

A Dynamic Model of Inter-Firm Competitive Strategy

ICCS 2004 Conference, Boston MA, 16-21 May 2004

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ABSTRACT

Models of positioning firms within strategy space have been criticized for their not being dynamic models, their focus on equilibrium, and their inability to consider multiple firm competition. More recent models such as the *NK* model introduced to strategic management by Levinthal have allowed increasing complexity to be incorporated into models, yet there are still deficiencies in creating a dynamic model that incorporates inter-firm competition. The model introduced in this paper overcomes some of these limitations, and extends the landscape model approach.

Overview

One of the most prevalent questions within strategic management is how firms are able to attain profits that allow them to gain superior competitive performance compared to their competitors. Porter's (1979, 1980) model of competitive strategy proposed that a firm's position within an industry was an important factor in attaining competitive advantage. More recent literature has focused on resources available to firms ('RBV', the resource based view), and has developed a framework where it is purported that the resources and capabilities possessed by firms are the precursors of differential firm performance (Barney 1986, Penrose 1959, Petraf 1993, Wernerfelt 1984). This has in some ways superseded the work of positioning in strategy space as proposed by Porter, positioning being seen as not being able to explain sufficiently differential firm performance when compared to the resource based view.

Traditional methods of analyzing industries and competitors have been criticized, particularly in industries that have variously been described as turbulent (Ansoff 1965), high velocity (Bourgeois and Eisenhardt 1988, Eisenhardt 1989), or hypercompetitive (D'Aveni 1994). There is therefore an incentive to devise a model of strategy that can be used in such environments, as well as being general enough to describe behavior in stable environments.

One of the criticisms of models based in industrial organization economics, and economics generally is their preconception of stasis and equilibrium.

Criticism of Economics Based Models

Knott (2003) introduces a drawback of using economic models: ‘the goal of strategy is persistent profits – in short, to overcome the microeconomic equilibrium of homogeneous firms with zero profits’. This emphasizes the over-reliance on microeconomic models of equilibrium and homogeneity as a paradigm within strategic management: such models are merely *models*, yet certain authors have assumed that the conditions assumed in such economic models actually apply to the real world; the equilibrium of zero profit homogeneous firms is the equilibrium of the *model* rather than the equilibrium (if there be one) we may (or more likely may not) observe in the empirical world.

Microeconomic models have a two-fold impact when used in strategic management: they provide analytical solutions to problems (in that they provide mathematical solutions to problems modeled), yet this also carries with it the over-emphasis on *equilibrium* as a prerequisite of such a formulation – the existence of which may not be present within the real business world, especially in high velocity or turbulent industries. The existence of homogenous ‘representative firms’ within economic models also builds in a bias against building models that explain inter-firm, intra-industry heterogeneity. As such, models such as this have been subsumed with later approaches (such as the resource based view), which give a more easily understood explanation of inter-firm heterogeneity.

Although *economic* models may be of restricted efficacy when modeling an industry of heterogeneous firms with differing strategies, we should not discard the framework of modeling: such models can be of benefit they can aid our understanding of firms’

environment by providing a model that, whilst as in any model not reflecting the entire idiosyncrasies of the environment, can however capture its salient features and therefore be of use to strategy formulation and testing.

The model presented in this paper allows us to represent the competitive landscape where a firm's profitability is dependent not only on its position, but that of the positions of competitor firms and of customers. By analyzing the deformation of this landscape with changing competitiveness for example, we present a model that can be extended to propose a response contingent upon different environments.

Finally, an analysis of the strategies appropriate to different levels of turbulence is discussed, and proposals are made for future research developing the model.

Landscape Models

In order to overcome some of the problems with models based in rationality and equilibrium, approaches from complexity research have been incorporated into the field of strategic management (Anderson 1999), much in the way that Porter (1991) aims towards a dynamic theory of strategy.

The use of 'landscape' as a metaphor within management has been widely used (for example Bettis and Hitt 1995). When considering a space occupied by firms, the concept of strategic groups (Hunt 1972, Porter 1979) proposes that certain positions within an industry are favorable compared to others. The concept of fitness is also used within population ecology

(Hannan and Freeman 1977). Levinthal (1997) popularized the NK model as originally developed by Kauffman (1993, 1995) in order to produce a complex landscape in N dimensional space following Wright's (1931, 1932, 1967) notion of a 'fitness landscape' created by mapping the 'fitness' (defined as success in reproduction) of the possible set of genotypes of an organism. The NK model is relatively complicated, and readers should refer to Levinthal (1997) or Kauffman (1993:40-45) for a thorough explanation.

An Introduction to the NK Model

The NK model is constructed in the following manner. Within an organization (be this a biological organism or a set of decisions within a firm) there are N traits. These traits can take the value 0 or 1 (and is therefore defined as 'Boolean' in that it follows Boolean algebra with logical values of 'on' or 'off'; 'true' or 'false'). Given that there are N traits, there are 2^N possible combinations of traits. So, if for example $N=3$, the $2^3=8$ possible combinations of traits are 000, 001, 010, 011, 100, 101, 110, and 111. The parameter K determines the number of 'epistatic' interactions between components of the system. K can take integer values between 0 and $N-1$. For instance, when $K=1$ and $N=5$, the construction of the interactions is shown in Figure 1.

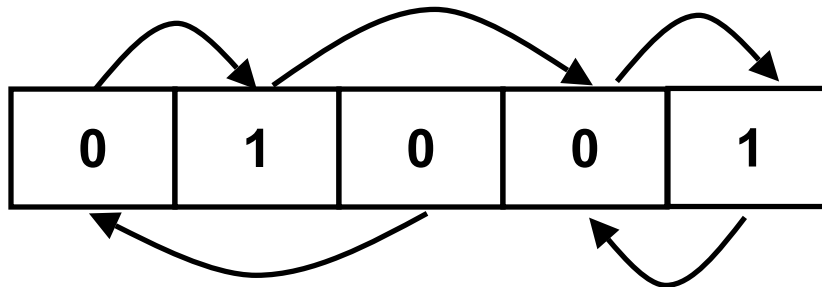


Figure 1: Construction of Interactions Between N Components in the Kauffman / Levinthal NK Model

The total fitness of a particular combination of traits is computed by summing the fitness contribution of each trait (which, depending on the level of K , depend on the other traits to which they are connected).

When $K=0$, the landscape produced by the model is 'smooth', in that climbing the landscape will produce a global optimum, whereas at the other extreme when $K=N-1$ (the fitness for each trait will always include the fitness component of that trait, therefore the maximum value of K is $N-1$ rather than N), the landscape produced is uncorrelated.

There are however several issues with the NK model when applied to an organizational context. These are discussed below.

No Definition of Fitness

The 'fitness landscapes' produced by the NK model are such that they produce landscapes where certain configurations are more favorable than others. However, the concept of this being a measure of 'fitness' being a definition based in biological science (although the term has been used in the organization ecology literature, but even here in the context of the growth rate of a population (Hannan and Freeman 1989:96)) has little significance in a model of organizational competition at an inter-firm (as opposed to population) level. Even within the biological discipline, there is no generally accepted definition of fitness within the literature. The most general definition is of an entity's ability to reproduce; and this generates an obvious question when transferred to management literature: firms do not reproduce, and therefore the concept of fitness may not be the most appropriate to use in an organizational context, especially where the term is not defined explicitly within strategic

management. Therefore, the import of a term with no direct analog within management science may produce problems in interpretation due to its poor original definition, which can lead to misinterpretation and ambiguity.

No Inter-Firm Competition

The *NK* model is a model of the *internal* strategies of a firm, and the way that their interaction causes differences in levels of fitness within the model. However, this creates a significant problem when we are using the model as it ignores *competitive* strategy.

Static Model

The *NK* model is static, in that the landscapes that are produced by the (randomly generated) degree of interaction between the N different strategies. There is no degree of change within the landscape and therefore there is no change in the landscapes, firms can move over these landscapes without the landscape moving; in addition, there is no ‘reaction’ of the landscape as a result of movement on it. This is not an intuitive part of the model, as one would expect a reaction of the system as a result of changing the firm’s position, and therefore must be considered a potential weakness of the model when considering the model for the purpose of modeling inter-firm competition. Levinthal (1997:944) deals with this problem by re-specifying a fitness landscape. However, this is an arbitrary re-specification, and this is the only way that the *NK* model can be considered non-static: turbulence is generated exogenously by respecifying the model.

Representation of the Landscape

Although the *NK* fitness landscape model provides a method of producing landscapes of differing roughness, there is a problem that they cannot be represented or visualized (as this requires a conceptualization of high *N* dimensional space). This is due to the fact that in order to create the differing levels of roughness, the number *N* has to be increased. *N* is also the number of dimensions in the model, therefore to create rough landscapes, *N* has to be very high, and due to the fact that it is very difficult to represent high-*N* space in a simple diagrammatic form, representation of the *NK* model is impossible. Although authors such as Levinthal and Warglien (1999:344-345) have attempted to produce diagrammatic representations of 'single peaked' and 'rugged' fitness landscapes, these representations are not created from the *NK* model; they are rather *schematic* representations of landscapes and therefore the utility of the *NK* model for the *representation* of landscapes (as opposed to the concept of firms inhabiting landscapes) is debatable. There are further issues with the representation of the *NK* model such as each of the *N* parameters can only take a value of zero or one; it is a binary model, therefore strategic decisions are either 'on' or 'off', there is no way of representing strategic decisions, for example the positioning of a product where there is a continuous attribute space, for example a component of strategy which decides the color of a product, where the color is not 'on' or 'off' but somewhere in a range of options.

However, this model concentrates on the internal aspects of firm strategy: competition between firms is not modeled explicitly. What makes the model proposed in this paper improve on models such as the *NK* model is that competition between firms is a prime factor in the motivation for and formulation of the model.

Rather than the interaction of decisions being used to create a landscape as in the *NK* model, we allow firms and ‘value-generating agents’ (a specific case would be customers) to interact, such interaction creating a complex profit landscape.

We therefore introduce a model of inter-firm competition that, whilst remaining to be a ‘landscape’ model of the form introduced by Levinthal, overcomes some of the limitations of the *NK* model that has been the genesis of the study of landscape models.

A Dynamic Model of Inter-Firm Competition

The model presented in this paper co-locates firms and ‘value-generating agents’ in a general strategy space. In its simplest interpretation, firms can be thought of as occupying a physical location in geographical space, customers also being positioned in the same geographical framework; the renaissance of geographical strategies within management has recently been reported (Sorenson and Baum 2003). Within population ecology models, ‘resource space’ (Carroll 1985) is defined to locate firms within an *N*-dimensional ‘social environment’ (Hannan and Freeman 1989:96). Boisot (1995:166) uses the conceptualization of a three-dimensional ‘Information-space’ or ‘I-space’. Product characteristics are modeled by the use of a ‘product characteristics space’ (Lancaster 1966). The model builds on models based in economics where firms choose their position in order to maximize their market share generated from capturing customers (Hotelling 1929), and models based in political science where political parties choose their position in issues space in order to maximize the number of voters who vote for the party (Downs 1957). Although the model presented in this paper can be thought of as operating in any of these geographical, social, information, or physical

spaces, we introduce the model here in terms of customers and firms co-located in a product strategy space: firms and value-generating agents such as customers automatically co-exist in this space and therefore the explanation of the model is simplified. It should be noted that the model is amenable to other strategic dimensions, and other combinations of firm and value-generating agents.

Strategy Space (Product Characteristics Space)

Product characteristics space is used to situate both firms and customers in a space and is the basic construct that produces the environment in which firms compete for customers. The use of product characteristics space is well documented within strategic management: Thomas and Weigelt (2000) use this space to measure distances between different automobiles with different attributes. Product characteristics space (Lancaster 1966) builds on the spatial competition models within economics introduced by Hotelling (1929) and extended by Salop (1979). Lancaster (1966) discusses this space in more detail. Such a space can be thought of as a special case of Porter's (1980) space used to position the strategies of firms in n strategic dimensions. However, the advantage of using Lancaster's product space is that firms and customers naturally co-exist within this space.

Positioning models have been developed within other domains of social science, such as Downs' (1957) model of political parties positioning themselves within a space characterizing political attributes of parties and voters. However, economic and strategic analyses of product characteristics space models have tended to concentrate on the positioning required of an entrant into a market (for example whether the entrant should differentiate their products from the products offered by the incumbent, or whether

positioning new products close to incumbent products is beneficial). Such models are useful but are however limited by the fact that they are essentially non-dynamic: once the entrant has entered the market, the model is of limited use. The positioning decision of the entrant is the only strategic decision that is modeled; the market share is divided between the entrant and the incumbents; therefore the strategy of an entrant firm within these models is purely to decide the initial location of the firm. In the model presented in this paper, this is developed so that strategy is considered to be the position *and movement* of the firm within the product characteristics space. Strategies of firms are therefore modeled to include the way that the firm alters its location and thus product characteristics over time.

Firms operate in a product strategy space, i.e. they position themselves according to their product strategies. Customers also occupy this space, and desire a certain combination of product characteristics according to their position within this space.

The notion of having both firms and customers making up the environment builds on Danneel's (2003:560) notion of customers being a key component of a firm's environment. The role of orienting a firm close to its customers is seen as a strategic device (Danneels 2003, Peters and Waterman 1982), yet the role of customers is largely considered to be within the domain of the marketing literature rather than the strategic management literature. Daneels (2003) notes that 'firms forge ... tight links with customers', yet this may not be the most appropriate way of constructing the problem: rather, it should be considered that the customers forge the links with the firms.

Game Theoretic Predicates

Game theory (Brandenburger and Nalebuff 1995, Ghemawat 1997, von Neumann and Morgenstern 1944) improves on other methodologies when considering the interaction of firms in a competitive landscape in that it focuses on competitive interactions between organizations. However, there are significant problems with using a game theoretic model to construct realistic models of firm interactions. Firstly, as in other mainstream micro-economic models, the focus of the game theoretic economist is to determine the *equilibrium conditions* for the set of interactions between only two players or firms and therefore their applicability in non-duopoly and non-oligopoly situations makes their applicability to the general multi-firm competitive environment somewhat questionable. The model presented in this paper presents a practical method of determining competitive interactions and the subsequent reactions of firms: if the strategy of a competitor is known, it is possible to model the ‘reaction function’ of the firm and thereby create a way of investigating the competitive behavior of firms that can be used, in turn, to investigate whether a firm’s reaction function is robust to changes in strategies of competitors.

Construction of the Profit Landscape

The model is initialized by randomly positioning a number of firms and a number of customers within the product strategy space. Each customer forms a link to the firm nearest to it in product characteristics space. The initialization of the model is shown in Figure 2. It is assumed that the profitability associated with a firm is dependent upon the number of links with customers (at the moment, the profit associated with each customer is assumed fixed and equal; this assumption could be relaxed as an extension to the model).

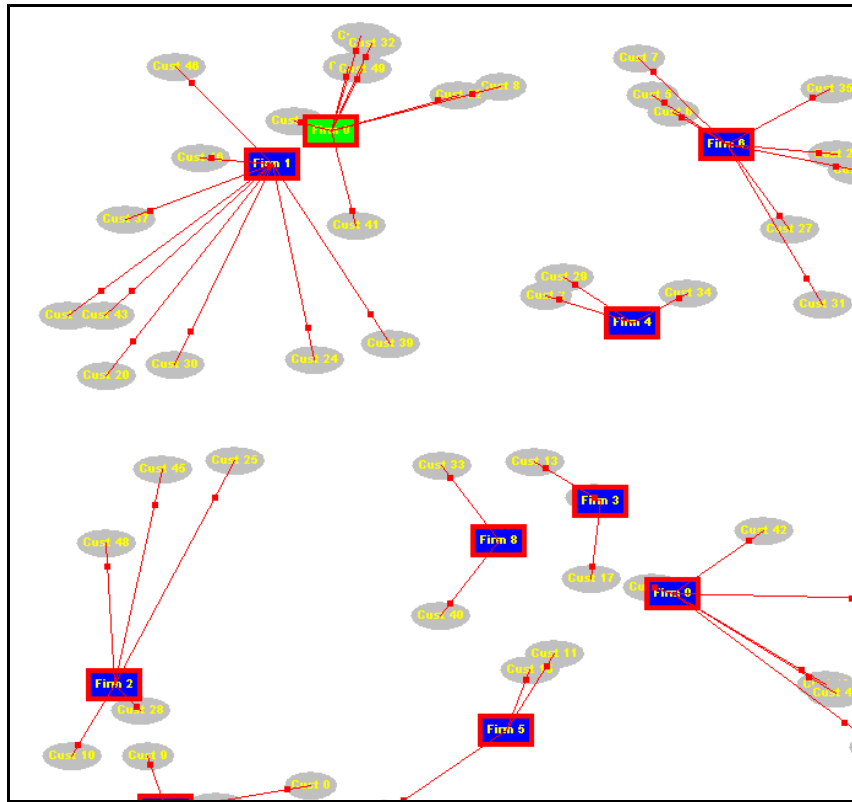


Figure 2: Initialization of the Model

By allowing both firms and value-generating agents to coexist in the same space, we create a ‘fitness landscape’ (Wright 1967) that shows the relative profitability that can come out of positioning a firm in this space. However, the notion of a ‘fitness’ landscape may not be the most appropriate terminology to use when describing a firm maximizing its profitability. ‘Fitness’, as referred to by Wright (1967), and later by Levinthal (1997) refers to the biological notion of the product of survival and reproductive success (Thain and Hickman 2000). In management, however, firms do not reproduce and therefore the notion of fitness may be misplaced. Therefore, in this model, we refer to a ‘profit landscape’ in preference to a fitness landscape. Similar to Levinthal’s (1997) *NK* model, which builds on Kauffman’s

(1993, 1995) model in evolutionary biology, the landscapes produced by the model presented in this paper may be ‘rugged’ and multi-peaked. The advantage however of this model over the Kauffman/Levinthal model (which may make it more amenable to the study of competitive strategy) is that rugged landscapes may be created in a low number of spatial dimensions (typically two as in Figure 2, although this can be extended to n dimensions) rather than an abstract (high N dimensional) space. This leads to the model being easier to represent diagrammatically and therefore easier to comprehend. The model also does not rely on exogenous mobility barriers as in Porter (1980) for creating differential firm performance; the model is sufficient in its endogenous form to create heterogeneous profits for differing firms. A further benefit of this model is that it integrates the approaches of a marketing framework and a strategic framework: there is a tendency for strategic models to be mainly interested in the effects of intra-firm competition (and lessen the emphasis on the needs of customers), where marketing models tend to concentrate on customers (thereby lessening the emphasis on intra-firm competition). The model presented here recognizes that *both* firms and value-generating agents such as customers are important when a firm is deciding which strategy to develop.

The formal construction of the model is shown in Equation 1.

Equation 1

$$\Pi(k, \mathbf{F}_k) = \sum_{i=1}^n \pi(k, i) \text{ where } \pi(k, i) = \begin{cases} 1 & \text{if } d(\mathbf{F}_k, \mathbf{c}_i) = \min_{j=1}^m d(\mathbf{F}_k, \mathbf{c}_j) \\ 0 & \text{otherwise} \end{cases}$$

where: Π is the profit accruing to firm k ;

n is the number of customers;

m is the number of firms;

\mathbf{F}_k & \mathbf{c}_n are the vectors representing the position of firm k and customer n within product strategy space; and

d is distance

In order to construct the model, the entrant firm can ‘steal’ a customer where it positions itself closer to the customer than any other incumbent firm. An example of this is shown in Figure 3.

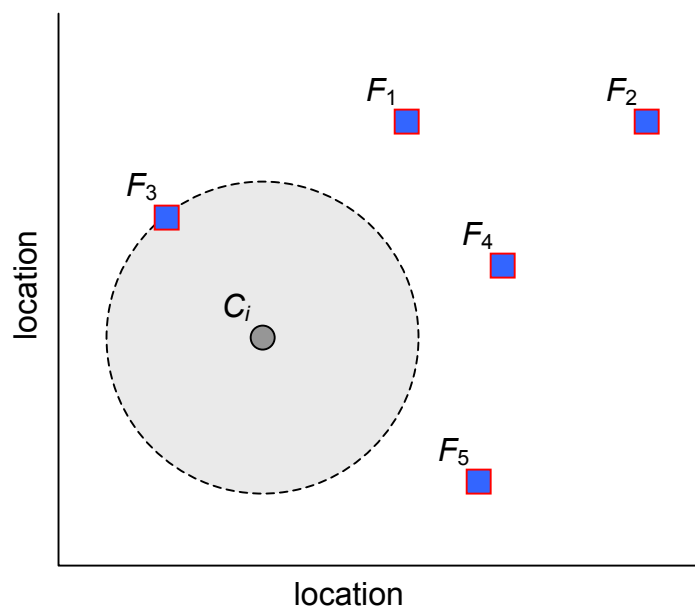


Figure 3: Locations for Incumbent Firm to Capture Customer

As can be seen from Figure 3, the possible locations for an entrant firm to capture a customer from the incumbent firms is the set of locations where the customer is closer to the entrant firm than all incumbent firms. In order to capture the customer, the firm has to locate closer to the customer than all other firms.

An example of how the fitness landscape is built up is shown in Figure 4. This shows that, in the case of two firms competing for one customer, there is a region where the object firm captures the customer (shown in green) and a region where the competitor captures the customer (shown in blue). A composite profit landscape is built by adding customers and competitors to the product characteristics space. The vertical axis shows the profit or market share accruing to the object firm (the market share not captured by the object firm accruing to competitors).

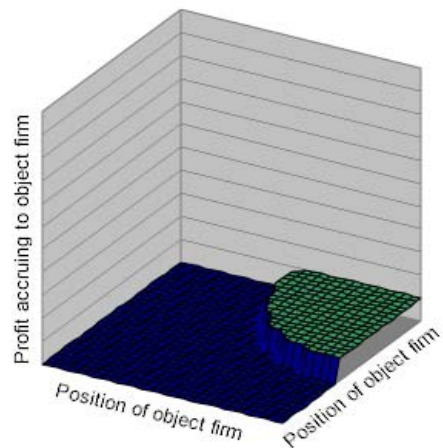


Figure 4: Example of competition for one customer by two firms

The production of a profit landscape with more than one firm can produce a complex problem that is not simple or intuitive and creates a ‘rugged’ (Levinthal 1997) profit landscape. One can note that this model produces a pictorial representations of landscapes whereas landscapes generated by the Levinthal/Kauffman model are schematic only: they are not generated by a model.

First, customers are distributed randomly (this can be weakened in extensions to the model, see below) in the product strategy space (Figure 5a). From this, we can create a customer density map (Figure 5b).

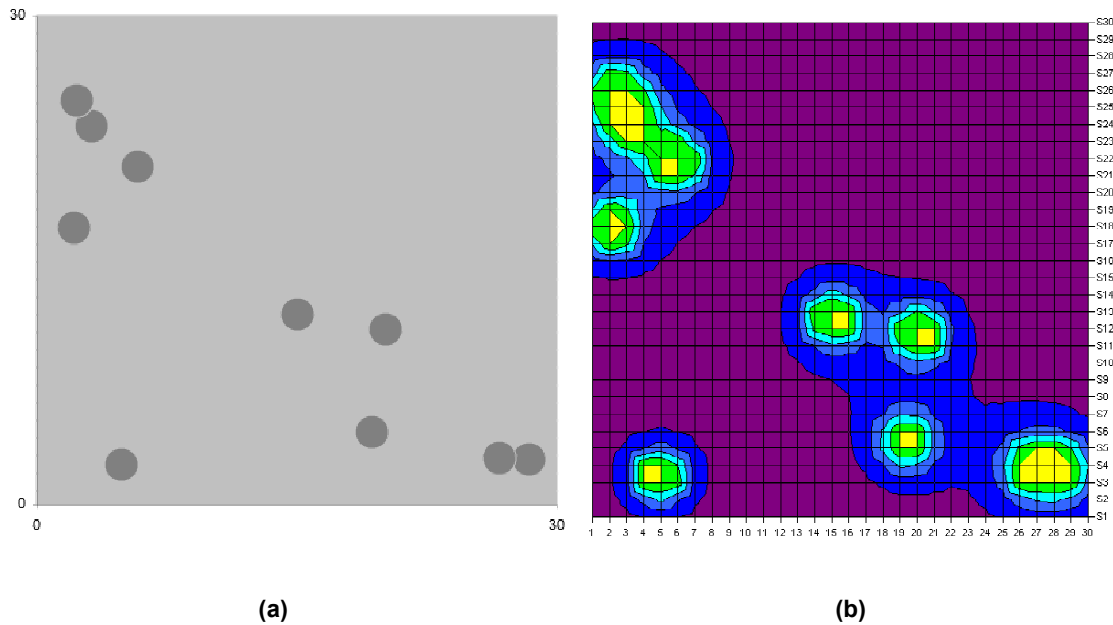


Figure 5: Customer Distribution (a) locations (b) density map

Firms also occupy the product strategy space. Firms are placed randomly on the same product characteristics space. Whilst specific industries may have levels of competition that mean that certain clustering is found and such empirical findings can be incorporated into the model as an extension, a sample industry is demonstrated here where firms are located randomly in the space.

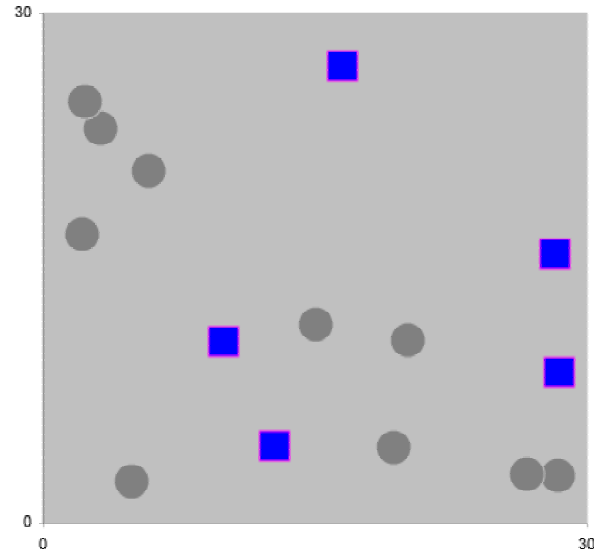


Figure 6: Location of Customers (Circles) and Firms (Squares)

From the interaction of firms and customers within this space, we are able to construct a profit landscape by plotting, for a point in the space, the level of profit accruing to a firm occupying that location, using the formula given in Equation 1. If we repeat this for all locations within the space, we are able to construct a profit landscape that indicates, for each position within the space, the level of profit that will accrue to a firm at that location. The profit landscape calculated for the random distribution of firms and customers shown in Figure 6 is shown in Figure 7. It is important to note that the profit landscape produced by the interaction of firms and customers does is not intuitively obvious. Moreover, the profit landscape is not identical to the customer density map, nor the firm location map, nor, importantly, a simple linear combination of the two. The system produced by the interaction is complex.

From this simple model of firms and customers co-existing in space (Figure 6 can be thought of as a map in product strategy space), there exists a complicated profit landscape,

which it is difficult for managers to assess. This may be why such simple strategies as differentiation from rivals (which can be thought of maximizing the distance between you and other firms) or following customers (which may be thought of as a strategy where a firm aims to position itself at the maximum customer density) do not produce satisfactory results. We therefore should be thinking of producing strategies that take account of the complex interaction between firms and customers – strategies that up until now may not have been envisaged. Simple strategies such as maximizing customer density or minimizing competitor firm density may not be optimal.

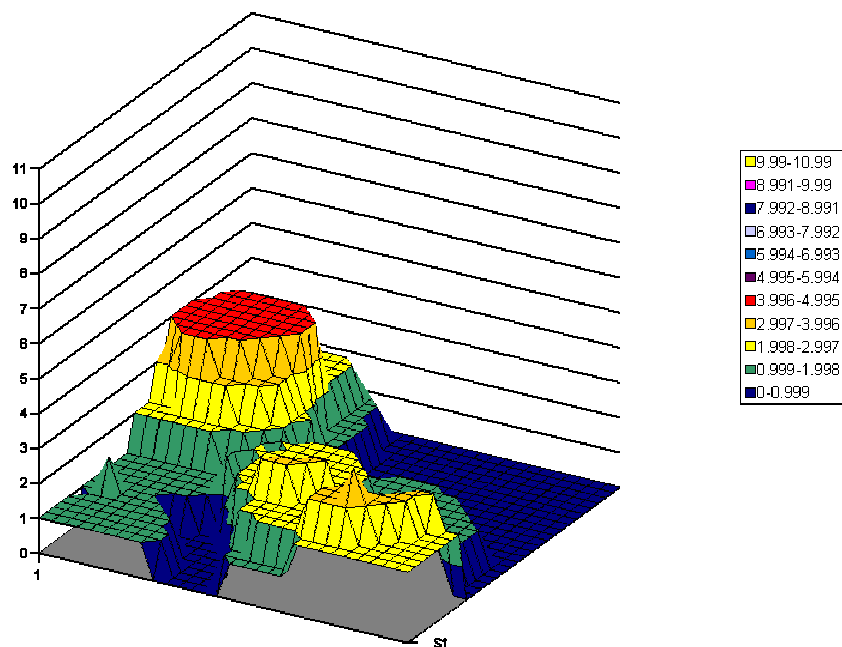


Figure 7: Profit Landscape

Idiosyncrasy of Landscape for an Individual Firm

In traditional analysis of industrial competition (Porter 1979, 1980), it is assumed that certain industry locations are a source of competitive advantage and hence excess profits accruing to

firms. Such excess profits can be maintained by the notions of for example mobility barriers that preclude competitors from entering these regions and hence acquiring profits from these firms. However, several authors have criticized the notion of mobility barriers and the possibility of their absence makes the notion of strategic groups controversial. The notion of mobility barriers is sufficient, in the eyes of strategic groups researchers, to maintain firm heterogeneity and therefore produce firms that, by their location, are able to attain sustainable competitive advantage.

In the model presented in this paper, the concept of mobility barriers is not modeled explicitly, but a similar effect is seen as an endogenous factor from the model; that is, certain positions within strategic space are more suited to firms than others. The notion of mobility barriers is not required in order to produce differential firm performance. However, such positions of such high profitability are not common to all firms, but are unique to each firm – therefore promoting an optimal position that is unique to each firm.

This model differs from others in that it recognizes that the competitive landscape is not identical for all firms – it is dependent on the *individual firm* – something that is often overlooked by other authors that consider that certain locations are optimal for *all* firms within an industry.

Figure 8 below shows the profit landscapes for two firms competing for one customer. It should be noted that the profit landscapes are not identical for each firm – as for example in the strategic groups literature. The locations where the Firm 1 will capture the customer are influenced by the position of Firm 2, and similarly the locations where Firm 2 will capture

the customer are influenced by the position of Firm 1. In this way, the model resembles a game theoretic model in that the positioning strategies of competitors need to be taken into account when deciding the optimal strategy. However, the model may be generalized to many firm agents who may move their positions over time.

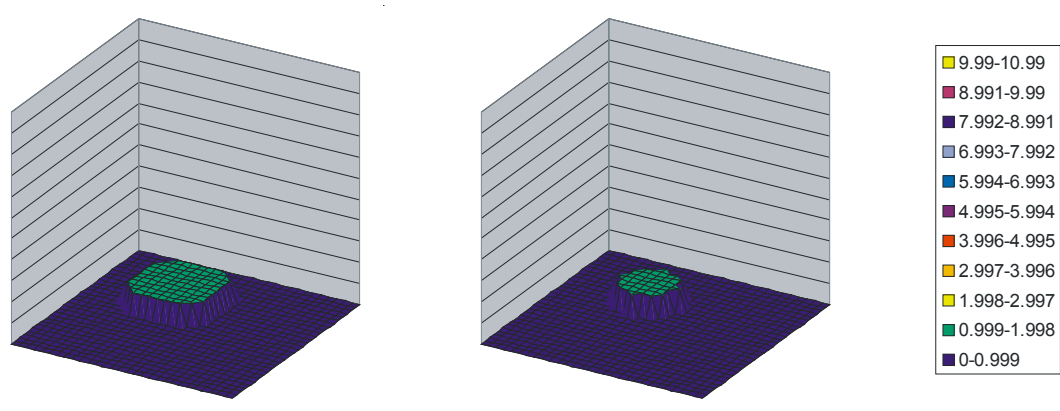


Figure 8: Differing Profit Landscapes for Different Firms

Analysis of the Model

Entry Decisions

One of the most important decisions for a firm to make when entering a market is where to position its products. Two different schools of thought are present – those, from a marketing perspective, that promote a strategy of differentiating the product from other firms. In our model, maximizing the distance between the entry point and other incumbent firms would do this; one can also think of this as positioning the firm at the minimum firm density. The second school of thought is to position the product where the customers are present, which would be done by positioning the firm at maximum customer density. However, both of these approaches are flawed fundamentally, for they do not consider the

interaction of firms and customers, approaches from a pure strategy perspective ignoring customers, and approaches from a pure marketing perspective ignoring inter-firm competition. By constructing a profit landscape that incorporates the dual elements of a market of firms and customers, this fundamental schism can be overcome, for this reduces the problem of entry positioning to one of maximizing the profit landscape produced by the interaction of firms and customers.

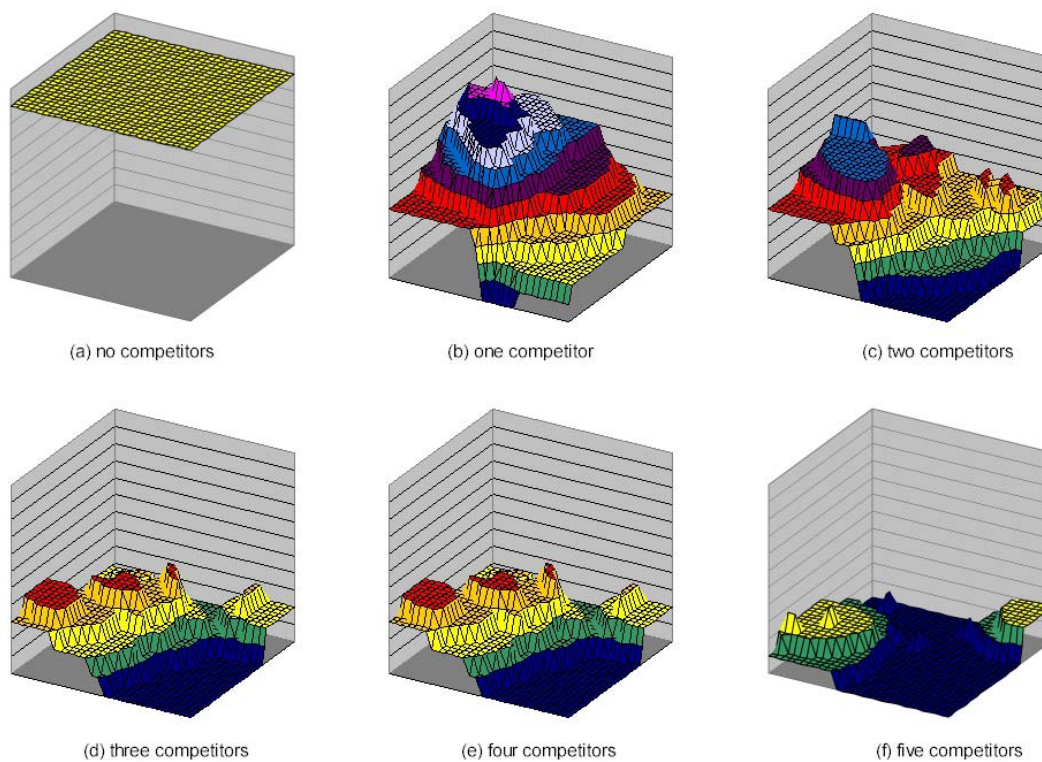


Figure 9: Profit Landscape Changing with Increasing Competitiveness

Figure 9 shows the effect of the number of competitors with regards to the profitability landscape. This represents the situation where there are 10 customers within the industry distributed randomly in this space. Figure 9(a) represents the situation where there is only one firm competing for customers. If one considers the product space to be a product space

defined as a new market or niche, this result is consistent with Lieberman and Montgomery's (1998) notion of monopoly profits accruing to the first mover. Regardless of where the firm situates itself within this space, the firm will capture all customers; a monopoly situation is occurring and monopoly profits accrue to the monopolist firm. As other firms enter the product space, the situation becomes more complex. When two firms are present in the industry, these customers are split between the two firms, as shown in Figure 9(b), which may cause the reduction in the incumbent's profits, as predicted by Lieberman and Montgomery (1998). Not only is this split between firms dependent on the location of the customers; it is also dependent on the location of the other firm. The profit landscapes shown in Figure 9 show the profit that accrues to the 'object firm', that is the firm that we are investigating, as a function of its location; profit (shown on the vertical axis) depends on the location of the object firm, and hence the landscape reflects the profit as a function of location. With just one competitor, the landscape is deformed from the flat monopoly landscape shown in Figure 9(a) to a complex landscape as shown in Figure 9(b). However, the landscape is relatively smooth and it would be possible to reach a global maximum by using a 'hill climbing' algorithm whereby the global maximum is obtained by climbing up the landscape. However, as further competitors are added as in Figure 9(c)-(f), the landscape deforms further to the situation where rather than being one global maximum, local maxima are formed (i.e. there is more than one peak in the landscape). Also of note is that the maximum profit attainable to a firm decreases as more firms are added, and there are locations where no profit is attainable to a firm (shown by the regions where the profit (on the vertical axis) is zero. It should be noted that the positioning of new entrants, who can be thought of as 'second movers' can produce profits in excess of the first mover, consistent with Connor (1988).

It should be noted that the representations of profit landscapes as shown in Figure 4, Figure 9, and Figure 10 represent the profit level of a firm were it to occupy a position. This does not mean that a firm possesses a map of its profit landscape – the firm could use an incomplete cognitive map of its environment, but in the absence of complete information of the location of all competitors and all customers, this will not match those as shown in the figures. In addition, every firm will have a different profit landscape.

The Effect of Movement of a Competitor

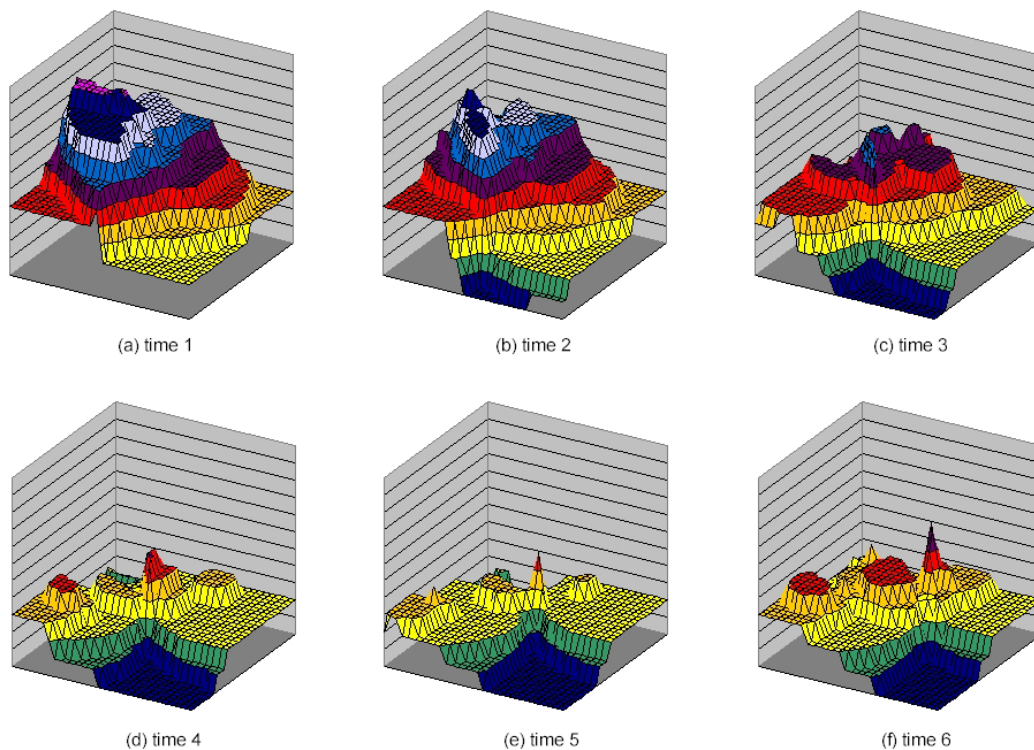


Figure 10: The Effect of Movement of Competitors

The effect of competitors is of note. Figure 10 shows the effects of one firm moving on a trajectory through product strategy space (all customers and all other firms remaining stationary). As can be seen, the profit landscape is transformed as a result of the other firm's movement. Although game theorists (Ghemawat 1997, following the conceptualization of von Neumann and Morgenstern 1944) have noted that firms should consider the impact of other firms, using game theoretic arguments, even such a simple model of customers and firms shows that the effect of the movement of a competitor may not produce linear, predictable outcomes. Indeed, in the time taken to assess this impact may mean that the landscape may have shifted in this time. Other competitors may have moved further making the results even more unpredictable and hence the assessment exercise of game theoretic analysis may prove futile.

Extensions to the Model: Exploration using Agent-Based Modeling

The model presented in this paper lends itself to investigation by means of agent-based modeling (Robertson 2003a). Agent based modeling can provide an appropriate methodology to explore the profit landscape presented by this model (Robertson 2003b) much in the way that agent-based models have been used to explore the *NK* model: Rivkin (2000) and Rivkin and Siggelkow (2002) have explored *NK* landscapes using agent-based models so that general observations can be made as to the way that firms should combine their strategies when faced with such complicated linkages within their strategic decisions. The paper presented here is not an agent-based model, but does allow the production of complex profit landscapes. Although this paper does not present results from simulation, it

is possible that this research is extended to produce results from simulation. This is left as an extension to this research agenda.

Conclusions

The model presented in this paper provides a new method for analyzing inter-firm competition on profit landscapes. While the results presented here are merely the first of many that may be generated from the model, it provides a basis for extending the model to investigate the effects of increasing competition, clustering of firms and customers, and other scenarios more suited to the individual circumstances of a particular industry. The model improves on landscape models in that (a) a landscape can be easily represented by using the model; (b) competition between firms is of central importance to the model; and (c) it incorporates inter-firm competition whilst considering customers (or other value-generating agents) as a fundamental source of profit. In addition, mobility barriers are created endogenously rather than being imposed exogenously as in industrial economics models. The model can be extended to introduce other forms of value-generating agent other than customers, value-generating agents can have different values to each other and to different values to each firm, can be generalized to more than two strategic dimensions over and above product strategy dimensions, and is more accessible and intuitive than the *NK* model, being predicated on a management problem rather than a biological model.

The aim of this paper is to introduce a general model that can be extended for specific empirical data, to model specific industries, or to model value-generating agents that are themselves of differing importance to a firm. The paper presents a sufficiently simple model

so that it can be adapted and utilized as a basis for integration with empirical data and for the basis of further analytical research.

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