied factors, including three design elements (a vertical hierarchy, an incentive system, the decomposition of decisions) and two contextual variables (the interactive pattern among decisions, the managerial limits) to examine under what circumstances an active (i.e., more centralized) hierarchy is the most efficient.[7]

Inherent in the business and organization literature are a treatment of one organization as the panorama of study and an abstraction of industrial competition. Therefore, such analysis tends to overlook the strategic aspect of an organization's structural decision and to view firms' structural decisions as mostly independent. An exception is strategic delegation (e.g., Fershtman and Judd, 1987). Lying at the border of business strategy and industrial

[7]Another strand of literature related to this problem specifically studies the "multi-unit multi-market (MUMM) firms", mostly conglomerates. Greve and Baum (2001) provide a thorough survey. Multi-market operation may lead to a greater scope of collusive strategies, but it evades the focus of this paper (on divisionalization in single markets). The multi-divisional mother firms referred in this paper fit better with the multi-unit/multi-product firms, but a key difference is that multi-unit/multi-product firms emphasize on their inter-unit coordination and strategic relatedness of activities, while this paper has the tacit assumption of divisional autonomy (and competition). Starting from an IO approach, we abstract the aspects of learning-by-doing, knowledge diffusion, organizational scale of economies discussed in Greve and Baum (2001) to a single divisionalization fixed cost, which will be explained in Section 3.1.

organization, strategic delegation analyzes the firm-internal managerial delegation problem in an industrial setting, incorporating the external competitive dynamics into organization design to study selection of managers or agents, allocation of decision rights, provision of incentives, etc. (see the survey by Sengul et al., 2012). As a broad survey, Sengul et al. (2012) included important IO papers on divisionalization (Schwartz and Thompson, 1986; Polasky, 1992; Baye et al., 1996) to the discussion of strategic delegation, but the two problems have a fundamental divergence in their focus: the divisionalization problem focuses on the organization's endogeneous structure choice while circumventing the principal-agent issue (by assuming that the firm and the manager's incentives are fully aligned); the principal agent problem, instead, treats the organization's divisional structure as exogenous while focusing on the potentially unaligned incentives.[8] In this regard, our paper might be the first to bring industrial competition effects into the endogenous determination of organization structure. We will restrict attention to strategic divisionalization and, due to a different focus, treat managerial incentives as perfectly aligned (this point will be elaborated in the model setup).

3 The Model

3.1 The setup and connection with organization theory

An ideal basic model ought to yield qualitatively realistic predictions on firms' divisionalization decision while allowing for variation across industries. While the basic element underlying such decisions is each firm's divisionalization cost—the higher the cost, the less likely the firm divisionalizes—it should not be the only factor governing divisionalization decisions, but is part of the firm's strategic planning as a whole as the firm interacts with other rival firms. That said, one may expect firms to make asymmetric decisions out of strategic consideration even when all firms are ex ante symmetric. To achieve this, our model starts with the basic two-stage game of strategic divisionalization as in Corchon (1991) and Baye et al. (1996) but adds a pre-stage or initial stage wherein each firm credibly commits to, and

[8] For instance, Fershtman and Judd (1987) and Sklivas (1987) have an oligopoly setup where each firm has exactly one owner and one manager. Vickers (1985) generalizes the assumption to one owner versus multiple managers, and connects with horizontal integration as one of the model's implications, but does not explicitly model strategic divisionalization in the delegation problem.

announces, whether it plans to divisionalize (action Y for "Yes") or not (action N for "No"), as a binary decision. Adding the initial (commitment) stage not only suffices to eliminate the unrealistic perfectly competitive outcome predicted in Corchon (1991), but also serves as a symmetry breaker for an otherwise perfectly symmetric market.

As the model has a conventional IO setup, each firm is treated as an indivisible unit in a way that abstracts away all its firm-internal, managerial and hierarchical characteristics. Therefore, to connect with organization theory we encapsulate the firm's internal tendency towards U-form (single-division) or M-form (multiple-division) in a fixed divisionalization cost. While highly abstracted, we assume that the fixed cost includes all factors that matter for such a decision in light of organization theory, i.e., the firm's internal factors such as its information flows, managerial capabilities, specialization cost, communication cost, cost of incentive control, etc., and the non-competitive environmental factors such as costs of adapting to local environments, costs of delay in response to environmental changes... It is a net cost gross of any benefits associated with the M-form. Formally, we assume that a firm must pay a fixed cost $f > 0$ to engage in (any level of) divisionalization, with this fixed cost being firm-specific and directly tied to the intra-firm factors that ought to govern the divisionalization choice of the firm according to classic organization theory.

Specifically, a firm whose internal factors favor M-form is postulated to have low fixed costs of creating divisions. For example, in such firms the benefit of adaption to local conditions may outweigh the benefit of action synchronization via divisional coordination (Dessein and Santos, 2006; Alonso et al., 2008). Or the firm may have sufficiently high return to knowledge specialization (for instance, when concerns for fast excution are important, as in Patacconi, 2009) or the cost of communication is sufficiently low between divisions and across hierarchies (Bolton and Dewatripont, 1994; Garicano, 2000). Or the firm has incentive problems that favor decentralization. The opposite holds true for a firm with an internal proclivity for the U-form, thus incurring high divisionalization fixed costs. Such firms may be much concerned about the managers' unaccountability when they make investment opportunities claims (Friebel and Raith, 2010), about managers' possibility of shading (Hart and Holmstrom, 2010), knowledge stealing, out of an imperative to protect the source of organizational rents (Rajan and Zingales, 2001).

In addition to the fixed cost f, divisionalization may also entail variable costs, which is denoted by δ for each additional division created. We will show that the binary choice of divisionalization (Y or N) depends on f while the number of divisions created by each divisionalizing firm (who has opted for Y) depends on δ, if δ is comparatively small. In the basic model the firms are symmetric in terms of their fixed cost f and variable cost δ. Firms also have an internal proclivity towards either U-form or M-form. We assume that there exists a threshold $\bar{f}$ such that, in light of classic organization theory, firms whose fixed divisionalization cost is below $\bar{f}$ tend to adopt M-form, and firms whose fixed divisionalization cost is above $\bar{f}$ tend to adopt U-form.

Lemma 1. *Assume f encapsulates all firm's internal factors and the non-competitive environmental factors that govern its divisionalization decision. Then by classic organization theory, a firm adopts M-form if and only if $f < \bar{f}$, U-form if and only if $f > \bar{f}$.*

Tacit in this Lemma is that firms' divisionalization decisions are strategically independent, as the way they are treated in a sizable works in organization theory, along with a downplay of industrial competition. An exception is strategic delegation (see Literature Review). Strategic delegation examines the impact of industrial competition on organization's delegation strategies such as the choice of managers, the design of managers' incentive contracts, etc., while fixing the organization's structure as either U-form (e.g., Fershtman and Judd, 1987) or M-form (e.g., Faulí-Oller and Giralt, 1995). In the same spirit but with an opposite focus, we study firms' structure decision while treating managers' incentive contract as fixed. Specifically, we assume that all divisions are competitive, managers' contracts are based on her own division's profit, i.e., not tied to other divisions' performances and based 100% on profit. This is the common setup adopted by most IO divisionalization works (Corchon, 1991; Baye et al., 1996; Yuan, 1999). The simplification on strategic delegation allows us to fully explore the strategic divisionalization problem. We show that under divisional autonomy and profit-based contract, asymmetric structure choices can arise as a Nash equilibrium outcome in an ex-ante perfectly symmetric industry, thus explaining the stylized fact presented in Introduction for GM vs. Ford and McDonald's vs. BK.

3.2 A model with fixed and variable divisionalization costs

Consider an industry with n initial firms, each firm may create independent divisions, and each division sells a differentiated variant of the same basic product (e.g., automobiles). This reflects the common view that one justification behind the process of divisionalization is the creation and management of differentiated products.

The demand system for these varieties is specified by the multi-dimensional linear inverse demand

$$P_{ij}\left(q_{ij}, q_{i,-j}, Q_{-i}\right) = a - bq_{ij} - \theta q_{i,-j} - \theta Q_{-i}$$

where q_{ij} denotes the output of the j^{th} division of Firm i, $q_{i,-j}$ denotes the output of other divisions of Firm i except its j^{th} division, and Q_{-i} denotes the output of all divisions of other firms than Firm i. For differentiated-product demand systems as usual, the condition $0 < \theta < b$ is needed so that the substitution effect of own output on its price exceeds any cross effect. If $\theta \to b$, products become homogeneous across all divisions and firms. If $\theta \to 0$, products become independent and thus each division acts as a monopolist in supplying its single variety of the product. Also notice that we assume that products are differentiated across all firms and divisions.[9] This simple and tractable demand system, probably the most widely used in industrial organization and business strategy (see Choné and Linnemer, 2020, for a comprehensive survey), goes back all the way to Shubik (1959).[10] One frequently cited behavioral justification for the linear structure is that (boundedly-rational) managers often perceive general demand functions only as a (first-order) linear approximation.

With the linear demand, and assuming that each division incurs the same marginal cost $c \geq 0$ in production, the divisional profit function for Firm i's j^{th} division is

$$\pi_{ij}(q_{ij}, q_{i,-j}, Q_{-i}) = q_{ij}(a - bq_{ij} - \theta q_{i,-j} - \theta Q_{-i}) - cq_{ij}. \tag{1}$$

[9] Our assumption on the substitution effects is different from Ziss (1998) and Yuan (1999). They assume that products are homogeneous within a firm but differentiated across firms, i.e., $P_{ij}\left(q_{ij}, q_{i,-j}, Q_{-i}\right) = a - bq_{ij} - bq_{i,-j} - \theta Q_{-i}$, while we assume products are differentiated even within the firm, across its different divisions. Our assumption is more relevant for some real markets: for instance, it is hard to say that Buick is homogeneous to Chevrolet although they are from the same mother firm GM. Consequently, in Ziss (1998) and Yuan (1999) firms will divisionalize less aggressively and the two-stage game has an inner solution in terms of the equilibrium number of divisions per firm, thus perfect competition is also avoided.

[10] For more recent advances, see Singh and Vives (1984) and Amir et al. (2017).

The cost associated with divisionalization contains a fixed part and a variable part. First, a firm must pay a fixed cost $f > 0$ to engage in (any level of) divisionalization, the cost directly tied to the intra-firm factors that ought to govern the divisionalization choice of the firm according to classical organization theory. Upon paying f, the firm can be said to have formulated an efficient, standardized routine of creating new divisions and have mastered the optimal information flow, the choice and search of managers, the design of in-division mini structure that balances specialization and adaption, etc. Then the firm only needs to pay a constant, implementation cost $\delta > 0$ for each additional division created. So, the total cost of mother Firm i with d_i divisions equals $f + \delta(d_i - 1)$ where $(d_i - 1)$ is the additional divisions created. Although the variable cost δ could be small or large compared to f depending on specific industry characteristics, we assume that δ is relatively small (elaborated below) so that the organization's structure choice between U-form and M-form depends on f, while the additional division number choice depends on δ. Hence, Firm i's profit is the sum of all divisional profits minus the divisionalization cost, i.e., $\Pi_i = \sum_j \pi_{ij} - \delta(d_i - 1) - f$, $i = 1, 2, ..., n$.

As noted earlier, the convention in strategic divisionalization is to assume that divisions are autonomous by letting the manager's payoff contain a fixed proportion of the division's profit, so that the manager's incentive is perfectly aligned with the firm's. However, the degree of autonomy is ambiguous here and needs to be specified. Sengul et al. (2012) note that "business-unit managers may be given decision rights for tactical competitive decisions (pricing, allocation of sales resources and advertising, inventory management, investment in plant improvements) but may well be constrained within preestablished limits in regard to major decisions such as capacity increases, major capital investments, and budgets." Hence in our model, division managers are responsible for the division's competitive decision (i.e., the Cournot output) while the corporate headquarter decides the organization's structure (i.e., how many divisions to create).

Forming divisions here corresponds equally well to the M-form and the H-form (Williamson, 1975) since the synergies that distinguish the two forms are absent: both forms correspond to running autonomous competitive divisions. The M-form firm can also be considered as the multi-unit or multi-product firm (Greve and Baum, 2001), but we are abstracting away from the learning-by-doing, knowledge diffusion, organizational scale of economies aspects for such organizations.

Now we are ready to introduce the game.

Game G_1.

Stage 1: Each firm announces and commits to whether (Y) or not (N) it will divisionalize, and pays the fixed divisionalization cost $f > 0$ upon choosing Y.

Stage 2: Any firm that has announced Y (i.e., M-form) chooses a number of divisions and pays $\delta > 0$ for each additional division created. Any firm that has announced N remains with one division (i.e., U-form).

Stage 3: Division managers maximize own division's profit and compete in Cournot fashion.

Notice that the last two stages constitute a typical divisionalization game. We will shortly show that with only the last two stages the game will end up in perfect competition, but this unrealistic equilibrium outcome can be avoided by adding the initial commitment stage.

Suppose Firm i chooses to create d_i divisions, $i = 1, 2, ..., n$, and let d_{-i} denote the total number of divisions created by other firms. Following backward induction, at Stage 3, there are in total $d_i + d_{-i}$ independent divisions whose manager maximizes divisional profit, thus typical differentiated Cournot competition gives rise to the per-division output:[11]

$$q_{ij} = \frac{a-c}{2b-\theta+\theta(d_i+d_{-i})} \text{ and } \pi_{ij} = b\Big(\frac{a-c}{2b-\theta+\theta(d_i+d_{-i})}\Big)^2. \tag{2}$$

At Stage 2, a divisionalizing firm's profit is the sum of all divisional profits, $d_i\pi_{ij}$, minus divisionalization costs. The firm then chooses the number of divisions d_i to maximize profit:

$$\max_{d_i} \frac{bd_i(a-c)^2}{\big(2b-\theta+\theta(d_i+d_{-i})\big)^2} - \delta(d_i-1) - f. \tag{3}$$

The first-order condition for (3) yields:

$$b(a-c)^2\left(2b-\theta-\theta d_i+\theta d_{-i}\right) = \delta\left(2b-\theta+\theta d_i+\theta d_{-i}\right)^3. \tag{4}$$

This equation implicitly defines Firm i's best response d_i^* if its rivals have created d_{-i} divisions combined. The trade off here is, as termed by Yuan (1999), the *competition effect* or that

[11] The derivation of Eq. (2) is included in Appendix S1.

creating more divisions erodes the profitability of each division, and the *business-stealing effect* or that having more divisions gains higher market share for the mother firm.

Notice if $\delta = 0$, then $d_i^*(d_{-i}) = d_{-i} + \frac{2b-\theta}{\theta}$. Since $b > \theta > 0$, we have $\frac{2b-\theta}{\theta} > 1$, implying that Firm i wants to outnumber the total divisions of other firms by more than one. Therefore in the subgame consisting of Stage 2&3, without an initial announcement stage, the unique equilibrium is $d_i^* = \infty$ for all i, thus perfect competition and zero profit are induced for all firms.[12] This corresponds well to the perfect competition equilibrium derived in Corchon (1991) though product differentiation is added here. In fact, firms' best response would be $d_i^*(d_{-i}) = d_{-i} + 1$ with homogeneous good (i.e., $\theta = b$), and production differentiation makes firms more aggressive in creating new divisions (i.e., $\frac{2b-\theta}{\theta} > 1$). In this scenario the business-stealing effect outweighs the competition effect to the extent that leads to infinite expansion of divisions for all firms.

At Stage 1, each firm announces and credibly commits to whether it will divisionalize or not. The extra stage of the game squares well with all the attending legal, administrative and organizational steps that a mother firm needs to undertake in order to actually implement a divisionalization decision. In particular, it readily fulfills the usual requirements for a credible commitment as applied to multi-stage games (Schelling, 1980). For the firm which decides to divisionalize, such a decision would be very costly to reverse after all the preparation steps, that is, the fixed costs f is sunk once the divisionalization decision is made.

Assume n_y many firms decide to divisionalize at Stage 1, $1 \leq n_y \leq n$, and $n - n_y$ many firms decide to remain with one division. The whole set of asymmetric equilibrium (including those where each divisionalizing firm creates different numbers of divisions) can be quite large, and we restrict our attention to the equilibria where divisionalizing firms create the same number of divisions. Let $d_y > 1$ denote the number of divisions created by a divisionalizing firm, then for such a firm, say Firm i, its rivals have created $d_{-i} = (n_y - 1)d_y + (n - n_y)$ many divisions, and thus the FOC in Eq. (4) becomes:

$$b(a-c)^2 \left(2b + \theta(n-1-n_y) + \theta(n_y-2)d_y\right) = \delta \left(2b + \theta(n-1-n_y) + \theta n_y d_y\right)^3. \quad (5)$$

[12] Using standard myopic Cournot dynamics yields a simple process via which the number of total divisions will increase without bound. Indeed, with each firm best-responding at each stage by creating $\frac{2b-\theta}{\theta}$ more division than its rivals, there is no end to this process.

Given the number of divisionalizing firms n_y, the optimal number of divisions d_y for such a firm is implicitly defined in Eq. (5). The cubic equation does not have an explicit solution. In Appendix S2, we prove the existence of a solution $d_y > 1$ for sufficiently small variable cost δ. Consider a simple example, where $n = n_y = 2$, so that both firms of the Cournot duopoly are assumed to divisionalize. Then Eq. (5) becomes $b(a-c)^2(2b-\theta) = \delta(2b-\theta+2\theta d_y)^3$, and $d_y > 1$ if and only if $\delta < \frac{b(a-c)^2(2b-\theta)}{2b+\theta}$. Depending on n and n_y, the actual threshold of δ could take a much more complicated form.

Notice that all variables for Stage 2&3—the number of divisions created by divisionalizing firm d_y, the per-division output q, the (divisionalizing and non-divisionalizing) mother firms' profits π_y and π_n—depend on n_y, thus can be written as $d_y(n_y)$, $q(n_y)$, $\pi_y(n_y)$ and $\pi_n(n_y)$.

Now substitute $n_y d_y(n_y) + (n - n_y)$ for $(d_i + d_{-i})$ at Stage 3, then the per-division equilibrium output given by Eq. (2) becomes:

$$q(n_y) = \frac{a-c}{2b + \theta n_y d_y(n_y) + \theta(n - n_y - 1)}. \tag{6}$$

$q(n_y)$ depends on n_y and $d_y(n_y)$ and is always positive. In Appendix S1 we show that the per-division equilibrium profit equals $\pi = bq^2$ (by FOC) and is also positive. Then the profits for the divisionalizing and non-divisionalizing firm are, respectively,

$$\pi_y(n_y) = bd_y(n_y)\big(q(n_y)\big)^2 - \delta(d_y(n_y) - 1) - f \quad \text{and} \quad \pi_n(n_y) = b\big(q(n_y)\big)^2, \tag{7}$$

where the subscripts stand for Yes and No in terms of divisionalization.[13] Obviously, π_n is always positive. As for π_y, without the fixed cost we have $bd_yq^2 - \delta(d_y - 1) > 0$ from Eq. (5) and (6).[14] So, all firms keep positive profits as long as the fixed cost f is not too high.

Back to Stage 1, we need to check that n_y many firms divisionalizing is indeed a Nash equilibrium by definition. Two conditions need to be satisfied: the M-form firm does not want to deviate to U-form and vice versa. For the former we need $\pi_y(n_y) \geq \pi_n(n_y - 1)$ where

[13] By inspection one can see that these expressions hold for $n_y = 0$ or n as well, where none (or all) of the firms divisionalize.

[14] Notice $bd_yq^2 - \delta(d_y - 1) = bq^2 + (bq^2 - \delta)(d_y - 1)$, where $bq^2 = b(\frac{a-c}{2b+\theta n_y d_y + \theta(n-n_y-1)})^2$. Using Eq. (5), this expression of bq^2 can be transformed to $\delta\frac{2b+\theta n_y d_y+\theta(n-n_y-1)}{2b+\theta(n_y-2)d_y+\theta(n-n_y-1)}$, and then both the denominator and numerator are positive. So $bq^2 - \delta = \delta\frac{2\theta d_y}{2b+\theta(n_y-2)d_y+\theta(n-n_y-1)} > 0$. So $bd_yq^2 - \delta(d_y - 1) > 0$.

$1 \leq n_y \leq n$, i.e., the firm cannot earn higher profits if it chooses not to divisionalize in which case the number of divisionalizing firms will decrease by one. By Eq. (7), this condition can be rewritten as

$$f \leq b\big(\big(q(n_y)\big)^2 - \big(q(n_y-1)\big)^2\big) + \big(b\big(q(n_y)\big)^2 - \delta\big)\big(d_y(n_y) - 1\big),$$

which imposes an upper bound for f. Similarly, for non-divisionalizing firms we need $\pi_n(n_y) \geq \pi_y(n_y+1)$ where $0 \leq n_y \leq n-1$, which imposes a lower bound for f,

$$f \geq b\big(\big(q(n_y+1)\big)^2 - \big(q(n_y)\big)^2\big) + \big(b\big(q(n_y+1)\big)^2 - \delta\big)\big(d_y(n_y+1) - 1\big).$$

Notice that the upper and lower bounds of f have the same functional form with different n_y. Let us define $F(\cdot)$ as

$$F(n_y) := b\big(\big(q(n_y)\big)^2 - \big(q(n_y-1)\big)^2\big) + \big(b\big(q(n_y)\big)^2 - \delta\big)\big(d_y(n_y) - 1\big).$$

Combining the upper and lower bounds we have: (i) $1 \leq n_y \leq n-1$ is an equilibrium if and only if $F(n_y+1) \leq f \leq F(n_y)$, (ii) $n_y = n$ is an equilibrium if and only if $f \leq F(n)$, and (iii) $n_y = 0$ is an equilibrium if and only if $f \geq F(1)$. Therefore, if $F(n_y)$ is a monotonic decreasing function, $F(1), F(2), ...F(n)$ divide $(n+1)$ line segments for f corresponding to the $(n+1)$ possible equilibrium outcomes, $n_y = 0, 1, 2, ..., n$.[15] The next Proposition summarizes our results.

Proposition 1. *In the three-stage divisionalization game with fixed cost $f > 0$ and sufficiently small variable cost $\delta > 0$ (for $d_y > 1$), we have:*

(a) if $F(n_y+1) \leq f \leq F(n_y)$ for some $1 \leq n_y \leq n-1$, then there are n_y firms divisionalizing in the equilibrium;

[15] If $F(1), F(2), ...F(n)$ is not monotonic decreasing, then depending on the actual values, some n_y's may not be an equilibrium because the interval between the upper and lower bounds is not well defined. Multiple equilibria may exist for some f if the intervals overlap. With the cubic function Eq. (5) and the reciprocal function Eq. (6), we cannot prove the monotonicity of $F(n_y)$. However, our simulation shows that except for extreme small δ, $F(1), ..., F(n)$ is always decreasing. Specifically, in the simulation we give value to parameters $a, b, c, \theta, \delta, n$, and then use Eq. (5), Eq. (6), and the expression of $F(n_y)$ to calculate $F(1), ..., F(n)$. The simulation code is available from authors upon request.

(b) if $f \leq F(n)$, then n firms divisionalize in the equilibrium;

(c) if $f \geq F(1)$, then no firm divisionalize in the equilibrium.

From Eq. (5) it is clear that the variable divisionalization cost δ affects how many divisions are created by a divisionalizing firm. This Proposition further shows that the binary divisionalization choice (Y or N) and thus the equilibrium number of divisionalizing firms n_y depend on the fixed cost f, which can take any value in $0, 1, ..., n$. Indeed, even when all firms are ex ante symmetric in their production and divisionalization costs, the game may result in some firms divisionalizing while some not, as each firm's divisionalization decision affects the industrial competitive dynamics so that any deviation from the equilibrium may hurt the mother firm's overall profitability against its rivals. We find that $F(1), F(2), ...F(n)$ in most cases are monotonic decreasing, meaning that n_y decreases in f (in the form of a step function). Therefore, in an industry where firms have a natural proclivity toward M-form according to classic organization theory (i.e., in industries where firms in general have a strong need to adapt to local conditions, or where the information flow facilitates an effective communication system, etc.), we also expect more firms to divisionalize in the strategic setting than industries where there is a natural proclivity toward U-form.

Our model is in fact a generalization of Baye et al. (1996) in three aspects. First, Baye et al. (1996) only considers variable divisionalization cost (i.e., $f = 0$) so it corresponds to case (b) in Proposition 1. Second, Baye et al. (1996) considers a homogeneous market, so it corresponds to the case where $\theta = b$. Lastly, Baye et al. (1996)'s model has only two stages and symmetry (i.e., all firms divisionalize) is imposed for solving the Nash equilibrium. In contrast, the extra stage of our game essentially allows a firm to deviate from $d_y > 1$ to $d_i = 1$, so the symmetry that arises when $f = 0$ (i.e., all firms indeed divisionalize) is endogenous.

The following example gives a numerical illustration of the Proposition.

Example. Assume there are $n = 3$ firms in the industry where the inverse demand for one division is $P_{ij} = 20 - 2q_{ij} - q_{i,-j} - Q_{-i}$, with identical marginal production cost $c = 2$. As a benchmark, a monopoly in this market has profit $\frac{(a-c)^2}{4b} = 40.5$. Assume the variable divisionalization cost is $\delta = 3$.

If no firm divisionalizes, each firm's profit in the standard Cournot game is $\pi_{n0} = 18$. If one firm divisionalizes, i.e., $n_y = 1$, by Eq. (5) it will create $d_y = 2.8$ divisions and the firm's profit (gross of f) is $\pi_{y1} = 24.4$, while the other two firms each has profit $\pi_{n1} = 10.6$. If $n_y = 2$, the two firms would each create $d_y = 2.7$ divisions, firm profit is $\pi_{y2} = 14.4$, and the third single-division firm has profit $\pi_{n2} = 7.1$. If $n_y = 3$, each firm creates $d_y = 2.5$ divisions with profit $\pi_{y3} = 10$.

Applying Proposition 1, $n_y = 0$ is an equilibrium for large fixed costs, i.e., $f > \pi_{y1} - \pi_{n0} = 6.4$. For $n_y = 1$ to be an equilibrium, we need $f < \pi_{y1} - \pi_{n0} = 6.4$ for the divisionalizing firm and $f > \pi_{n1} - \pi_{y2} = 3.8$ for the non-divisionalizing firm. Analogously, $n_y = 2$ is an equilibrium if and only if $2.9 < f < 3.8$, and $n_y = 3$ is an equilibrium if and only if $f < 2.9$.

Therefore, for any specific fixed cost f there exists a unique equilibrium (up to the number of divisionalizing firms), and all scenarios $n_y = 0, 1, 2, 3$ can be an equilibrium outcome for some appropriate f. Also notice that despite paying the fixed cost, a divisionalizing firm generally earns higher profits than a non-divisionalizing firm in an equilibrium. The reason is that $\pi_n(n_y)$ in general decreases in n_y, so even the outside option (by switching to not divisionalizing) of a divisionalizing firm, which is not chosen by the firm in equilibrium, is greater than a non-divisionalizing firm's equilibrium profit. For instance, if $n_y = 1$ is an equilibrium, it is always true that $\pi_{y1} - f > \pi_{n0} > \pi_{n1}$, the first inequality by the divisionalizing firm's incentive constraint and the second by the fact that π_n decreases in n_y.

Lastly, when the variable cost becomes cheaper (e.g., $\delta = 1.5$), the divisionalizing firms will create more divisions in any equilibrium as well as the fixed-cost thresholds will all shift up. The opposite holds when the variable cost is higher (e.g., $\delta = 4$). $\square$

Since our model studies strategic divisionalization using IO approach while encapsulating organization theory (in the simplest form) via the fixed cost, it can be said to capture both the firm effects and the industry effects as determinants of the firm's organizational form. Compared to Lemma 1, the inclusion of the strategic aspect under a game framework leads to asymmetric structure choices among ex ante identical firms.

There are two implications of the model. First, depending on the industry-level fixed divisionalization cost f, different degree of divisionalization may be observed in different markets. In industries with high f, chances are that no firm will ever create additional competitive divisions, while in industries with low f, one may see all major firms end up divisionalizing. For example, the major pharmaceutical companies in the United States do not seem to be interested in inducing intra-firm divisional competition; They do have different subsidiaries, but each subsidiary is noncompetitive in the sense that they serve different markets.[16] One explanation is that pharmaceutical products are almost homogeneous in terms of their effectiveness (corresponding to a high θ). Since both the per-division output and profits in Eq. (6) & (7) decrease in θ, creating additional divisions is not very profitable in such cases. Relatively, the fixed divisionalization cost (including R&D for new products) can be said to be quite high in such industry. Therefore, there is little market share gain by creating competitive divisions. Rather, it is more valuable to expand the firm's business and capture more niche markets with noncompetitive subsidiaries. The same argument may fit electronics firms such as GE, Philips and Siemens, each owning a wide range of divisions that operate in different industries ranging from Energy & Power, Mobility & Aviation, Healthcare, to Digital technology. The level of product differentiation depends partly on the product's nature and consumer preferences. In industries where the level of product differentiation is high such as the automobile industry, fixed divisionalization is relatively low compared to the divisional profitability and divisionalization is observed.

The second implication is that due to strategic consideration, firms with similar sizes, capacities, market positions, etc., may end up with different levels of divisionalization. GM and Ford entered the automobile industry around the same time in the early 1900s, but the former soon acquired Buick, Oldsmobile, Cadillac, while Ford focused on forging its own brand name. There are certain historic reasons behind this divergence of the two firms' divisionalization outcomes. For instance, the founder of GM was initially rooted in the business of horse-drawn vehicle manufacturing and formed the GM Company mainly as a holding company, while Ford was by then an established automobile manufacturer. This explained GM's initial attempts to divisionalize, specifically, in the form of acquisition. However, over the course of a century's development, the two firms seem to have kept their

[16] Johnson & Johnson has many subsidiaries including Acclarent (Balloon Sinuplasty devices), DePuy (orthopedics and neurosurgery), McNeil Consumer Healthcare (over-the-counter drugs), etc., but does not have two brands serving the same market. For instance, the two major over-the-counter Ibuprofen brands in the U.S. are Advil (by Pfizer) and Motrin (by J&J), which otherwise do not have any close substitutes from the same mother firm.

initial practices: GM maintained its competitive, highly autonomous divisions while Ford refrained from doing so.[17] It may simply be no longer profitable for Ford once Ford sees that GM has already divisionalized. The same argument may fit fast food chains (McDonald's vs. BK) as mentioned in the Introduction or other franchises that exhibit similar patterns, where different degree of franchising is observed for different companies in one local market.

4 Extensions

4.1 A model with fixed divisionalization cost only

We had some general analysis on strategic divisionalization with both variable and fixed divisionalization costs. In this section, we consider a scenario where the variable divisionalization cost is zero. It is worthy of discussion for two main reasons. First, this is not a special case of the general model, as the previous discussion relied on $\delta > 0$ in Eq. (4). Second, this is also how the main stream strategic divisionalization literature deals with divisionalization costs. The reason is that including variable cost prevents the model from having a closed-form solution thus losing on the intuitive grounds. By getting rid of the variable cost, we can therefore present a neat model and show how it contrasts classic models and thus gains prediction power. Lastly, the model without variable cost probably delivers a sharper insight: it is the strategic consideration entailed in the initial commitment stage that prevents firms from excessive divisionalization even when it becomes practically costless.

Consider the same Game G_1, with $\delta = 0$ at Stage 2. By Eq. (4) Firm i's best response becomes

$$d_i^*(d_{-i}) = d_{-i} + \frac{2b - \theta}{\theta}. \tag{8}$$

Back to Stage 1, a key observation is that if *more than one* firm chooses Y (i.e., $n_y \geq 2$), each having the best response (8), then the unique outcome is for each of them to create infinitely many divisions, and perfect competition follows. Considering the fixed cost f, the U-form firms now have zero profit while the M-form firms have strictly negative profit, $-f$.

[17] In fact, Ford once owned Land Rover, Jaguar, Volvo but sold them after a short period of ownership. Ford still owns Lincoln, which is mostly a luxury car, so this is a vertical, rather than horizontal differentiation.

This cannot be a Nash equilibrium because M-form firms can increase its profit from $-f$ to 0 by choosing not to divisionalize. As for $n_y = 0, 1$, both can be equilibrium for appropriate fixed cost: $n_y = 1$ is equilibrium when f is sufficiently small, while $n_y = 0$ is equilibrium when f is sufficiently large. The next Proposition summarizes the discussion and the formal proof is included in Appendix S3.

Proposition 2. *In the three-stage divisionalization game with $f > 0$ and $\delta = 0$, let $\tilde{f} = \frac{b(a-c)^2(2b+(n-3)\theta)^2}{4\theta(2b+(n-2)\theta)(2b+(n-1)\theta)^2}$ and there are two possible equilibria:*

(a) $n_y = 1$, if and only if $f < \tilde{f}$;

(b) $n_y = 0$, if and only if $f > \tilde{f}$.

We now compare Proposition 2 to classic strategic divisionalization theory and classic organization theory, respectively. Compared to the former, our model has added an initial commitment stage associated with fixed cost, which immediately eliminates the perfect competition outcome predicted by Corchon (1991) and Polasky (1992). In fact, perfect competition is never an equilibrium outcome with the existence of the initial stage, even if $f = 0$.[18] Notice that without variable cost, $n_y \geq 2$ is no longer a possible equilibrium outcome, which fits the case of GM vs. Ford. Compared to the latter, Lemma 1 states that a firm's (independent) divisionalization decision is mostly contingent on the firm's internal factors and the non-competitive environmental factors, which are summarized by a threshold $\bar{f}$. Proposition 2 also entails a threshold $\tilde{f}$, but instead of dictating whether a firm should divisionalize or not, it determines the number of divisionalizing firms in the market and tacitly admits the inter-dependence between firms' divisionalization decisions. Therefore, $\tilde{f}$ and $\bar{f}$ may be said to function quite differently besides their potential magnitude difference. We will provide a more general discussion on this point in the next subsection.

A caveat here is that one firm divisionalizing as the equilibrium prediction is only applicable for firms that enter an industry around the same time, as indicated by the simultaneous first-stage move. A new firm entering an established industry may still divisionalize even if some other firms have already divisionalized, as the latter may not respond by further

[18] Multiple equilibria may arise when $f = 0$, but only $n_y = 0, 1$ can be equilibrium if one applies the equilibrium selection tool Pareto Dominance. All perfectly competitive outcomes are Pareto dominated. The proof is available from the authors upon request.

divisionalizing due to organizational inertia or additional costs.

4.2 Asymmetric duopoly with fixed divisionalization cost only

This subsection provides a complete comparison with the classic organization theory in an asymmetric duopoly context. For the sake of neat presentation, we restrict attention to duopoly with no variable divisionalization cost (i.e., $\delta = 0$) but allow firms to have different fixed costs, f_1 and f_2. Without loss of generality, let us assume $f_1 < f_2$.

Recall that the fixed divisionalization cost is sunk at Stage 1, so the subgame starting from Stage 2 is the same as the one studied earlier, thus Firm i's best response is still Eq. (8). At Stage 1, there are four possible strategy pairs for Firms 1 and 2: (Y, Y), (Y, N), (N, Y) and (N, N), where Y stands for divisionalizing with fixed cost f_i and N for not divisionalizing. By Eq. (8), we know that in the subgame of (Y, Y), both firms will create infinitely many divisions (i.e., $d_1 = d_2 = \infty$) and perfect competition follows. In the subgame of (Y, N), Firm 2 will remain with one division (i.e., $d_2 = 1$) and Firm 1 will best respond by creating $\frac{2b}{\theta}$ divisions (i.e., $d_1 = \frac{2b}{\theta}$). Vice versa for (N, Y). In the Subgame of (N, N), both firms will remain with one division (i.e., $d_1 = d_2 = 1$). Plugging d_1 and d_2 in Eq. (2) gives the per-division profit π_{ij} at Stage 3, and then $d_i \pi_{ij}$ is Firm i's profit gross of the fixed cost at Stage 2. At Stage 1 the fixed cost is subtracted, and thus the two firms' payoffs can be summarized in Table 1.

[Insert Table 1 Here.]

By basic comparison of payoffs, we know that if Firm j chooses Y, Firm i's best response is N since $\frac{(a-c)^2}{16b} > -f_i$. But if Firm j chooses N, Firm i's best response is Y if and only if $\frac{(a-c)^2}{8\theta} - f_i > \frac{b(a-c)^2}{(2b+\theta)^2}$, or $f_i < \tilde{f}$, where

$$\tilde{f} = \frac{(a-c)^2(2b-\theta)^2}{8\theta(2b+\theta)^2}.$$

Notice that $\tilde{f}$ is the same as the one defined in Proposition 2 by letting $n = 2$. It is the cost threshold that makes a firm indifferent between choosing N or Y when the rival firms choose N. When facing a U-form rival in duopoly, a firm will divisionalize if and only if its fixed cost is below the threshold $\tilde{f}$.

To summarize, if $f_i > \tilde{f}$, Firm i always chooses N regardless of its rival's action—in this case, N is a dominant strategy for Firm i. If $f_i < \tilde{f}$, Firm i's best response to Y is N, and to N is Y. We have just proved the next result.

Proposition 3. *Consider the duopoly game where $\delta = 0$ and $f_2 > f_1 > 0$.*

(a) If $f_1 < \tilde{f} < f_2$, the game has a unique Nash equilibrium, (Y, N).

(b) If $f_1 < f_2 < \tilde{f}$, the game has two Nash equilibria, (N, Y) and (Y, N).

(c) If $\tilde{f} < f_1 < f_2$, the game has a unique Nash equilibrium (N, N).

Due to space limit we have put the complete analysis for this result in Appendix S4. We restrict attention to three interesting scenarios where the classic organization theory and our model are in full agreement, partial agreement, and full conflict. Organization theory emphasizes the non-competitive factors as determinants of the firm's optimal structure, which is reflected by the threshold fixed cost $\bar{f}$ in Lemma 1. In comparison, Proposition 3 on one hand has the firm's internal proclivity towards U-form or M-form reflected by the fixed cost f_i, and on the other hand, encompasses industry competition namely the pros (business-stealing effect) and cons (competition effect) of strategic divisionalization in the cost threshold $\tilde{f}$. So it can be said to be a synergy of both firm and industry effects.

A key assumption here is

$$\bar{f} < \tilde{f}. \tag{9}$$

That is, any firm that chooses to divisionalize as a monopolist will also divisionalize as a duopolist facing a U-form firm, but not vice versa. This is obviously a direct implication of the analysis of this paper, as such a duopolist would have an incentive to form divisions as a way to preempt a larger market share in the product market, above and beyond its own internal organizational incentives.

Case (a) in Proposition 3 is a priori the most interesting case for this game, as it specifies the role assignment that is missing in Proposition 2 as to which firm divisionalizes in the equilibrium. With $f_1 < \tilde{f} < f_2$, Firm 2's high fixed cost makes N to be its dominant strategy, while Firm 1's low fixed cost implies that Y is the best response, so the game has a unique equilibrium, (Y, N). The divisionalizing firm, Firm 1 earns a higher profit than Firm 2.[19] It may be said that the heterogeneous divisionalization cost naturally selects the equilibrium wherein the more efficient firm divisionalizes who thereby ends up earning the higher profit.

Case (a) may be in full or partial agreement with Lemma 1. If $f_1 < \bar{f} < \tilde{f} < f_2$, organization theory calls for Firm 1 to divisionalize (as $f_1 < \bar{f}$) and Firm 2 to not divisionalize (as $\bar{f} < f_2$). Since (Y, N) is also the unique prediction of Proposition 3 in this parameter range, the two theories are in full agreement. However, if $\bar{f} < f_1 < \tilde{f} < f_2$, organization theory would call for both firms to not divisionalize, thus (N, N) follows. Then the two theories lead to the same prediction for Firm 2 but conflicting prediction for Firm 1. One interpretation is that the conflict may originate from the overlooked business-stealing effect. Put differently, were Firm 1 a monopolist, it would have chosen not to divisionalize, but as a duopolist facing an U-form rival, Firm 1 chooses to become an M-form firm to ensure a higher overall market share in the industry.

The two theories can also be in full conflict. In Case (b), since $f_1 < f_2 < \tilde{f}$, we have shown that for both firms the best response to N is Y, to Y is N, thus the game is an anti-coordination game with two equilibria (N, Y) and (Y, N). Notice that (Y, N) is the socially more efficient equilibrium, as Firm 1 is more efficient in divisionalizing. The less efficient outcome, (N, Y), may lead to full conflict between the two theories. Indeed, if $f_1 < \bar{f} < f_2 < \tilde{f}$, then (Y, N) is predicted by Lemma 1 instead of (N, Y). Although each firm's internal factors incline to either U or M-form, the industry effects impel them to choose the opposite. In this case, Firm 2 preempts the market by committing to M-form and the best response of Firm 1 is then to remain U-form despite of its lower cost.

The three examples encapsulate the possible discrepancy between organization theory and the proposed theory in this paper, ranging from full agreement to full conflict, depending on the relative cost configuration. The same firm may alter its divisionalization decision as a monopolist were it in a duopoly market. Shedding light on the strategic aspect of the divisionalization problem, a major contribution of this paper is perhaps to provide a more integrated view on the key organizational decision.

[19] Here, Firm 1's profit is $\frac{(a-c)^2}{8\theta} - f_1$ and Firm 2's profit is $\frac{(a-c)^2}{16b}$. Since $\frac{(a-c)^2}{8\theta} - f_1 - \frac{(a-c)^2}{16b} > \frac{(a-c)^2}{8\theta} - \tilde{f} - \frac{(a-c)^2}{16b} = \frac{(a-c)^2(2b-\theta)(6b+\theta)}{16b(2b+\theta)^2} > 0$, Firm 1's profit is higher than Firm 2's.

5 Conclusion

This paper has proposed to modify the canonical model for strategic divisionalization by adding an initial stage to the standard two-stage game to allow firms to credibly commit to whether they will create additional divisions or not. Such a simple revision suffices to eliminate the perfectly competitive outcome and generate a unique equilibrium prediction that is consistent with the key stylised fact that, in industries with divisionalized firms, often only one of the mother firms alone creates independent divisions while the others do not.

The model has a novel and powerful implication for organization theory, in capturing what may be seen as endogenous strategic organizational heterogeneity of competing firms. This reflects the novel idea that, under imperfect competition, a firm's optimal organizational form cannot be decided only on the basis of internal characteristics to the firm and the non-competitive environmental dynamics. Rather, all the decisions of the firms in the same industry are strategically entertwined and thus form a coherent whole.

This multi-divisional firm gains an edge over its rivals by securing a higher overall market share. This advantage that accrues to a single mother firm reflects a benefit that may be seen as a novel advantage of commitment, in line with similar effects in political science (Schelling, 1980), economics (Shapiro, 1989), and strategic management (Ghemawat, 1991). The predictions of the present view substantially diverge from those of classic organization theory, and reflect a tendency for organizational heterogeneity of strategically competing firms.

We close with a final word recognizing some limitations of the present analysis. By focusing on the preemption motive in the strategic struggle for market share by divisionalizing firms and limiting divisionalization costs to a fixed cost, this paper has disregarded some aspects of the functioning of M-form and in particular MUMM (multiunit and multimarket) firms that may be important in some industry contexts, including in particular the coordination and central planning aspect exercised by the mother firm over its constituent divisions. Another key aspect of MUMM firms not addressed here is that, by operating in mutiple markets, the scope for tacit collusion may be enhanced via increased scope for retaliation and foreknowledge of this may motivate firms in favor of this organizational form in the first place (this is the so-called mutual forbearance theory, Greve and Baum, 2001).

Nonetheless, this paper may pave the way for further research on the incentives for divisionalization and on the comparative performance of M-form and U-form firms. Some promising avenues to further explore are the strategic dimension of organization theory with inter-dependence between the demand and cost sides;[20] the scope and effects of forming R&D alliances (Runge et al., 2021); the possible interaction between mutual forbearance and market share preemption; the effects of increased competition on M-form firms; and an in-depth look at vertical relationships such as the corporate parenting advantage (Feldman, 2021) or the role of organizational distance (Belenzon et al., 2019). Finally, the implication of intra-industry organizational heterogeneity would be an interesting hypothesis for further study and empirical testing.

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Appendix

S0. Tables

Note: The pair of payoffs in a cell stands for (Firm 1's payoff, Firm 2's payoff).

Firm 1 \ Firm 2	Y	N
Y	$-f_1, -f_2$	$\frac{(a-c)^2}{8\theta} - f_1$, $\frac{(a-c)^2}{16b}$
N	$\frac{(a-c)^2}{16b}$, $\frac{(a-c)^2}{8\theta} - f_2$	$\frac{b(a-c)^2}{(2b+\theta)^2}$, $\frac{b(a-c)^2}{(2b+\theta)^2}$

TABLE 1 Payoffs in Stage 1 of Game G_1

S1. Derivation of Eq. (2).

At Stage 3, given d_i divisions of Firm i, d_{-i} divisions of other firms, the profit function for the j^{th} division of Firm i is $\pi_{ij} = (a - bq_{ij} - \theta q_{i,-j} - \theta Q_{-i})q_{ij} - cq_{ij}$. The manager of the j^{th} division of Firm i maximizes profits by choosing q_{ij}, and the FOC is

$$a - c - 2bq_{ij} - \theta q_{i,-j} - \theta Q_{-i} = 0. \tag{10}$$

Let $Q_i = \sum\limits_j q_{ij}$ denote the total output of Firm i, and $Q = \sum\limits_{i=1}^{n} Q_i$ the industry output. Notice each division of Firm i has the same FOC as described in Eq. (10), thus such divisions are symmetric, and $q_{ij} = \frac{Q_i}{d_i}$. Substitute $q_{ij} = \frac{Q_i}{d_i}$, $q_{i,-j} = \frac{Q_i}{d_i}(d_i - 1)$ and $Q_{-i} = Q - Q_i$ in Eq. (10) to obtain

$$Q_i = \frac{d_i}{2b - \theta}(a - c - \theta Q). \tag{11}$$

Sum up Eq. (11) for all i and then substitute $Q = \sum\limits_{i=1}^{n} Q_i$ to obtain $Q = \frac{a-c-\theta Q}{2b-\theta} \sum\limits_{k=1}^{n} d_k$. Re-arranging the above expression yields that the third stage solution for industry output denoted by $Q(\mathbf{d})$ where $\mathbf{d} = (d_1, ..., d_n)$, is given by

$$Q(\mathbf{d}) = \frac{(a - c)\sum_{k=1}^{n} d_k}{2b - \theta + \theta \sum_{k=1}^{n} d_k}. \tag{12}$$

Substituting Eq. (12) into Eq. (11) yields that the third stage solution for Firm i's output is

$$Q_i = \frac{(a-c)d_i}{2b - \theta + \theta \sum_{k=1}^{n} d_k}. \tag{13}$$

Thus the third stage solution for the output of the j^{th} division of Firm i is $q_{ij} = \frac{Q_i(\mathbf{d})}{d_i}$, the same as given in Eq. (2). Profits of the j^{th} division of Firm i is $\pi_{ij} = (a - c - bq_{ij} - \theta q_{i,-j} - \theta Q_{-i})q_{ij}$. Notice from the FOC, Eq. (10), we have $a - c - bq_{ij} - \theta q_{i,-j} - \theta Q_{-i} = bq_{ij}$. Thus $\pi_{ij} = bq_{ij}^2$, and substituting q_{ij} gives the profit's expression as given in Eq. (2). Also notice all divisions of Firm i (indeed, all divisions across firms) are symmetric and have the same q_{ij} and π_{ij}.

S2. Existence of solution to Eq. (5)

We first reason that for sufficiently small $\delta > 0$ there exists a solution $d_y > 1$ to Eq. (5). The explicit solution to Eq. (5) is not attainable from the cubic function form. But first notice that, for strictly positive δ, the left-hand side is a linear function of d_y, which increases in a much slower speed than the right-hand-side cubic function (the LHS even decreases in d_y when $n_y = 1$). Second, when $d_y = 0$, the LHS is strictly positive as $b(a - c)^2 (2b + \theta(n - 1 - n_y)) \geq b(a - c)^2 (2b - \theta) > 0$, but the RHS is arbitrarily close to 0 for sufficiently small δ. So if $\delta > 0$ is sufficiently small, the RHS is less than LHS at $d_y = 0$ but they will cross at some $d_y > 1$, i.e., sufficiently small δ guarantees the existence of a solution $d_y > 1$ to Eq. (5).

S3. Proof of Proposition 2

Let us first derive each firm's profit when no firm chooses to divisionalize, i.e., $n_y = 0$. Then $d_1 = d_2 = ... = d_n = 1$ and $\sum_i d_i = n$. By Eq. (2), $\pi_{ij} = \frac{b(a-c)^2}{(2b+(n-1)\theta)^2}$. Since each firm only has one division, $\Pi_i = \pi_{ij}$ for all i.

Next, let us derive each firm's profit when there is one firm divisionalizing, i.e., $n_y = 1$. Without loss of generality, assume Firm 1 chooses Y and other firms choose N at Stage 1. Then other firms will commit to maintaining one division at Stage 2, i.e., $d_2 = d_3 = ... = d_n = 1$, whereas Firm 1 will optimally create $d_1 = (n - 1) + \frac{2b-\theta}{\theta}$ many divisions. The per-division profit, which is the same for all firms, is then given by substituting $\sum_i d_i = 2(n - 1) + \frac{2b-\theta}{\theta}$ in

Eq. (2), so $\pi_{ij} = \frac{b(a-c)^2}{(4b+2(n-2)\theta)^2}$. Therefore, Firm 1's profit is $\Pi_1 = d_1\pi_{ij} - f = \frac{b(a-c)^2}{4\theta(2b+(n-2)\theta)} - f$, and for other firms $\Pi_k = \pi_{ij} = \frac{b(a-c)^2}{(4b+2(n-2)\theta)^2}$, $k \geq 2$. Note that all firms can keep positive profits in this case given f sufficiently small.

Lastly, assume two or more firms choose Y, i.e., $n_y \geq 2$. Since each divisionalizing firm wants to create $\frac{2b-\theta}{\theta}$ more divisions than other firms combined, the unique outcome is $d_i = \infty$ for the divisionalizing firms. Then $\sum_i d_i = \infty$. By Eq. (2), all divisions generate zero profit, thus non-divisionalizing firms will earn zero profit, while divisionalizing firms will earn $-f$.

Given the above analysis, $n_y \geq 2$ immediately disqualify as an equilibrium, because by deviating from Y to N, the divisionalizing firm can increase its profit from $-f$ to either 0 (when $n_y > 2$) or $\frac{b(a-c)^2}{(4b+2(n-2)\theta)^2}$ (when $n_y = 2$). For $n_y = 1$ to be an equilibrium, we further need the incentive constraint for the divisionalizing firm: $\frac{b(a-c)^2}{4\theta(2b+(n-2)\theta)} - f > \frac{b(a-c)^2}{(2b+(n-1)\theta)^2}$, or $f < \frac{b(a-c)^2(2b+(n-3)\theta)^2}{4\theta(2b+(n-2)\theta)(2b+(n-1)\theta)^2}$. Otherwise, $n_y = 0$ is the equilibrium. Q.E.D.

S4. A complete comparison between Lemma 1 and Proposition 3

In the text, we have discussed Case (a) and a subcase of Case (b) where $\bar{f} < f_1 < \tilde{f} < f_2$. Now we present the other subcases of Case (b) and Case (c).

In light of (9), there are two more subcases of Case (b) here.

(i) If $f_1 < f_2 < \bar{f} < \tilde{f}$, the non-competitive factors alone would clearly lead to the outcome (Y, Y), or both firms divisionalizing. Hence, comparing with the game prediction (N, Y) and (Y, N), there is a conflict for the firm choosing N. We can say that the competition effect forces the latter firm to forego cost-effective divisionalization to avoid unraveling towards perfect competition and zero profit.

(ii) If $\bar{f} < f_1 < f_2 < \tilde{f}$, then the non-competitive factors alone leads to the outcome (N, N). Thus the two theories are in agreement for the firm choosing N, but in conflict for the firm choosing Y. This is the major message conveyed by this paper: one firm may want to divisionalize to capture a higher market share even if its internal factors dictate the opposite.

In Case (c), $\tilde{f} < f_1 < f_2$, so N is a dominant strategy for both firms, and equilibrium (N, N) follows. Therefore, if firms' divisionalization costs are too high, no firm would choose to divisionalize (despite the lure of increased market share). In light of (9), the only possibility for $\bar{f}$ is $\bar{f} < \tilde{f} < f_1 < f_2$. Therefore, both firms possess a natural proclivity for the U-form in terms of non-competitive factors. The two theories are thus in full agreement.