Cooperative and competitive behaviors during the process of creative destruction

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This paper examines cooperative and competitive behaviors between interdependent firms during the commercial development of new technologies. Two frameworks on cooperative and competitive behaviors are developed by examining contrasting forces required to drive Schumpeter's process of creative destruction. This paper argues that the stage of technology development must dictate which framework is applied to develop policy initiatives that guide the development of technologies.

1. Introduction

The commercial development of new technologies has been of great importance to the economic vitality of US firms. This economic position is now being threatened by global competitors capable of commercializing these technologies faster than US firms. While there are many factors that impact the ability of firms to commercialize new technologies, this paper focuses on the external interdependencies they have to manage.

New technologies set in motion a sequence of events that can disrupt, destroy, and render obsolete established competencies, or create totally new organizations and industries [38]. In other words, these innovations have a 'transilient' capability to transform established systems of technologies and markets [2]. Such new technologies are often rejected by existing industry participants because of the strength and inertia built into their existing technological paradigms [13].

Therefore, entrepreneurs must create new technical, economic, and social industry infrastructures necessary to sustain the commercial development of new technologies [26,44].

Rarely does any one firm possess all the necessary resources and competencies to create an industry infrastructure [5,16,36]. Consequently firms enter into a complex set of horizontal and vertical interdependencies with others [32]. A vertical interdependence exists among collaborating partners who complement each other in commercializing a new technology. A horizontal interdependence exists between rivals developing close substitute products for the same market.

A key issue confronting firms in managing these interdependencies is the balance they strike between narrow self-interest and wider group-advocacy. This tension between narrow self-interest and wider group-advocacy manifests itself as cooperative and competitive behaviors. It is easy to see the presence of technological competition among rivals as they attempt to achieve commercial success for their products over those being developed by others. It is also easy to see the presence of cooperation between collaborating partners as they share complementary assets and skills to commercialize a new technology. However, collaborating partners often compete over the scope and nature of their contracts [24]. Moreover, rivals sometimes cooperate as von Hippel and Schrader point out in the context of know-how trading [40,50] Thus, cooperative and competitive behaviors occur between rivals as well as between collaborating partners.

Olson provides insights on when we might expect to witness cooperative or competitive behaviors between interdependent firms. Olson makes a distinction between the collective and

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private goods arenas. The collective goods arena is one in which it is not possible to exclude ‘non-purchasers’ from consumption. In contrast, only purchasers can enjoy the consumption of private goods. Given this distinction, Olson suggests that:

... a society will, other things being equal, be more likely to cohere if people are socialized to have diverse wants with respect to private goods and similar wants with respect to collective goods. [31]

From this perspective, cooperative behaviors are more likely between interdependent firms if their needs in the collective goods arena are similar, while their needs in the private goods arena are different. For instance, rivals are more likely to exhibit cooperative behaviors if they offer differentiated products and confront collective threats to their survival. In contrast, they are more likely to exhibit competitive behaviors if they offer undifferentiated products while shaping industry standards to benefit proprietary product developmental efforts.

Olson’s arguments can also be extended to understand cooperative and competitive behaviors between collaborating partners. Collaborating partners are more likely to cooperate if they possess complementary skills and agree on a common research agenda and the appropriability of profits. In contrast, collaborating partners with similar skills and dissimilar research agendas, or disagreement on the appropriability of future profit streams, are more likely to exhibit competitive behaviors.

Whereas Olson provides a basis for understanding when we might expect to witness cooperative or competitive behaviors between interdependent firms, it is not clear how these behaviors change as a technology evolves. Several other authors have studied the changing nature of competition among rivals during technology evolution [9,14,38,46]. While these authors provide key insights, a unified view of interdependencies must consider behaviors not only between rivals, but also between collaborating partners.

This paper attempts to provide such a unified view. The first part examines how behaviors between rivals influence behaviors between collaborating partners. The second examines how these behaviors change as a technology develops over time. To accomplish these objectives, the paper begins with a study of Schumpeter’s process of creative destruction that accompanies the commercial development of new technologies [41].

Driving this process are two forces that form the basis for developing contrasting frameworks on cooperative and competitive behaviors between interdependent firms. Technological competition represents one force. Klein [21], among others, provides the basic premises, concepts, and propositions to develop a framework embodying this facet of creative destruction. This framework (henceforth called the dynamic-competition framework) suggests that rivals compete with one another by developing new technologies while

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<td>Dynamic-competition framework</td>
<td>Structure-conduct-performance framework</td>
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<tr>
<td>Competitive behaviors • innovate continually • establish technological superiority • shape institutional environment to benefit proprietary technology development efforts.</td>
<td>Cooperative behaviors • erect barriers • differentiate</td>
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<td>Cooperative behaviors • ensure flexible/mutually accommodative relationship Fluid state • technological ferment &amp; uncertainty</td>
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entering into flexible cooperative relationships with their collaborating partners. A second force is monopoly protection that firms seek to appropriate benefits from their risky entrepreneurial activities. The structure-conduct-performance framework may be employed to represent this facet of creative destruction (see e.g. [8,23,34]). In contrast to the dynamic-competition framework, the structure-conduct-performance framework focuses on cooperative behaviors between rivals and competitive behaviors between collaborating partners. This framework suggests that firms develop defensible niches by: (1) building entry and mobility barriers, (2) offering products differentiated from those of rivals, (3) agreeing with rivals on the boundaries to competition, and (4) establishing and exercising bargaining power over collaborating partners.

Neither framework is sufficient by itself to understand industrial dynamics over time. In particular, early stages in the commercial development of new technologies are better characterized by organizing concepts comprising the dynamic-competition framework. In contrast, later stages of technology development are better characterized by concepts comprising the structure-conduct-performance framework (see Table 1). Therefore, depending upon the stage of technology development, it is important to tailor policy initiatives to manage and regulate these interdependencies.

2. Process of creative destruction

Simply put, the process of creative destruction is one where new technologies continually displace existing technologies. Because discontinuous change is involved, this process is fraught with risks as particular firms win or lose based on the technologies they choose. Why should any firm engage in such risky entrepreneurial activities?] The answer is that the successful commercialization of new technologies provides opportunities to reap extraordinary profits. This view, however, is not without its critics. To a neoclassical economist, for instance, extraordinary profit implies the existence of market imperfections. In the world of perfect competition, monopoly and competition are viewed not only as being antithetical, but are also mutually exclusive. To demonstrate the presence of competition is to prove the absence of monopoly and vice versa.

Schumpeter offers two critiques of the neoclassical perspective. First, he argues that a perfectly competitive world has never existed and that substantial economic progress has been achieved despite the absence of a perfectly competitive world. Second, he argues that perfect competition is undesirable, even if it could be achieved, because perfect competition removes the very incentives that promote risky entrepreneurial activities. In his view, investments in risky entrepreneurial activities need 'protection' by institutional mechanisms, such as the allocation of intellectual property rights or enforceable long-term contracts with other economic agents. Therefore, profits can be realized through innovation only if competition from rivals can be limited or prevented altogether. Thus, while many authors associate Schumpeter only with technological change, it is important to recognize that the process of creative destruction requires both technological competition and monopoly protection.

The simultaneous presence of both technological competition and monopoly protection may appear as a paradox. However, Schumpeter argues that:

There is no more of a paradox in this (having elements of technological competition and monopoly protection) than there is in saying that motorcars are traveling faster than they otherwise would because they are provided with brakes. [41]

Therefore, technological competition and monopoly protection are not mutually exclusive concepts but necessary ingredients if the process of creative destruction is to be realized. Monopoly protection has a stabilizing influence; technological competition, on the other hand, involves change. These two forces form the basis for the articulation of two contrasting frameworks of the conduct of firms during the process of creative destruction. These frameworks are developed in the next section with a focus on cooperative and competitive behaviors among rivals and collaborating partners.

1 Teece has studied this aspect of technological change with the concept of 'appropriability regimes'. See e.g. [43].
2.1. The dynamic-competition framework

Technological competition constitutes a key force influencing the nature of cooperation and competition between interdependent firms in the dynamic-competition framework. Technological change is associated with uncertainty; the more discontinuous the change, the greater the uncertainty. Because of this uncertainty, firms place their bets on a diversity of technological paths, each path based on different incompatible assumptions [13, 28].

Galbraith points out that the uncertainty and the diversity of paths creates a situation where it is difficult for rivals to coordinate their R&D activities [15]. The only response to unpredictability and the inability to coordinate research activities is to “do unto your competitors what they can do to you” [21]. Thus, technological change undertaken by one firm can be matched only by corresponding technological change by rivals.

This interaction between rivals has the potential to develop into a vicious cycle of unrestrained competition. Freeman labels this process as the ‘bicycle syndrome’, where it is important to pedal as hard as possible to survive [14]. Indeed, Klein argues that it is technological competition, rather than the institutionalization of innovations that Schumpeter writes about in his later work, that brings about technological change. Klein, therefore, suggests that without this competition, innovation will automatically vanish.

Besides competing to develop new technologies, rivals also strive to shape emerging industry structures and standards required to support their development and diffusion. The creation of new industry structures and standards offers rivals an opportunity to build their technology attributes directly into society as institutional rules [12, 25]. Thus, the success of any firm depends not only on effective proprietary technology development activities, but also in its ability to shape the institutional environment to gain legitimacy and resources.

These arguments establish the high level of competition that technological change engenders among rivals. Rapid technological change, however, can be highly disruptive to collaborative relationships. In particular, the introduction of new technologies can disrupt agreements reached between collaborating partners based on particular technological platforms. Such a disruption creates problems in situations where complex technologies are involved. It takes considerable time and effort to commercialize products based on complex technologies. In most instances, several product versions have to be developed before commercial success can be realized. Therefore, the disruption of collaborative relationships can result in a loss of both technological resources and shared knowledge embedded in the relationship.

The uncertainty and upheaval associated with technological change therefore requires cooperative behaviors between collaborating partners. Relationships between collaborating partners need to be flexible, accommodating, and characterized by trust. These attributes are possible only if collaborative relationships are considered to be ‘positive-sum’ games where both parties stand to benefit from the successful commercial development of new technologies [17, 21].

This description constitutes the dynamic competition framework. Technological change that forms the basis for this framework results in competition among rivals while requiring cooperation among collaborating partners. The next section highlights the contrasting behaviors that form the basis for the structure-conduct-performance framework.

2.2. The structure-conduct-performance framework

The structure-conduct-performance framework was developed to assist government policy makers in the formulation of economic policy as a means to ensure perfect competition among firms in an industrial economy [34]. It was only later that strategy theorists turned the original policy objectives of this model upside down. Instead of assisting policy makers in reducing firms’ returns to a fully competitive level, strategy theorists have developed models to help firms obtain higher than normal economic returns on their business investments.

The early structure-conduct-performance framework as developed by Bain and Mason [8, 23] proposes that industry structure determines firms’ conduct which, in turn, determines firms’ performance. Industry structure is defined as the relatively stable economic and technical context in which competition takes place. This context includes barriers to entry, the number and relative...
size of firms, the existence and degree of product differentiation in the industry, and the overall demand elasticity in the industry. Conduct is a firm's choice of key decision variables such as price, advertising, production capacity and quality. Performance includes aspects such as profitability, cost minimization and innovativeness. As articulated originally, a firm's performance is fully determined by industry structure that can not be changed by any one firm. The only choice a firm has is between different businesses and the 'right' mix of product pricing and advertisement for each.

However, this deterministic view does not adequately capture firm behaviors. Firms do structure and change their environments, either individually or collectively, creating defendable niches where they can enjoy relatively high profits without being threatened by rivals and entrants. Individuals, firms create a defendable niche by erecting barriers insulating them from rivals and potential entrants. Firms also create these niches by entering into exclusive contractual relationships with collaborating partners, thereby foreclosing access to factors of production. Firms have to possess 'bargaining advantage' over their collaborating partners, while crafting and maintaining such relationships so as to 'squeeze out the best deal' from their collaborating partners [33]. However, such a zero-sum mentality (by even one collaborating partner) engenders competitive behaviors as suggested by Weick [51] and experimentally demonstrated by Kelly and Stahelski [20]. Collectively, firms engage in strategies that jointly mobilize resources to achieve ends shared by industry members [7]. These ends include the ability to reap extraordinary profits by: (1) dissuading the entry of new firms and substitute technologies, (2) reducing environmental uncertainty and complexity, and (3) entering into agreements with rivals on the boundaries to competition [35].

In sum, the structure-conduct-performance framework directs attention towards cooperative behaviors between rivals and competitive behaviors between collaborating partners. The underlying quest for monopoly protection that results in this configuration of cooperation and competition discourages change. Mobility barriers insulating firms from competition between rivals reduce the need to innovate, and any working agreement between rivals on the extent of competition again leads to some degree of stability and predictability. Similarly, exclusive binding contracts with collaborating partners reduce the flexibility required to innovate and change. In this way, the structure-conduct-performance framework directs attention to behaviors that are very different from the behaviors that constitute the dynamic-competition framework. The next section explores how these two contrasting frameworks can be reconciled to understand industrial dynamics as creative destruction ensues.

3. Industrial dynamics

In a recent paper, Jacobson argues that many former advocates of the structure-conduct-performance framework have begun articulating views that move closer to Schumpeter's and other Austrian economists' way of thinking. However, as Jacobson points out, inconsistencies arise when attempting to integrate other frameworks with the Austrian frameworks. In particular, Jacobson provides Porter's work as an example. According to Jacobson:

...Porter failed to reconcile his continued advocacy of restricting competitive forces as a means of achieving higher profits with his conclusion that a company should actively seek out pressure and challenges, not try to avoid them, to provide sufficient pressure for innovation. [18]²

A way to integrate the two frameworks is to embed them within an overall temporal frame that captures contextual changes that occur as technologies develop. Abernathy and Utterback provide just such a temporal frame [3,47]. Their study of the automobile industry suggests that a productive unit (defined as the confluence of products and processes associated with a technology) progresses from a fluid to a specific state. The fluid state represents an era of ferment that, Tushman and Anderson suggest, is characterized by rapid technological change and associated uncertainty [45]. Forces that can bring about technological change subside as frontiers of achievement capabilities embodied in the new technology are

² For similar arguments, see also [11].
reached. The era of ferment gives way to an era of incremental change and a shift occurs from dynamic to static efficiency [21]. While dynamic efficiency is concerned with making continual advances in fundamental aspects of the technology, static efficiency involves incremental changes in order to reduce costs and improve quality.

During the fluid state, congruent with the dynamic-competition framework, rivals attempt to build their technology attributes directly into emerging industry structures even as they seek market dominance. In Olson's view, this represents a fractious group of rivals with dissimilar needs in the collective goods arena and similar needs in the private goods arena. As a result, rivals are more likely to compete during the fluid state of technology development.

The high level of competition among rivals, as explained earlier, requires a high degree of cooperation among collaborating partners because of the constant change and uncertainty. Cooperation among collaborating partners is indeed possible at this stage of technology development. This is because firms enter into collaborative relationships if they possess complementary assets or skills while having a shared interest in seeing that products from their symbiotic relationship are commercialized. This situation represents similar needs in the collective goods arena and dissimilar skills in the private goods arena. Moreover, when collaborative relationships are in their early stages, issues relating to the appropriation of profit streams can be postponed until after the commercial development of products. As a result, collaborating partners are more likely to cooperate during the fluid state of technology development.

As forces that bring about technological change are exhausted, the structure-conduct-performance framework becomes useful in understanding cooperative and competitive behaviors among interdependent firms. Individually and collectively, rivals seek to establish a stable industry order as they become interested in recouping their investments. Competitive behaviors between rivals are replaced by cooperative behaviors as rivals differentiate their products while following industry-wide standards with the emergence of a dominant design [47]. Thus, a situation develops where rivals have similar needs in the collective goods arena (that of establishing a stable industry order) while having different needs in the private goods arena (with products that are suitable for different niches). As a result, rivals are more likely to cooperate during the specific state of technology development.

While the relationships between rivals become cohesive, other forces change the character of behaviors between collaborating partners. The collective quest for increased profits by rivals now changes the nature of their association with their collaborating partners – from one of mutual accommodation and cooperation to one of bargaining and competition. Galbraith's notion of countervailing power is particularly useful in understanding why competitive behaviors may be observed between collaborating partners when rivals cooperate to increase their profits. He noted:

In the typical modern market of few sellers, the active restraint is not provided by the competition (among rivals), but from the other side of the market by strong buyers. [15]

Moreover, previous interactions lead to a similarity of skills [49]. In short, collaborating partners now have similar skills in the private goods arena while having dissimilar needs in the collective goods arena. As a result, collaborating partners are more likely to compete during the specific state of technology development.

Thus, there are reasons to believe that behaviors corresponding to the structure-conduct-performance framework are more likely during the specific state of technology development, while behaviors corresponding to the dynamic-competition framework are more likely during the fluid state of technology development. 3

Reviewing a government study of US businesses, Blau and

3 I thank an anonymous reviewer for providing examples that run counter to the basic proposition developed in this paper. There is evidence that rivals cooperated with one another during early stages of the PC industry development. In particular, software engineers exchanged technical information with one another (see [37,39]). Similarly, it appears that the nature of relationships between collaborating partners in the PC industry has changed from one characterized by a 'hands-off' attitude to one that is characterized by trust and cooperation during the later stages of industry emergence. These observations suggest that the basic proposition developed in this paper may need to be refined with respect to industry contingencies. In particular, the nature of cooperative and competitive behaviors between rivals and collaborating partners may depend upon whether they perceive the nature of their interdependence to be a zero-sum or positive-sum game.
Scott report similar changes in cooperative and competitive behaviors between rivals and between collaborating partners over time. They noted:

In sum, as a few large organizations became dominant in each market, the focus of their endeavor shifted from competing with others in the same market to struggling over the conditions and terms of exchange between buyers and sellers, a struggle that induced former competitors to become allies and organize mutual benefit associations. [10]

4. Discussion and conclusion

This paper explores industrial dynamics during the commercial development of new technologies. An examination of Schumpeter’s process of creative destruction suggests the presence of two forces, technological competition and monopoly protection. These forces are the basis for articulating two contrasting frameworks on the conduct of firms. The dynamic-competition framework (corresponding to forces of technological competition) suggests that rivals will compete with one another to establish technology dominance in markets and institutions. The high degree of change engendered by this type of competition requires that firms establish flexible cooperative agreements with their collaborating partners. In contrast, the structure-conduct-performance framework (corresponding to monopoly protection) suggests that rivals enter into cooperative agreements with one another to establish a stable industry environment within which to recoup their investments. Efforts to increase such profits lead to contractual agreements between collaborating partners based on bargaining power as each party attempts to ‘squeeze out the best deal’. Such efforts eventually lead to competitive behaviors among collaborating partners. The paper also suggests that cooperative and competitive behaviors congruent with the dynamic-competition framework are more likely to be present during early stages of technology development. In contrast, behaviors congruent with the structure-conduct-performance framework are more likely during later stages.

These propositions highlight the importance of not lumping together different stages of technology development in exploring policy initiatives.

Different strategic postures and policy endeavors must be crafted for each stage of technology development. For instance, applying the structure-conduct-performance framework as an action-frame during the fluid state may lead a firm to focus on the erection of barriers instead of focusing on the development of new products. An exclusive focus on the erection of barriers at this stage of technology development may be misplaced if rivals’ products render barriers ineffective. Similarly, inflexible contractual relationships between collaborating partners may be inappropriate during early stages of technology development when firms are likely to engage in discontinuous technological changes. Thus a strategic posture congruent with the structure-conduct-performance framework may be an inappropriate action-frame to guide the operations of a firm during the fluid state of technology development [1,14,21].

Similarly, a strategic posture that is congruent with the dynamic-competition framework may be an inappropriate action-frame to guide the operations of a firm during the specific state of technology development when structures and institutions inhibit change. Efforts to compete with rivals by introducing new products may be difficult as industry structures begin supporting entrenched products. Similarly, a relationship with collaborating partners that seeks flexibility could be open to opportunism as collaborating partners appropriate a higher share of profits because of their bargaining power. However, firms that do adopt a strategic posture congruent with the structure-conduct-performance framework during the specific state of technology development are particularly vulnerable to major technological changes or industry dematuration [4]. Consensus among rivals may lead to complacency and vested interests in entrenched technologies. Moreover, competitive behaviors between collaborating partners will make it difficult to effect any new technological change.

While exploring industrial policy, it is important once again to apply these two contrasting frameworks in a temporally relevant fashion. Cautioning against extreme levels of competition, Lawrence offers what he calls the competitive principle:

an industry needs to experience vigorous competition if it is to be economically strong, ei-
ther too little or too much competitive pressure can lead an industry to a predictably weak economic performance characterized by its becoming inefficient and/or non-innovative. [22]

Based on this competitive principle, Lawrence suggests that industrial policy be matched to the stage of an industry’s development. The two frameworks developed in this paper can be employed for this purpose. For instance, it is widely recognized that the commercial development of new technologies requires efforts of several firms to create needed industry infrastructures. These collective goods are difficult to create because of the inherent problems associated with collective action. The difficulties associated with the creation of industry infrastructures are further exacerbated by the competitive strife that unfolds between rivals as they develop competing technologies. It is under these circumstances, where cooperation is desirable but difficult to achieved, that government agencies may assume the role of fostering cooperative efforts among rivals. It is not just enough to do away with impediments to cooperative behavior, such as modifications of the anti-trust laws as Jorde and Teece suggest government agencies can facilitate the coordination of private efforts to create collective goods so that new technologies are commercialized rapidly.

In contrast to the early fluid state of technology development, cooperative efforts by entrenched rivals may result in monopoly rents by the creation of entry and mobility barriers during the specific state of technology development. As Schumpeter suggests, this is a reward to risk-seeking entrepreneurs. However, Williamson [52] argues that successful firms may enjoy monopoly profits indefinitely if market forces cannot dislodge them. Dominant firms may erect significant entry barriers to protect their monopoly position over time. As a protection against such continued dominance, government initiatives are required to promote basic scientific research so that creative destruction ensues. Several researchers argue that basic scientific research may be under-funded by firms (from a social perspective) because of its collective goods properties [6,27]. Therefore, government funding of basic scientific research is required. Moreover, fostering creative destruction also involves the transfer of knowledge from public to private laboratories. Government efforts to facilitate knowledge transfer is required as this process entails transaction difficulties. These actions, funding basic research and facilitating its transfer to private laboratories, can result in the commercial development of new technologies that render entrenched technologies obsolete.

References


4 Particulars of industry infrastructures required for the commercialization of new technologies are detailed in [48].
5 For inherent difficulties in collective action, see [29,30].
6 For transactional difficulties that arise in the transfer of knowledge, see [42].
[40] S. Schrader, Information Technology Transfer between Firms: Cooperation through Information Trading, MIT working paper Nr. BPS-3135-90.

