Strategy Dynamics, Repositioning Costs, and Competitive Interactions

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PRELIMINARY DRAFT: March 1, 2013

Abstract

In this paper we propose an approach to the modeling of strategic interaction that incorporates the costs to firms of changing their strategies. These costs, which we term repositioning costs, have been identified in the organization and strategy literatures as critical aspects of strategic change, but have been largely ignored in game-theoretic treatments at the grand strategy level. Including such costs changes the nature of strategic dynamics and the implications of strategic interaction for strategic choice. Because we believe that the existence of costs to change strategies are a key defining feature of what constitutes a strategic choice, we argue that all models of dynamic strategic interaction at the level of grand strategy should include such costs. We also propose a typology of repositioning costs that not only allows us to classify currently existing models that incorporate such costs, but also helps us to identify its heretofore underexplored aspects. To demonstrate the fertility of the repositioning cost approach, the paper incorporates into a simple example of inter-firm competitive interaction the notion that repositioning costs can increase with the length of time that a firm has been executing its current strategy, and demonstrates how the inclusion of this feature changes the nature and outcome of the game in nonobvious ways.

A. Introduction

Strategic interaction is a core concern of strategic thinking, yet game theory, the primary tool available to analyze strategic interactions, has had limited traction when applied at the level of a firm’s grand strategy. Part of the explanation may lie in the concern that business strategies are too complex and multifaceted to be usefully captured in game-theoretic models. Such models, it is argued, tend to analyze one or two primary choices and make very strong assumptions regarding available information and the decision makers’ forward-looking rationality (e.g. Saloner 1991). Perhaps in view of these considerations, game-theoretic analyses have arguably been most persuasive in tactical situations such as pricing and market entry where the key choices are circumscribed and for which the structure of strategic interaction is relatively simple.

In this paper we propose an approach to applying game theory that better allows such modeling to inform grand strategy. Our approach is to focus on incorporating repositioning costs into game theoretic models of strategy. By repositioning costs we have in mind the costs that a firm incurs in changing its market position or the way in which it is configured to deliver value. We think about this repositioning as a changing of its activity system (Porter 1996). Such costs depend, for example, on the “distance” between the old activity system and the new activity system and the time over which the
firm has employed a given activity system and the difference in the resources needed to support each position. Thus, repositioning costs are path dependent. We propose that all dynamic strategy-level interactions should incorporate repositioning costs. Implementing this adaptation to the conventional game-theoretic models requires making explicit assumptions regarding transition costs from one activity system to another.

Our focus on repositioning is inspired by Pankaj Ghemawat’s perspective on commitment as strategy (Ghemawat 1991). He persuasively argues that a strategic choice is one that involves commitment. Because commitment to a particular choice necessarily implies a cost to change from that choice, from the viewpoint of strategy dynamics, all strategic choices involve repositioning costs and, hence, such costs are essential elements. In this view, commitment defines what constitutes a strategic choice and repositioning costs become fundamental to analyzing strategic change. But consideration of one’s own repositioning costs is only a partial picture of the strategic environment. Hence, there is value in developing the implications of repositioning costs and commitment in the context of strategic interaction.

There is a voluminous literature, mostly in economics, that explores the impacts of specific mechanisms through which commitment operates which focuses on topics such as entry, pricing, capacity expansions, etc. Our approach is similar in methodological spirit to this research, but differs in its emphasis on exploring general repositioning cost structures associated with changes in higher-level or “grand” strategy rather than on specific commitments that firms choose that tend to operate below the level of grand strategy. Cost structures could, for example, depend on the distance a new activity system is from the current activity system or the time the current system has been in place. Because of the complexity of the activity system of a firm, we believe identifying specific mechanisms through which such systems change is less valuable and less generalizable for analyzing grand strategy than the exploration of higher-level categories of repositioning cost structures which we propose. There is clearly room for both approaches, but we believe one hindrance to the use of game theory to understand the interaction implications of grand strategy changes has been the prevailing preferences in the academy that push researchers who explore commitment in the direction of specific mechanisms.

In the next section of this paper we develop the idea that repositioning costs are central to understanding strategy dynamics and argue that this is an essential feature that needs to be included in all models of strategic change. We provide context for this idea from both the strategy literature and to a limited extent from the economics literature. In section C, we propose a typology of these repositioning costs. Section D provides an example of how repositioning costs can be incorporated in

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2 Ghemawat (1991) notes that many think of strategy as a broad pattern of behavior that persists over time. Activity systems have the characteristic of generating such patterns.

3 One could see the endeavor we propose as more similar to the economics literature regarding multiple-period interactions which, rather than modeling specific mechanisms that unfold over time, are focused on understanding the dynamic choice aspects associated with particular classes of payoffs. Here we have in mind research on repeated prisoner dilemma games. Such games, with very few exceptions, treat the choices of the players as effectively being costless (the history does not matter for the cost of making the choice itself). Thus, not only is the object of the exercise different, there is almost no attention paid to the critical element of commitment.
game-theoretic models of strategic change. This example illustrates how one can incorporate such costs in game-theoretic models and the value and fertility of the proposed modeling approach both in terms of intuition and in terms of differences relative to models that do not incorporate such costs. Section E examines issues relating to modeling strategy as opposed to tactics, the endogeneity of repositioning costs, and the value of game-theoretic models for developing strategic advice. Section F concludes.

B. Repositioning Costs and Commitment in Various Literatures

Before providing context for how our ideas fit to the literature, it is important to clarify the context we have in mind and how we discuss key terms. Our focus is on how a firm’s strategy may change over time in anticipation and in response to strategy choices of competitors. For the purpose of this paper, we refer to a firm’s current configuration of resources and activities as its “activity system” and reserve the use of the term grand strategy to refer to an overall plan that allows for major changes in the activity system consistent with the idea of strategic change. Repositioning cost is referred to a change from one activity system to another. These definitions are chosen to support our focus on strategy-level questions. The definitions are also consistent with the use of the term “strategy” in game theory where a strategy is a plan of action for the entire game. Our repositioning cost approach is, of course, also applicable to actions that have more of a tactical feel. But in such settings, the cost of changing actions will not always be first order.

Our starting point is Pankaj Ghemawat’s (1991) theory of commitment as the essential element in identifying strategic choices. We review this theory and how it fits with our approach. We then discuss how the literature has treated the two main elements—repositioning costs and inter-firm interaction—around which our approach is built.

Ghemawat sees commitment as the factor that defines what is a strategic choice and what is not. He argues that committed choice creates the persistent pattern of action that most observers would characterize as strategy. Top-level strategists are advised to focus their attention on irreversible choices since those are the decisions that guide and constrain the future path of the firm. More easily reversed choices (e.g., pricing in most cases) may be important, but they are not, in this view, strategic. As the degree of and importance of commitment varies on a continuum, choices might be best thought of as being ordered in strategic importance. Along these lines, one example of strategic choice offered by Ghemawat is that of product choice by airframe manufacturers who arguably bet their company on each major product. This is a major strategic choice for airframe manufacturers because of the lengthy product development cycle and the commitment of resources, plus the (hopefully) long lifetime of the product. For companies with a large product portfolio and modest product launch and exit costs, product introduction may be less strategically important.

Not only does the Ghemawat perspective treat repositioning costs as an essential element in assessing strategy dynamics, it also helps a strategist determine which choices should be assessed. In tactical situations, the choice set is more obvious than in most situations involving grand strategy, especially when the contemplated strategic shifts are not quite so obviously grand. In such settings and in those
involving true grand strategy, the commitment criterion (along with irreversibility) helps to screen out less relevant options.

Repositioning in the Strategy Literature

Repositioning costs figure quite prominently in the literature addressing strategic change. Depending on one’s strategy or organizational worldview, such costs can be discussed in many different ways. What we have in mind can be most easily understood from the perspective of Porter’s positioning school of strategy (Porter 1980, 1985, 1996) and we draw on the terminology of that school to describe our model of strategy. In the positioning school, a firm is characterized by a set of activities that collectively create value for the customer. These activities can be thought of as various parts of the value chain which may fall under traditional groupings such as research and development, manufacturing, and marketing, or across such groupings. Each position is defined by the tradeoffs that the position entails. So, for example, one firm would have an activity system that is configured to best deliver value to a particular customer segment, but this configuration would make it difficult for that firm to serve a different customer segment. For a given position, competitive advantage is enhanced when these activities are reinforcing. This implies that a firm’s competitive advantage is partly the result of the way the various activities are integrated and the way they complement each other (Drazin and Van de Ven 1985, Khandwalla 1973, Porter 1996). This perspective of the activity system that is configured to best deliver value also maps very closely to the concept of “business models” (Casadesus-Masanell and Ricart 2010).

From this perspective, strategic changes can be thought of as major changes to a firm’s activity system which are understood in relation to the path through which the current and previous activity systems were reached (Ahuja and Katila 2004, Mintzberg and Waters 1985, Sigelkow 2002). The more tightly integrated the activity system and the greater the change, the higher the costs of repositioning. Furthermore, a significant change in position also means that it will also be costly to return to a previous position. Repositioning costs are, therefore, first-order features of major strategic changes and one would expect the magnitude of those costs to depend on the extent to which the preceding activity system had been integrated and the degree of change (what we call the “distance” of the change).

Support for the existence of significant repositioning costs can be found in a variety of perspectives in the literature on strategic change. Much work has noted that organizations display significant inertia to change (e.g., Barnett and Carroll 1995, Christensen 1997, Hannan and Freeman 1977, Kotter 1997, O’Reilly and Tushman 2008, Tushman and Anderson 1986), which might also include the cognitive inertias of the managers (Tripsas and Gavetti 2000). This inertia would increase the cost to move away from a strategic position. Strategic change normally requires significant changes in organizational routines. From this perspective, strategic change is costly both in terms of anticipated and known investment and in terms of an evolution of supporting organizational capabilities and institutions (e.g., Selznick 1949), routines (e.g., Argyris 1985, Argyris and Schön 1978, Downs 1967, Nelson and Winter 1982), and culture (e.g., Schein 2010). The evidence that organizations continue to reflect their original form despite changes in their external environment also supports the presence of high repositioning costs (Stinchcombe 1965, Marquis and Huang 2010).
The development of organizational capabilities is generally a critical aspect of strategic change. From a positioning worldview, one can think of these capabilities (and the resources that underlie them) as components of an activity system that may fall within a particular functional area or may cross a number of areas. Although one might think of the development of a capability as not subtracting in any way from previously existing capabilities, the often tacit nature of these capabilities strongly suggests that one cost of developing a new capability is the potential diminution of one or more previously existing capabilities (Kogut and Zander 1992, Levinthal and March 1993). Empirical research supports this view of the cost of capability development and underscores the idea that repositioning costs include both the change to reposition and the ensuing costs that this repositioning entails (including a return to a prior capability) (e.g., King and Tucci 2002, Tripsas 1997).

In summary, there is significant consensus in the organizational and strategy literature that major strategic change involves significant costs. Despite the recognition of these costs in the literature, as will be argued next, game-theoretic models developed to illuminate grand strategy questions have largely not incorporated such costs. In our view the absence of such costs from models raises serious questions about the robustness of such models when applied to major shifts in strategy. In fact, one could argue that this weakness may justify some of the skepticism that game-theoretic models have met with when such models have been used to address strategic questions.

**Commitment and Inter-firm Interaction in the Literature**

Although game theory is a tool that was designed to focus directly on strategic interactions, it has only had limited traction in the field of strategic management. This is not the result of game theory’s sterility for understanding social science phenomena: game theory has played a central role in scholarship in both economics and political science over the past four decades or more. It has been essential to our understanding of market interactions, political competition, and individual incentives.

To be sure, there is a large stream of academic and popular work that emphasizes the intuition provided by game theory (e.g., those emphasizing the metaphor of war). But this work either does not really exploit the tools of game theory and or tends heavily to more tactical applications. In terms of the latter, many texts (Dixit and Skeath 1999, Podolny, Shepard, Saloner, 2000, Spulber 2004, others), for example, have applied findings from industrial organization on commitment and irreversibility to strategy. These texts provide examples of firms deploying commitment devices such as pre-emptive investment in excess capacity, most-favored nation clauses and price commitment mechanisms to improve performance, but the cases are skewed toward the tactical end of the strategy spectrum.

There is also a large literature which has explored specific strategic situations using game theoretic tools. Ghemawat (1997) used game theory to discuss many business cases, pointing out some of the limitations in applying these tools to business strategy in the process. Game theory has been used to study the dynamics between competitors (e.g. Esty and Ghemawat 2002), “competing complements” (Casadesus-Masanell and Yoffie, 2007), strategic interactions in multi-sided platforms (Caillaud and Jullien, 2003, Evans, Hagiu and Schmalensee, 2006, Hagiu 2008), time-compression diseconomies (Pacheco-de-Almeida and Zemsky 2007) and other strategic settings. But they have largely tended to
explore pricing decisions (including dynamic price paths), timing of new product introductions, investment timing or other such variables that explore a relatively well-defined mechanism and arguably, therefore, have a more “tactical” nature to them.

Another impactful stream of work has applied cooperative game theory to strategy (Brandenburger and Stuart, 1996, Lippman and Rumelt, 2003). This stream of work has developed an elegant framework that integrates value creation and value capture with competition using cooperative game theory, focusing on the bargaining power of the various actors in the framework and how that is crucially determined by the unique value they add to the system. While these approaches are often powerful, they also do not focus on repositioning costs that are involved when the firms in these games change their strategies.

Thus, few applications explicitly incorporate repositioning costs into their setups. This is not to say that the importance of repositioning costs in strategic interactions has not been noted before. For instance, Michael Porter (1980, p. 101) argues that “If the firm can convince its rivals that it is committed to a strategic move it is making or plans to make, it increases the chances that rivals will resign themselves to the new position and not expend the resources to retaliate or try to cause the firm to back down. Thus, commitment can deter retaliation.” Furthermore, Shapiro (1989, p. 127) pointed out “[W]ith its emphasis on strategic commitment, the theory of business strategy takes the field of I.O. in the opposite direction from that of the well-known theory of contestable markets (Baumol, Panzar, and Willig, 1982). Contestability theory applies when there are no sunk costs. This translates into a complete absence of strategic behavior, since any action that is costlessly reversible has no commitment or strategic value. Since sunk costs are ubiquitous, I regard strategic theories of rivalry as appropriate and natural, in contrast to contestability theory, which appears to be an empty box.”

These observations might have been expected to pave the way for a rich tradition that incorporated various mechanisms of repositioning cost from the strategy literature into game theory models in strategy. Surprisingly, until recently almost all of the strategy-related work of this type has its genesis in the economics literature. The most directly related literature is that on the economics of switching costs. For our purposes, we divide this literature into work that assesses the implications of either buyer or supplier switching costs on the competitive interactions of focal firms and work that addresses the switching costs among the options considered by focal firms. The first of these categories is where the majority of attention has been focused. But the second category is most on point to this paper, that is, the costs to the firms of changing their actions, and the strategic implications of those costs. In terms of general models exploring the effect of switching costs to player choices, there is a small literature in the general game theory domain (Lipman and Wang 2000, Caruana and Einar 2008).

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4 In some cases, e.g., Casadesus-Masanell and Yoffie (2007) and Casadesus-Masanelland Ghemawat (2006), key strategic features of a competitive interaction are explored, but even then, strategic change is not the primary focus of the analysis.

5 See Klemperer and Farrell (2007) for a survey of the literature on customer switching costs.

6 There is also some literature on costs that buyers face when switching suppliers. This could be perhaps be seen as belonging to the second category – since it involves a cost to the focal firms of changing their actions (i.e., switching suppliers). Some of these models, e.g. Richardson (1993) do not involve strategic interaction among the buyers. Others such as Monteverde and Teece (1982) do consider strategic interaction, but are interested in the role these costs play in the decision of the focal firm to vertically integrate along its supply chain.
In recent years some game-theoretic work in strategy has been done highlighting the impacts on strategy of implementation costs. This work is much closer in spirit to what we have in mind with respect to modeling repositioning costs. Pacheco-de-Almeida and Zemsky (2007) formalize the notion that “the faster a firm develops a resource, the greater the cost”. While such costs are similar to repositioning costs in many ways, they differ because they are not incurred in moving from one activity system to another (although it could be a part of it). Chatain and Zemsky (2011) formalize the “frictions” in industry value chains that prevent some actors from transacting with each other, thus destroying potential value in the process. This cost too is an important incurred cost, but is different from repositioning costs discussed earlier, which are costs incurred when firms undertake strategic change.

C. A Typology of Repositioning Costs

The Challenge of Modeling Strategic Dynamics

We believe that one of the contributions of this paper is in focusing attention on repositioning costs in contexts involving strategy dynamics. As noted above, the observation that repositioning costs have to be accounted for in strategic change is not a novel one. Neither is the fact that they should be important components in dynamic strategic interactions. Rather, we argue that rather than being yet another variable that could be included as a modeling choice, repositioning costs are a necessary feature of games involving strategic change – they are what make a game quintessentially strategic à la Ghemawat.

As discussed above, one feature of the economic models built around some form of commitment is that they are usually precise about the mechanism of commitment. This precision has obvious virtues, but precision forces the application towards more clearly defined settings and arguably narrower applications; hence previous commitment models have a decidedly tactical feel to them. That is not to argue that a model of grand strategy needs to be imprecise. Rather, such models should be oriented to modeling particular cost structures characteristic of strategic change as identified in the organizational and strategy literature. For example, such costs would emphasize the structure of costs associated with repositioning existing and future activity systems (along with needed acquisition or development of competitive capabilities) and not the specific committed investment that is needed to enter a product or geographic market. The idea is that the specific implementation of a grand strategy should be modeled not just as an acquisition of specific resources, but as the general costs of a set of anticipated activities or resource developments that are related to competing with a given activity system of the firm. The challenge is to identify a set of general cost structures and then to model them parsimoniously.

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7 One early exception is Chen and MacMillan (1992) that explicitly accounted for the fact that both “attackers” and “defenders” suffered “implementation costs” when they changed their strategic actions. Their approach is very much in the tradition of the industrial organization literature.

8 Repositioning costs include, of course, organization change costs such as the political costs of change.
A Typology of Repositioning Costs

In keeping with this approach, we propose a typology of repositioning costs. We attempt to group the various costs that might be incurred during strategic repositioning into three “levels”. This structure serves a few different purposes. It allows us to place the different instances of repositioning costs in the literature discussed earlier into a coherent broader framework. It then allows us to compare these specific mechanisms that have been explored before in different disciplines, and also allows us to focus attention on the relatively unexplored and non-obvious mechanisms that also result in repositioning costs. Finally, by breaking down these costs in a (quasi) systematic manner, we begin to allow for sharper empirical measurements of the costs.

Level 1: Destination-Based Costs: Destination-based costs are repositioning costs that are based on the properties of the activity system (capabilities) that the firm is moving to (“Destination”). Such costs result from the difficulty in acquiring the resources and capabilities to effectively set up the new activity system that the firm is repositioning to. A large portion of the investigations in the traditional industrial organization literature focus on this set of cost considerations. For instance, games with pre-emptive investment in excess capacity, intellectual property-based entry barriers, or other entry barriers more generally hinge on an incumbent firm increasing the cost to an entrant to move to that position.

From a formal game-theoretic perspective, a level 1 treatment would be one in which the repositioning cost function, and thus the net payoff to the firm, takes just the Destination action as its argument. For example, if player 1 plays action “A” and player 2 plays action “a”, the resulting payoff to player 1 can depend on those actions only (as in usually the case in the initial period of standard games).

Level 2: Distance-Based Costs: Distance-based costs are repositioning costs that are based on the properties of the “Origin” (initial activity system that the firm is moving from) and the “Destination”, as well as the relationship between the Origin and the Destination. An immediate example of these costs is the intuitive notion of the “distance” (or degree) of the strategic repositioning. For instance, if the set of resources and capabilities required to effectively execute the Origin activity system are very different from those that are required for the Destination activity system, the distance of the change could be said to be larger, and the repositioning cost incurred would be higher. Such costs would also account for difficulties in changing from the initial activity system of the firm (i.e., Origin), for example, difficulties in unwinding and changing the current operations, the costs breaking off current commitments (for example, contract cancellation fees with a supplier), and so on. These costs most directly map onto the classic considerations of commitment discussed earlier.

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9 A more formal way to think of this classification would be to think of the number of previous period plays that go into the payoff function of any given state of the world. From this perspective, this typology would be reflected in the number of previous periods’ actions that have to be accounted for in any given period’s payoff. Thus, one could think of higher “levels” of repositioning costs as introducing higher degrees of path dependence into the payoff function for a given period. Another formal classification scheme could be to sort the considerations as being “state-based” or “ordering-based”, i.e., just the states that the firm has been in (or action that it has chosen) in the past, or the order in which they were done.
From a game-theoretic perspective, a “distance-based” repositioning cost function takes both the Destination action as well as the Origin action as its arguments. Thus, the payoff to any given state of the world for a player will also be a function of its previous period action – a path-dependence accounting for one period of history.

A more nuanced version of distance-based costs would include the actual path (and not just the point to point distance in a resource-capability space) that the firm takes in undertaking the repositioning. This notion is based on various streams of strategic thought, including the directionality and path dependency of search and learning (Cohen and Levinthal, 1991, Levinthal 1997, Levinthal and March 1993, Nelson and Winter, 1982), the notion of the reducing productivity of resources the “farther” one moves from the core uses (Montgomery and Wernerfelt 1988), and the path dependent nature of resource acquisition (e.g., Ahuja and Katila 2004, Kogut and Zander 1992, Stuart and Podolny 1996). In such a path-based cost structure, a firm will suffer a higher repositioning cost to “move” a position if it initially “moves” in the opposite direction. Along these lines, an interesting dimension to explore would be the movement between an exploitation orientation to an exploration orientation (e.g., March 1991 and O’Reilly and Tushman 2008).

We analyze a simple two-firm model with such distance-based costs in the appendix. An example of distance-based costs which has characteristics of path dependency would be the literature on time-compression diseconomies (Pacheco-de-Almeida and Zemsky 2007), where changing the path from the same Origin to the same Destination by compressing it on the time dimension increases the cost.

**Level 3: History-Influenced-Costs:** History-influenced costs depend on the previous history of the firm beyond merely the (immediate) Origin and the Destination. This class of repositioning costs, while relatively uncommon in game theoretic treatments, have strong antecedents in the strategic change literature. Some examples include different learning mechanisms (Argyris and Schön 1978, March and Levinthal 1993, Nelson and Winter 1982), absorptive capacity (Cohen and Levinthal 1991) and core rigidities (Leonard-Barton 1992) among others. Sosa (2012), for example, argues for differential R&D productivity of firms based on their different “pre-histories”. In all these mechanisms, the prior experiences of a firm alter its costs of changing its activity systems. Thus, two firms with the same Origin...
and Destination activity systems (and thus the same distance) could still experience different repositioning costs due to their different histories. It is important to recognize why history-influenced repositioning costs are virtually never implicitly “accounted for” in the payoffs in typical multi-period bimatrix games. To account for such repositioning costs, it would have been necessary to have each payoff matrix have payoffs that are contingent on the historical path of choice of each player.\textsuperscript{12}

From a more general game-theoretic perspective, history-influenced repositioning cost functions (and thus net payoff functions) take as their arguments, in addition to the Destination and Origin actions/states, prior actions of the firm that go beyond just the previous period (i.e. more of the firm’s historic actions beyond just the Origin). Thus, they would correspond to a path-dependence of two or more prior periods.\textsuperscript{13}

A simple example of this class of costs is the notion of increasing change inertia the longer a firm has been in a position. This idea relates to the development and embeddedness of routines over time (Nelson and Winter 1982), the notion that exploitation and learning tend to increase competence for local actions while decreasing competence and motivation to search far and undertake change (Levinthal and March 1993), the acquisition of position specific resources and capabilities over time (Barney 1991, Peteraf 1993, Teece, Pisano and Shuen 1997), and so on. In this time-based cost structure, the longer a firm has been executing a certain strategy, the higher will be its repositioning cost to move to a different strategy.

In the next section, we will explore an example of this type of repositioning cost in a setting with two strategically interacting firms.

D. An Example

In this section we explore some implications of the “time” structure on repositioning costs (i.e. an example of Level 3: History-Influenced-Costs) with a numerical example of a two-firm interaction involving multiple periods. The details of the strategic dynamics are developed in detail below, but the core intuition of the example is that time-based repositioning costs can cause the discovering firm to wait or hold off a strong competitive response, in order to get its competitor locked in to the option that it wants the competitor to play. And anticipating this forbearance from the discovering firm, the competitor will choose an action that it would not have chosen otherwise. Crucially, this dynamics hinges on the repositioning costs, and would not be possible without it. Furthermore, both firms can be fully aware of this mechanism and it is still optimal for the firms to make these choices. (I.e., it is not the

\textsuperscript{12} An argument can be made that distance-based repositioning costs are implicitly embedded in the payoffs, but while this is theoretically true, it is often unclear, in practice, whether modelers are developing such payoffs taking repositioning costs into account or not.

\textsuperscript{13} To be sure, there are models in the classic industrial organization tradition that have this feature, for example, games with experience curves in their production costs. But they usually tend to be very specific and limited instantiations of this more general notion.
necessary that the firm that is getting locked in is somehow unaware of being locked in before it happens.)

Our general approach requires more structure than is usually assumed in conventional game-theoretic treatments of rival choice. We allow for potential heterogeneity between rivals in terms of their strategies and allow for a cost to changing strategies. Furthermore, the game begins with each firm having an existing strategy based on a historical choice. These inherited strategies may be the same or different and reflect the importance of history in our setup. History is also important because it determines the strategy options that are available and the costs of changing from one strategy to another. This structure is intended to better represent the strategy choice setting normally faced by rival firms. It emphasizes differences in firms and that the options represent commitments as discussed by Ghemawat and also emphasized by Porter. Of course, while the formalization of these core aspects of strategy is more “realistic,” the value of the emphasis on this category of game-theoretic models depends on whether it has the potential to deliver valuable intuition regarding strategy choice that goes beyond that offered through the analysis of the less-realistic conventional alternatives.

*The Model*

Two firms, row-firm and col-firm, choose activity systems from a set \( \{A,B\} \) and \( \{a,b,c\} \), respectively. The game models the effect of a new activity system option (here, col-firm’s action \( c \)) which had not previously been available. This option is the possible impetus for strategic change. When only \( \{A,B\} \) and \( \{a,b\} \) were available, row-firm and col-firm had been playing \( A \) and \( a \), respectively.\(^{14}\) These previous choices constitute the relevant history of the game.

To simplify exposition the structure of play is assumed to be sequential and alternating with row-firm choosing first. Thus, in period one only row-firm chooses and period-one payoffs result from the combination of row-firm’s current choice and col-firm’s previous period choice. In the second period, col-firm chooses and the second-period payoffs result from the combination with row-firm’s period one choice, and so on.

The per-period market payoffs to resulting from their choices are given in the “pure payoff” matrix:

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<th>( a )</th>
<th>( b )</th>
<th>( c )</th>
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<tr>
<td>( A )</td>
<td>( 1,1 )</td>
<td>( -1,0 )</td>
<td>( 2,-1 )</td>
</tr>
<tr>
<td>( B )</td>
<td>( 3,0 )</td>
<td>( -2,2 )</td>
<td>( 1,4 )</td>
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The particular numerical values for the payoffs represent a rivalrous situation with firms that have different capabilities and somewhat different market positions. One can, for example, think about each of the activity systems as supporting a particular market position. For example, row-firm with \( A \) has a

\(^{14}\) In a repositioning cost game with the same structure in which row-firm and col-firm only have access to \( \{A,B\} \) and \( \{a, b\} \), respectively, it is easy to show that row-firm playing \( A \) and col-firm playing \( a \) is an equilibrium. Row firm’s incentive to choose \( B \) is checked by the subsequent reaction of col-firm. Here, the size of the repositioning cost does not matter.
quality image that allows it to sell well to both the middle and upper quality part of the market whereas col-firm with a has a cost advantage and is focused on the middle and lower-quality part of the market. This differentiation allows them to share the market with positive profits.

Row-firm could choose to reposition to focus on the middle part of the market (action B), with presumably some decline in its quality. If col-firm stays with its middle-lower position (action a), row-firm wins more of the middle market. However, if col-firm also repositions to focus on the middle market (action b), its cost advantage results in greater success than row-firm for the middle segment. On the other hand, if it was col-firm that had repositioned from the initial equilibrium by moving “upmarket” to the middle segment (action b), row-firm’s quality advantage from A hurts col-firm’s ability to compete in the middle segment, resulting in lower payoffs for it, but also reduced payoffs for row-firm resulting from the increased competition.

The payoffs to the new option c are attractive only when row-firm switches to activity system B which it is not currently employing. That is, col-firm’s immediate payoffs in response to B are greatest if col-firm chooses c. This seems to be a problem as row-firm’s single-period best response against c is to stay with its current activity system A. One strategic question is whether col-firm induce row-firm to switch?

In addition to these per-period market payoffs, there are also repositioning costs κ that are only incurred when a switch is made from an activity system that has been in place for three or more periods. That is, if the firm had made the same activity system choice twice in sequence, it incurs repositioning costs for a switch, but it would not incur costs if it switches from a newly chosen activity system. The repositioning cost structure is a simple version of time-based repositioning costs which captures the idea that it takes time to implement (commit to) a new activity system so that quick changes of position are less costly than changes occurring after a firm has employed an activity system for a long time. In this example, we suppress the possibility that the relative “distance” between activity systems affects the size of the repositioning costs. The repositioning cost parameter κ can be varied to explore the effects of different levels of time-based costs. For example, we will set κ = 0 to compare conventional outcomes emerging from no repositioning costs games to outcomes of games involving repositioning costs.

After each period, payoffs to each firm are realized. These payoffs consist of market payoffs and repositioning costs which may occur if the activity system is changed. These two components cannot easily be combined in a single representation as the repositioning costs are path dependent.

Each firm knows the payoff and repositioning cost structure and observes the actions its rival. Because of the sequential structure and our motivation to allow time to affect repositioning costs, we assume the game involves six periods. Players are assumed to maximize the (undiscounted) sum of their market payoffs minus repositioning costs over the game. As is standard in the analysis of noncooperative games, we look for Nash equilibrium strategies which in our setup mean that each firm’s “grand strategy” is a best response to the other firm’s grand strategy. Nash equilibrium strategies have the critical feature that neither player can improve her payoffs by deviating from her Nash equilibrium strategy. This approach assumes that both firms understand the game as laid out in the assumptions and
exercise rational foresight in making current choices. Effectively, each firm correctly anticipates the other’s actions (subject to information considerations). Given the structure we assume for the games, it is straightforward, though tedious, to solve these games through backward induction. Our focus is on the implications of including repositioning costs and not on the analysis itself.

Analysis and Interpretation

A full game tree for this example branches that fan out from the choices available to row-firm in period 1 to include all possible combinations of succeeding choices. As the game ends after period 6, the analysis begins by determining the optimal choices for the col-firm in period 6 (the last choice in the game) and using those anticipated col-firm choices to determine the optimal row-firm choice at the beginning of period 5 and so on. To illustrate this technique and to give provide an example of how the game and repositioning costs structure work, consider a subtree that begins with period 4 choices and which represents (exhaustively) the possible combination of actions until the game ends in period 6.

Because the history of activity system (action) choices affects the structure of repositioning costs, it is necessary to also provide the play history for the previous four rounds. In this illustration, suppose that the history was that the row-firm and the col-firm chose B and a, respectively, for their previous two choices. Under the repositioning cost structure assumed for this example, repositioning costs of $\kappa$ would be incurred by col-firm if it were to switch from a to either b or c in period 4, while row-firm would incur such costs if it were to switch to A in period 5. Col-firm’s period 6 repositioning costs depend on what it chooses in period 4. (If col-firm switched to b or c, there would be no repositioning costs whereas if it remained at a, there would be a repositioning cost of $\kappa$ if it changed to b or c in period 6.)
In the subtree shown in Figure 2, a series of actions $a$, followed by $A$, and then $a$ results in a payoff of $5 - \kappa$ for row-firm and 2 for col-firm.

Using the backward induction solution approach, it is easy to find the solution to this subgame and then to use that solution as a building block to solving the entire game.\footnote{The solution to this subgame depends, of course, on the repositioning cost $\kappa$. Suppose that $\kappa = 2$. Then, to solve the game one begins with the choice faced by col-firm in period 6. Depending on the previous choices, there are six possible positions or “nodes” where one can be in the tree. For each of these positions, col-firm would select the choice ($a$, $b$, or $c$) which maximizes col-firm’s current and future payoffs. Since period 6 is the last period in the game, these payoffs are just the period 6 payoffs. For example, if col-firm had played $a$ in period 4 and row-firm had played $A$ in period 5 (i.e., the uppermost node in the tree), then in period 6 col-firm would receive 1, $-\kappa$, and $-1 - \kappa$, for choices $a$, $b$, and $c$, respectively. The optimal choice for that node is $a$. A similar analysis can be done for the rest of the period 6 nodes. With this analysis in hand, we now turn attention to row-firm’s choice in period 5. Row-firm makes its optimal choice to maximize current period payoffs and the payoff associated with col-firm’s optimal response which was just calculated. Again focusing on the top node (which represents the game if col-firm had selected $a$ in period 4), row-firm would choose $B$ and receive $3 + 1$ rather than choose $A$ and receive $1 - \kappa + 1$. We repeat this exercise for the three nodes in period 5 to determine row-firm’s optimal responses for}
different equilibria depending on the size of the repositioning cost. As before, we focus on the equilibrium path of play under different assumptions about the repositioning cost.\textsuperscript{17} If \(1 < \kappa < 4\), then the equilibrium path of play would be B-a-B-c-B-c, whereas with \(\kappa = 0\) an equilibrium path would be B-c-A-a-B-c.\textsuperscript{18}

This game captures a potential change in grand strategy that emerges when one rival acquires an additional option. In the example, col firm now has activity system \(c\) as a potential option. Presumably, this option was not effectively available in previous periods because neither player could implement the system on a cost-effective basis. Both firms obviously have many more options than modeled in the example, but one should think of these omitted options as being activity systems that are completely dominated by the activity system options that are included in the game. The new option \(c\) is now possible, perhaps because of some technological breakthrough by col-firm or a change in market conditions that affects the col-firm versus the row-firm.

This new option causes both players to rethink the grand strategy they have been implementing in the past. Consider first the play of the game under conventional assumptions where there are no repositioning costs. Previously, the row-firm resists choosing activity system \(B\) when col-firm plays \(a\) because row expects that col-firm will respond to \(B\) by playing \(b\). With option \(c\), however, row-firm expects the col-firm to respond with \(c\) instead of \(b\). This would be a good choice for col-firm unless row-firm responds to \(c\) with \(A\) which it has an incentive to do, but then col-firm will return to activity system \(a\).

Now consider how the game changes when one considers repositioning costs. Col-firm would like to get a stream of per-period payoffs of 4 associated with the interaction of \(B\) and \(c\). Without repositioning costs, col-firm anticipates that if it were to select \(c\), row-firm would respond with \(A\), resulting in a col-firm payoff of -1. A repositioning cost greater than 1 prevents row-firm from such a response. But with \(\kappa > 1\), why would row-firm choose \(B\) given a starting point of \(A\)? The answer comes from the time structure of the repositioning costs. If repositioning costs were incurred for each change in activity system, then row-firm would not switch to activity system \(B\). Then, with this structure row-firm and col-firm would continue to play \(A\) and \(a\), respectively.

Now reconsider the dynamics with the time-based repositioning cost assumed in this example, namely, that there is no repositioning cost until a firm has maintained its same activity system for two or more choices (here, that translates effectively to four periods). Start again with col-firm trying to obtain the payoff of 4 associated with the interaction of \(B\) and \(c\). Suppose that row-firm plays \(B\) in the first period. Col-firm could respond with \(c\) which then results in row-firm responding with \(A\) in the third period. This outcome is much like the situation faced in the no repositioning cost setting. The immediate problem each possible period 4 col-firm action. Finally, we determine the optimal choice for col-firm in period 4 by comparing its current and future payoffs associated with each possible action. These payoffs are \(4 - \kappa\), \(8 - \kappa\), and \(12 - \kappa\) for choices of \(a\), \(b\), and \(c\), respectively. The equilibrium path of optimal actions in this subtree is then \(c-B-c\). This is shown by the bolded arrows.

\textsuperscript{17} See the Appendix for a formal statement of the equilibrium strategies and analysis.

\textsuperscript{18} In this edge case where \(\kappa = 0\), since we are using integer payoff values, there are other possible equilibria due to indifference at certain choice nodes.
for col-firm is again the lack of a repositioning cost friction that prevents row-firm from choosing A in response to c. But actually, col-player can do better. If, in response to a row-firm B choice, col-firm waits an extra round before choosing c, it allows row-firm to commit to its activity system B from which there is now a repositioning cost. Given this repositioning cost, row-firm will not respond to c with A and col-firm obtains its period payoff of 4 in all future periods. Given this dynamic, would row-firm play B in the first place? If the repositioning cost of moving from A to B is high, row-firm has a limited incentive to make the move and hence the dynamic desired by col-firm will never come about. However, the beauty of col-firm’s restraint is that it increases the payoff to row-firm of moving from A to B. Col-firm waits an additional round (two periods) before choosing activity system c. Now row-firm has an incentive to move from A given moderate repositioning costs.

This example illustrates the power of considering repositioning costs as part of strategic interaction. The repositioning costs change the dynamics of responses, but without the strategic interaction analysis, it is not evident how the dynamics can be turned to strategic advantage. There are many examples of firms that take advantage of some sort of lock-in associated with continued investment in an existing technology or user group. These examples (e.g. those involving variants of judo strategy [Yoffie and Kwak 2001], unwillingness to cannibalize existing user groups) are consistent in spirit to the back end of this example where repositioning costs are a function of time. It is arguably not a big leap to expect strategists to recognize that it takes time for a rival’s new positioning to take hold and, accordingly, to understand when it makes sense to delay one’s own action, or, as applied to this model, that a rival would see the value of exploiting your repositioning costs. The full strategic insight developed in the example may not be so obvious—it is for this reason that game theory has value for offering insight and advice. In the example, only the row-firm needs to see the entire picture, col-firm need only see the direct strategic implication of the repositioning costs. Hence, while the value of the advice depends on some level of strategic sophistication (in a game theory sense) of the players, oftentimes really only (the smart) one needs to be truly sophisticated. More generally, the strategic dynamics contained in this model suggest some interesting forces that may lead to increased differentiation in an industry. For example, one interpretation of the example just discussed, is that repositioning dynamics facilitates strategies that increase differentiation amongst rivals in a market. In the example, such gains are inter-temporal: row-firm is the initial beneficiary of the dynamic, while col-firm benefits in the later periods.

19 There are a number of direct examples in the intellectual property area of firms waiting for others to commit. For example, it was alleged by the FTC that Unocal represented to various key parties that it “lacked, or would not assert, patent rights concerning automobile emissions research results....[and that]... Unocal (1) induced CARB to adopt reformulated gasoline standards that substantially overlapped Unocal’s patent claims and (2) induced other refiners to reconfigure their refineries in ways that subsequently exposed them to Unocal’s patent claims.... Unocal claims it is entitled to hundreds of millions of dollars in royalties from refiners who are now required to follow CARB’s standards.” In the Matter of Union Oil Company of California, FTC Docket no. 9305, 2005, p. 1. See Farrell, Hayes, Shapiro, and Sullivan (2007) for additional examples.
E. Discussion

Tactics vs. (Grand) Strategy

The discussion in this paper is written to emphasize the grand strategy-level application of non-cooperative game theory as opposed to a more tactical-level application. We have done this because we believe that repositioning costs are a central element for any model of interaction at the level of grand strategy. While the dichotomy between strategy and tactics is a convenient way to separate changes in pricing from changes in a firm’s activity system, firm actions fall on a continuum. The degree of commitment and irreversibility of actions as suggested by Ghemawat provide a measure with which actions can be located along this continuum.

Our approach can be fruitfully applied along the whole continuum from pure tactics to grand strategy, though repositioning costs, now relabeled cost of changing an action, may oftentimes be second order for the former. In fact, most game-theoretic models in economics usually consider only destination-based costs in part (we hope) because of the apparent reversibility of actions. At the grand strategy level where commitment identifies the strategic options, an analysis of grand strategy must consider repositioning costs. Here, as previously discussed, one can think about a change in the activity system as a system change that involves many of the firm’s activities and the integration across these activities. More tactical changes would involve smaller changes, sometimes largely confined to a single activity of the firm. The commitment to an action, in the Ghemawat sense, while possibly present for changes made by a single activity of the firm are more likely to be stronger when multiple activities are involved as would be the case with a change in the activity system. Further, changes of this sort suggest that a return to what one had previously done would also entail costs.

For competitive interactions in the middle part of the continuum, repositioning costs are more likely to be among the important factors rather than being a defining factor. In fact, the treatment of commitment costs as emerging as part of a direct mechanism that describes the competitive interaction (e.g. capacity addition) seems an appropriate middle ground to accommodate multiple factors. As one moves to higher-level strategy, however, the precise mechanism that identifies commitment costs becomes hard to precisely identify. But one expects that managers, for example, will typically have at least a first-order sense of the actual structure of repositioning costs even when the costs of repositioning are not precisely understood. Thus, identifying the precise mechanisms is not necessary for a strategic interaction analysis to be valuable at the grand-strategy level. In fact, in addition to adding to our knowledge of precise mechanisms that contribute to repositioning costs, a fruitful path to better understanding higher-level strategy dynamics would be to explore general structures of repositioning costs.

Endogeneity of Repositioning Costs

Given the history dependence of repositioning costs and the multiple-period choice structure of the models underlying the examples, there is an element of endogeneity of repositioning costs already built into models which assume distance-based or history-influenced costs. When defined at a more macro-level the endogeneity of these costs is similar to that in any multiple-period model in economics where...
Competitively-relevant variables change based on action in previous periods, e.g., an experience curve, switching costs associated with a user base, or past experience. Experience curve models offer a particular mechanism for repositioning. To address the interaction of strategies, our interest in repositioning costs is at a yet more macro level. As we have argued, an interesting way forward would be to investigate models based on particular structures that one could identify, in principle, from existing empirical work on strategic change. The typology described earlier aids in this endeavor by forcing clarity about the underlying assumptions made regarding the nature of repositioning costs. The analytical models could then be used to generate insight into the competitive implications associated with each structure.

The time-related repositioning cost structure explored in the example is one such history-influenced structure which proxies for a large set of inertia-based costs that increase over time as a set of capabilities, routines, cognitive frames, and organizational relationships become more aligned with the existing strategic position over time. In practice, a strategist might approach the estimation of repositioning costs in terms of a relative comparison of the capabilities needed to compete at the new position versus the capabilities that would exist at the “old” position. One component of such an analysis would be an accounting for the resources (as defined in the strategy literature) that would need to be added to move to the new position.\(^\text{20}\)

Future research, then, could draw on the richness of our knowledge pertaining to strategic change to shape the structure of repositioning costs for particular applications, and then to use game-theoretic modeling to develop the competitive interaction implications of the nature of strategic change. Clearly, there are strands of this type of modeling, especially regarding competitive interactions at a more tactical level, but these exercises seem largely focused on the competitive outcomes and less on exploring the structures of repositioning costs.

One potentially fruitful combination would be a game-theoretic exploration of the macro-routines for change capabilities that is raised in the work on dynamic capabilities (Teece, Pisano, and Shuen 1997, Helfat 1997). For example, Eisenhardt and Martin (2000, pg. 1111) define dynamic capabilities as “[S]pecific organizational and strategic processes (e.g., product innovation, strategic decision making, allying) by which managers alter their resource base”. They specifically focus on the features of the best practices that firms converge to in order to deal with environmental turbulence, and distinguish between the best practices in low-medium-velocity markets and high-velocity markets. Such capabilities have the feature that they lower repositioning costs and would have attendant competitive consequences. Incorporation of such mechanisms into the framework proposed here could generate insight into the strategic interaction element of dynamic capabilities.

Another related and potentially interesting direction involves the degree of alignment of the various resources and activity systems of the firm. Tight alignment of the different resources (and activity systems) of the firm is usually assumed to be a positive feature, leading to superior competitive

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\(^{20}\) The resource accounting idea is complicated in that the positioning options are, in part, determined by the level and type of resources that support that option.
advantage. On the other hand, it is conceivable that such tightly coupled systems will be difficult to change, i.e., their repositioning costs will be high. This in turn gives an advantage to firms with loosely aligned resources when considering change. Thus, focusing attention on repositioning costs could lead to insights regarding the value of tight alignment in various business environments. Such models might also contribute to our understanding of the competitive consequences associated with generalist versus specialist organizations. For example, a model could investigate the tradeoffs between a more flexible activity system, which would presumably lower costs of repositioning to “closer” activity systems but for some variable cost penalty, and the costs of decreased specialization.

**Normative Implications of Game-Theoretic Analyses**

One of the core perspectives of this paper is the importance of and the need for careful consideration of strategic interactions among firms, particularly at the grand strategy level. While this seems an obvious point, there have been few systematic explorations of the interaction element involving strategic change at a grand strategy level. Many potential explanations for the absence of work in this area exist including the bias towards more precise mechanisms and, therefore, tactics, discussed earlier and concerns that the complexity of grand strategy reduces the value of assessing strategic interaction given the level of rationality and foresightfulness usually demanded in game-theoretic analyses.

With respect to the latter concern, the robustness of the insights generated by game-theoretic analyses are a major differentiating factor between good and bad analysis and attention to these concerns is obviously important in evaluating such models. But, for now, rather than joining this debate, we limit ourselves to a discussion of the potential value of our approach for practice. We use the example as the basis for discussion.

Our analysis in the example, to be sure, does depend on anticipation, foresight, and rationality. However, the sequential choice structure eliminates simultaneous estimation of actions that one’s rivals will play as well as considering what they think you will play. In fact, the sequential structure has a more comfortable contingency or scenario planning feel. Anticipation of future actions is still critical, but the demands on anticipation and rationality are less.

Consider again the example developed above. It suggests that row-firm more aggressively plays option $B$ in anticipation that col-firm will delay a response to allow row-firm to become more committed to the “$B$” activity system. There are two parts to this strategic analysis. First, col-firm needs to see that allowing row-firm to become more committed is beneficial should row-firm play $B$. That is, col-firm

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21 This is not to say that the literature has ignored the fact that the performance of a firm depends on the actions of other actors. The notions of competitive advantage, competitive position, and valuable resources are crucially dependent on the other actors. But the point here is that most of these perspectives take a limited view of the interaction. While acknowledging that the actions of the other actors impact the performance of the focal firm, they usually take these outside factors as parameters in a decision problem, over which the strategist optimizes. This approach misses the important consideration that the actions of the other actors are not fixed, but in fact depend on the actions of the focal firm (and other actors). Game theory offers a solution to this simultaneity of choice issue.

22 Part of the gain here is because of the combination of complete information and the sequential structure.
needs to realize the existence of the lock in phenomenon and how the locking-in of row-firm to B can be valuable to col-firm in deploying the new option c. And in order to achieve this lock in, col-firm has to realize that it has to wait, holding off on the usual competitive response if and when row-firm plays B. The second part of the analysis requires row-firm to anticipate that col-firm action will realize this lock in potential and how it can benefit col-firm, causing it to abstain from a strong competitive response if row-firm plays B. Then, realizing that col-firm will abstain in this manner, row-firm has to see that playing B is better than sticking with A.

While there is certainly merit in the argument that most firms are unlikely to envision a complex sequence of eventualities, we believe that many sequences can be anticipated and profitably acted on. Consider again the timing example above. There is considerable evidence suggesting that firms do time their moves. Yoffie and Kwak (2001) provide examples in which challenger firms take advantage of entrenched activity systems that prevent responses to their actions. For example, Pepsi was able to attack Coca-Cola with a twelve ounce bottle because Coca-Cola had a network of bottlers that were invested in Coke’s original six and one half ounce bottles (Yoffie and Kwak 2001, p. 81) which increased the costs of a Coke response. Furthermore, it is reasonable to assume that firms realize that entrenchment can increase over time, and knowing this, they might wait until the competition becomes firmly entrenched along some path before revealing a different, novel option. Thus, it is plausible that firms incorporate the first part of the analysis into their strategic thinking. It is in fact the second step, which adds to this, that seems harder to accept. But if playing the timing game is a move that already exists in the strategic playbook, then the second part of the analysis seems consistent with what decision makers can expect from one another. Conditional on firms making the part one move, part two takes this rational chain one step further. Without the game theoretic analysis it is likely that many if not most strategists would not have considered how the aggressive B move is protected by the other firm’s interest in delaying its response. Yet, if one accepts that the rival will likely delay if it sees B, then such a move would be a useful piece of advice. The nice part of this advice is that it does not depend on the rival firm seeing the logic behind this move.

F. Conclusion

In this paper we have argued that the inclusion of repositioning costs is essential to game-theoretic models that purport to address strategic change at a grand strategy level. The complexity of strategy, however, makes it difficult to identify specific mechanisms by which grand strategy changes. We believe that a fruitful approach would be to focus on general repositioning cost structures (such as time-based structures) which can be identified from the organization and strategy literature. We hope that the classification of repositioning costs proposed here is a first step in that direction.

More generally, it is important to keep in mind that the primary value of game-theoretic models for practice is that such models generate insights through the logical discipline that such models provide.

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23 A classic example of the strengths and weaknesses of entrenchment in warfare would be the Maginot line.
24 See, e.g. examples in Farrell, et. al. (2007) noted above.
The complexity of the business competition is a two-edged sword in this regard. Complexity increases the value of imposing a logical analysis that forces strategists to ask sharper questions and to have tools to discard bad intuitive analyses. But complexity also increases the difficulty of creating a model that captures enough of the essence of an actual situation to be useful. Because models of competitive interactions are necessarily limited in the number of factors they consider, advice is only partial. Hence, using such models to advantage is not easy and, arguably, is an aspect of bringing modeling to strategy practice which deserves more attention.

Appendix:

Formal statement of equilibrium of the example:

Given the history of the two firms at the beginning of the game are as follows: row-firm: \((A,A)\); col-firm: \((a,a)\), it is straightforward though very tedious to show that the following strategies constitute a Subgame Perfect Nash Equilibrium if \(1 < \kappa < 4\):

Row-firm:

- **Period 1:** \(B\)
- **Period 3:** \(\begin{cases} B \text{ if } a \text{ played in period 2} \\ A \text{ otherwise} \end{cases}\)
- **Period 5:** \(\begin{cases} B \text{ if } B \text{ played in period 3} \\ B \text{ if } a \text{ played in period 4} \\ A \text{ if } c \text{ played in period 4} \\ B \text{ if } b \text{ played in period 4 and period 2 and } 1 < \kappa \leq 2 \\ A \text{ otherwise} \end{cases}\)

Col-firm:

- **Period 2:** \(\begin{cases} a \text{ if } B \text{ played in period 1} \\ a \text{ otherwise} \end{cases}\)
- **Period 4:** \(\begin{cases} c \text{ if } B \text{ played in period 3} \\ a \text{ otherwise} \end{cases}\)
- **Period 6:**

\(\begin{cases} \text{if history of } (b,b) \text{ and } 1 < \kappa \leq 2, a \text{ if } A \text{ played in period 5, } b \text{ if } B \text{ played in period 5} \\ \text{if history of } (c,c) \text{ and } 1 < \kappa \leq 2, c \text{ if } A \text{ played in period 5, } c \text{ if } B \text{ played in period 5} \\ \text{otherwise, } a \text{ if } A \text{ played in period 5, } c \text{ if } B \text{ played in period 5} \end{cases}\)

The equilibrium path of play will be \(B-a-B-c-B-c\) and the expected payoff from this equilibrium from row-firm is \(12 - \kappa\) and that for col-firm is \(12 - \kappa\). Two possible deviations from these equilibrium strategies deserve comment. The main deviation that needs to be checked is that by col-firm in period 2 to \(c\). Although this gives an immediate payoff increase of \(4 - \kappa\), it results in substantially lower payoffs in the next 3 periods (0 in total), followed by a payoff of 4 in the final period, resulting in a total payoff of
The other potential deviation is by row-firm to A in period 3. This results in the same payoff of $12 - \kappa$ for row-firm, and hence is not a profitable deviation.\(^{25}\)

If $\kappa = 0$, then the following strategies constitute a subgame-perfect Nash equilibrium:

<table>
<thead>
<tr>
<th>Period 1:</th>
<th>B</th>
</tr>
</thead>
</table>
| Period 3: | \(B\) if \(a\) played in period 2  
\(A\) otherwise |
| Period 5: | \(B\) if \(a\) played in period 4  
\(A\) otherwise |

| Period 2: | \(c\) if \(B\) played in period 1  
\(a\) otherwise |
| Period 4: | \(c\) if \(B\) played in period 3  
\(a\) otherwise |
| Period 6: | \(c\) if \(B\) played in period 5  
\(a\) otherwise |

The equilibrium path of play will be \(B-c-A-a-B-c\).

**An Example of Distance-Based Costs:**

We now explore a multi-period example of distance-based costs, i.e., where the magnitude of the repositioning cost depends on the “distance” or extent of the repositioning involved in the strategic change. As before, the setting is that of two firms (row-firm and col-firm) who have been competing in a market. Each firm has two available strategic choices, but each firm has been historically choosing and sticking with first of the two options. Row-firm would like to change its choice, but if it did so, the col-firm would change to its second (“reaction”) option in the following period, negating any advantages accrued to row-firm from the change. This row-firm worry of its rival’s response is keeping the system in the current state of equilibrium.

Now, suppose that col-firm developed the capability to execute a third strategic option in the following period. The third option is dominant in terms of the payoffs to col-firm, but it is in the opposite “direction” from the second (“reaction”) option. So, if col-firm chose the second option, it increases the “distance” of the required repositioning to this dominant third option.

The repositioning cost structure assumption in this example is that the greater the distance of the repositioning, the higher the repositioning cost. The core intuition of the example is that the discovery of a new option, without the ability to actually deploy it until a later time, may change the current

\(^{25}\) This deviation does, however suggest that another equilibrium that generates an equilibrium path of \(B-a-A-a-B-c\) exists. Such an equilibrium is less robust to discounting than the one we focus on as the positive payoffs to row occur later.
equilibrium if the new option is in the “opposite direction” from the current change option. This result depends on the existence of distance-based repositioning costs, and will not hold if there are no repositioning costs.

Now let us look at the example in more detail.

The initial setup is the same as in the previous example. Consider a setting in which row-firm and col-firm are employing activity system options A and a respectively. Further assume that both firms have a second activity system option, B and b respectively, which they are not playing currently. This is a subset of the game that we analyze in this section, but it is useful to understand how it works before moving to the actual example which includes a third option c for col-firm.

The “pure” payoff matrix (i.e., purely based on the states of the world that result from the actions, not accounting for any repositioning costs) is the same as in the previous example, and is as follows:

<table>
<thead>
<tr>
<th></th>
<th>a</th>
<th>b</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1,1</td>
<td>-1,0</td>
</tr>
<tr>
<td>B</td>
<td>3,0</td>
<td>-2,2</td>
</tr>
</tbody>
</table>

Our primary interest is in an expanded game based in which col-firm discovers a new option/activity system c that is not available to row-firm. Furthermore, assume that c will be available to col-firm as an actual choice only for its second turn, i.e. period 4. We have in mind an acquisition that does not consummate immediately or a discovery that requires some development prior to actual implementation. Importantly, this option is known by both firms at the start of period one.

Let the new market payoff matrix be:

<table>
<thead>
<tr>
<th></th>
<th>a</th>
<th>b</th>
<th>c</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1,1</td>
<td>-1,0</td>
<td>1,2</td>
</tr>
<tr>
<td>B</td>
<td>3,0</td>
<td>-2,2</td>
<td>2,4</td>
</tr>
</tbody>
</table>

This new payoff matrix gives the (before repositioning cost) payoffs for each period but, of course, action c is only available in period four.

In this example we wish to explore the effect of distance-based repositioning costs. Effectively, this means that the cost of repositioning depends on the path through which a firm gets to an activity system choice. We, therefore, could allow repositioning costs to fully vary by dyad (of options) and direction, i.e., $\kappa_{i,j}$ is the repositioning cost of changing from activity system i to activity system j. To keep things simple, however, we just allow $\kappa_{b,c} \gg \kappa_{a,c}=\kappa_{a,b} = \kappa_{b,a} = \kappa$ for the col-firm and assume that all repositioning costs for row-firm also equal $\kappa$. One can think of this particular structure of repositioning costs as one where c is “in the opposite direction” from b relative to a. That is, the repositioning to the new market is in the opposite direction from the “upmarket” movement in the current market.
A game-tree for this strategic interaction is provided in Figure 1. The game tree depicts the choices of each firm, the order in which those choices are made, what is known when the choice is made, and the payoff consequences of each set of actions. The game begins at the far left of the diagram where in the first period, row-firm chooses between action A and action B. The current period payoffs for each firm are given by the ordered pair with the left number being the payoff to row and the right number the payoff to column. The next layer to the right represents the second period, where col-firm observes row-firm’s first period action then chooses between action a and action b. The third period is the next layer, etc. Note that the game tree is an exhaustive representation of the possible actions both good and bad. The best choices are determined through an analysis of the “solution” to the game.
A backward induction solution to this game is based on the idea of solving for the optimal choice at a
given choice node (the location in the tree that has been determined by all previous actions of the
players) and then using this optimal choice as the anticipated choice for the previous decision. Because
the solution involves potential repositioning costs, it is also necessary to know the previous history of
activity system choices by each firm.

As the game ends after period 4, the analysis begins by determining the optimal choices for the col-firm
in period 4 (the last choice in the game and the part of the tree to the furthest right) and using those
anticipated col-firm choices to determine the optimal row-firm choice at the beginning of period 3 and
so on.\textsuperscript{26}

The solution to the game is a set of (grand) strategies for each firm each of which gives the best-
responses for each firm for each possible preceding action (whether optimal or not) at each stage of the
game. Of primary interest is the “equilibrium” path of optimal actions. It is clear that the addition of
repositioning costs has the potential to alter the strategic interaction. In this particular case compare
the equilibrium paths for the conventional analysis which would assume $\kappa = \kappa_{b,c} = 0$ with that of a setting
with repositioning costs $\kappa < 2$ and $\kappa_{b,c} > 2$, i.e., larger repositioning costs when having moved in the
opposite direction in initially.

With no repositioning costs, an equilibrium sequence of actions of each firm would be $A$-$a$-$B$-$c$. (The
lightly bolded arrows in Figure 1.)\textsuperscript{27} The addition of option $c$ in the fourth period changes the optimal
play relative to the two option game discussed earlier. Because $c$ is a dominant strategy for col-firm, col-

\textsuperscript{26} Consider the topmost node in period 4. This node is reached as the result of a sequence of preceding actions:
Action $A$ by row in period 1, $a$ by col-firm in period 2, and $A$ again by row-firm in period 3. In period 4 the col-firm
maximizes only its period 4 payoff since that is the last period of the game. Col-firm receives 1, 0-$k$, and 2-$k$ for a
choice of $a$, $b$, or $c$, respectively. If $\kappa$ were zero, for example, then the optimal choice would be $c$, but with $\kappa = 2$,
col-firm’s period 4 optimal choice would be $a$. To solve this game we first solve for the optimal response of col-
firm depending on the previous history of actions. There are 8 possible histories at this stage in the game. These
optimal period 4 (best response) choices then become “inputs” to row-firm’s period 3 decision. For each possible
history of period 1 and 2 actions, row-firm calculates the choice which maximizes the sum of row-firm’s period 3
and period 4 payoffs taking into account that col-firm will play col-firm’s optimal choice in period 4. Thus, again
using the topmost node for illustration and assuming $\kappa = 2$, in period 3 row-firm can choose $A$ to which row-firm
expects a col-firm response of $a$. This results in a payoff of 1+1. If row-firm chooses $B$ instead, row-firm gets 3-$k$+2.
Row-firm would therefore choose $B$. Row-firm would calculate the optimal choice for each of the four possible
histories. The period 3 and period 4 optimal choices would then be used as best response inputs by col-firm in
period 2 who would choose the optimal choices for each of the two possible histories from period 1. In turn, Row-
firm in period 1 would select between $A$ and $B$ depending on the payoffs to row-firm corresponding to the
subsequent best response choices of both firms. The payoffs to this initial choice for both firms is provided as the
far right pair of values in the figure.

\textsuperscript{27} In this edge case where $\kappa = \kappa_{b,c} = 0$, since we are using integer payoff values, there are other possible equilibria.
But these alternative equilibria are not robust to an infinitesimal small, positive repositioning cost. I.e., when we
let $\kappa = \epsilon, \epsilon \to 0^+$, these alternative equilibria disappear, and we are left with the proposed equilibrium with the
equilibrium path of play of A-$a$-$B$-$c$ as the unique SPNE.
firm, absent repositioning costs, will play c once this option becomes available. Anticipating this, row-firm has no concern about playing B in period three, but will not play B to start (period 1) as it expects that col-firm would respond with b in period 2. The logic is quite similar to that of the game without option c until the third period.

Now consider the effects of repositioning costs. With “significant” repositioning costs, $\kappa < 2$ and $\kappa_{b,c} > 2$, the individual optimal sequence is B-a-B-c, row-firm now chooses to play B instead of A in the first period. (The heavily bolded arrows in Figure 1.) Without repositioning costs col-firm would respond to B in the second period by choosing b. Under the assumed significant cost structure, however, moving to b increases the repositioning costs associated with the anticipated period four move to c, so much so that it is no longer worthwhile for col-firm to move from a to b as a response to row-firm’s first period choice of B.

This straightforward example illustrates how strategic interaction is affected by the specific structure of repositioning costs. The repositioning costs of interest in this example are those associated with col-firm who gains a new and attractive option that can be deployed in period four. The strategic interaction effect is that row-firm, recognizing that col-firm will want to eventually move to its new option and that such a move entails different repositioning costs depending on where it moves from, is no longer worried about an aggressive response (option b) to row-firm’s choice of B, and hence chooses B. While generalizing from a single example is dangerous, this example does suggest the intuitive notion that repositioning costs are, on average, likely to dampen actions that are short-term oriented because of their effect on the more important longer-term strategy of a firm. Models with repositioning costs increase the direct restraints against pursuit of short-term gains. Colloquially, the addition of repositioning costs may remove some of the attention deficit disorder feel of games that lack such costs. Without repositioning costs, the implications of game-theoretic models taken literally might arguably give too much attention to the period-by-period effects of each action, thereby adding to the discomfort strategists have with the uses of game theory to inform grand strategy.

Strategic movements across a location space (e.g., positions with respect to various consumer segments) provide good examples of where strategic changes involve cost differences which depend on both the starting and ending point. A classic example of this can be seen in U.S. elections where an overall strategy for election consists of a strategy for winning a primary election (e.g. winning an election with voters from one political party) and then winning the general election. For example, candidates in primaries that are seen as having a smaller chance of winning, have greater positioning freedom relative to the front-runner because it is anticipated that the front-runner will more heavily weigh the costs in the general election of moving position. Similar situations are sometimes faced by firms in evolving markets in which demand is anticipated to shift from one customer segment to another over time. Another context where these position change costs may cause a firm to restrain itself from a

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28 In fact, this game could also be analyzed in terms of the value to discovering option c. An interesting point to note here is that under current conditions, in the resulting equilibrium the payoffs to col-firm will be actually lower than what it was before c was discovered (i.e. when both firms were playing a-A-a-A-...). Before the discovery of c, the payoff to col-firm at the end of period 4 was 4. Now, it will be 4 − κ. If col-firm did not do the strategic analysis, col-firm might have thought discovering option c was strategically valuable.
short-term profit opportunity is that of alliance partnerships. There, establishing an alliance with one partner may have cost implications for establishing an alliance with another potential partner who is a rival of the first partner.

**Formal statement of equilibrium of the distance-based example:**

If $\kappa < 1$ and $\kappa_{b,c} > 2$, it is straightforward to show that the Subgame Perfect Nash Equilibrium is:

**Row-firm:**

<table>
<thead>
<tr>
<th>Period 1</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period 3</td>
<td></td>
</tr>
</tbody>
</table>

| A if $a$ in period 2 |

| B if $b$ in period 2 |

**Col-firm:**

<table>
<thead>
<tr>
<th>Period 2</th>
<th>$a$ irrespective of what row–firm plays in period 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period 4</td>
<td></td>
</tr>
</tbody>
</table>

| b if $b$ in period 2 and $A$ in period 3 |

| c otherwise |

The equilibrium path of play is $B-a-B-c$.

If $1 < \kappa < 2$ and $\kappa_{b,c} > 2$, the Subgame Perfect Nash Equilibrium is:

**Row-firm:**

<table>
<thead>
<tr>
<th>Period 1</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period 3</td>
<td></td>
</tr>
</tbody>
</table>

| A if $a$ in period 2 |

| B if $b$ in period 2 |

**Col-firm:**

<table>
<thead>
<tr>
<th>Period 2</th>
<th>$a$ irrespective of what row–firm plays in period 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period 4</td>
<td></td>
</tr>
</tbody>
</table>

| b if $b$ in period 2 and $A$ in period 3 |

| c otherwise |

The equilibrium path of play is $B-a-B-c$.

If there are no repositioning costs, i.e. $\kappa = \kappa_{b,c} = 0$, the Subgame Perfect Nash Equilibrium is:

**Row-firm:**

<table>
<thead>
<tr>
<th>Period 1</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period 3</td>
<td></td>
</tr>
</tbody>
</table>

| A if $A$ in period 1 and $b$ in period 2 |

| B otherwise |

**Col-firm:**

<table>
<thead>
<tr>
<th>Period 2</th>
<th>$a$ if $A$ in period 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period 4</td>
<td>$b$ if $B$ in period 1</td>
</tr>
</tbody>
</table>

The equilibrium path of play is $A-a-B-c$.
Technical Considerations Regarding the Model

The purpose of this paper is to argue for the inclusion of repositioning costs in discussions about strategic interactions. The examples, while potentially interesting, are meant to illustrate the application and fertility of the approach, rather than provide a template for modeling strategic interactions at the grand strategy level. Nevertheless, it is valuable to provide some of our thinking about the structure of the examples and their limitations, which may provide some guidance for those who wish to understand the examples more deeply.

The sequential action, one-action per period, model is not general, nor standard. Of course, how one models a situation depends on what the modeler is trying to learn. Sequential structures seem more natural than their simultaneous choice brethren, but one needs to recognize that temporally (or near temporally) simultaneous choice is not the reason such a structure makes sense in many settings. Rather, the question is one of observability. Actions of rivals that occur at different times, but are not observable to the other are effectively chosen simultaneously. Our focus on grand strategy and macro strategic changes as embodied in changes to a firm’s activity system, suggests actions that take place over time and are relatively observable. In such cases the sequential structure seems defensible. Further, because the time period for (small) strategy responses is long, it also seems sensible to define a period as one where one firm is allowed to act and then to allow payoffs to occur after each such period. Changing these game structure assumptions has the effect of changing specific outcomes, but not the general thrust of the examples.29

As discussed above, repositioning costs have been explicitly incorporated in many types of market interactions, for instance in buyer and supplier switching cost and market entry games. The irreversibility of these costs, however, is typically not a defining feature which dictates the spectrum of options that are considered. In the dynamic strategic change context that we focus on, repositioning costs are the primary factor that distinguishes strategic choices. Choices that involve little commitment, can be seen as subsumed within a single choice option—with an interpretation that the payoffs from the interaction of such options involve an optimal choice of these easily adjustable elements of a larger choice.

REFERENCES


29 In principle, the analytical method described is easily extended to analyze multiple-firm interactions. Along these lines it would be interesting to investigate whether firms in multiple-rival markets actually focus their attention on a limited subset of their rivals.


