From Courtroom to Converse:
My 30 Year Journey

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Introduction

Documenting one's cumulative research program can be a humbling experience. First, such an assignment requires acknowledging that most of our work has limited impact on the academic and practitioner communities. Second, even setting impact aside, there is the issue of trying to make it appear that there is some master plan that guides our research. Here again, I suspect most of us conduct our research without any overarching plan in mind. Certainly, this has been true for my research program. Still, it is possible for me to tell a story that provides some structure to this research and hopefully in the process helps the reader see my research program as a progression of ideas. With this in mind, I have decided to provide a brief background of my almost 30 years of study of channel management and channel structure issues, and in the process discuss the specific challenges that I addressed during this journey.

My travels started in the fall of 1971. The year before, I joined the GSIA faculty at Carnegie Mellon University. At that time, the marketing group was made up of three newly minted assistant professors including myself. Like most young assistants, I was deeply involved in trying to publish my thesis and learning how to teach. These activities were disrupted when a lawyer, who was also a professor at GSIA, asked me if I would like to be an expert witness in a legal case. The case involved an automobile manufacturer who, over a seven year period, owned and operated a dealership in Pittsburgh at a "loss." Perhaps more significantly, this vertically integrated dealership was competing with other privately-owned dealerships selling the same make of automobiles. Although I was ill-equipped to be an expert witness (I had only taken one MBA course in marketing and one undergraduate course in microeconomics), I agreed to take on the assignment. Over the next 8 months or so, I learned a lot about automobile dealerships, the distribution of automobiles and the economics of making and distributing cars.

One of the premises underlying this case was that since the factory store was losing money each year, the automobile manufacturer was providing a "subsidy" to its downstream channel partner. Moreover, since a number of other downstream sellers competed with this factory store, the theory went that these other dealerships also should receive this subsidy. In order to investigate the validity of this premise, I developed a model that explained why a manufacturer might want to distribute its products through a factory store (even though it lost money at the retail level) in addition to distributing its products through its franchised system (where it never incurred retail level losses). I then used this model to quantify the effects of such a dual channel system on retail prices and retail profits.

I will not go into too many details about the case (perhaps Tim McGuire will provide you some), other than to say my first attempts to solve this general channel problem were very crude. However, since this work provided the original impetus for my subsequent work in channel management, I think it is valuable to document some of the important lessons/outcomes that occurred during my initial attempts to model dual channel systems.

First, and foremost, I quickly learned that it is often useful to work with someone else, especially a person who can complement your own abilities. This led me to approach a fellow faculty member, Tim McGuire, a highly knowledgeable economist who was very skilled at modeling marketing problems. After hearing the facts of the case, he agreed to work with me to prepare a final report and to augment my initial model. This collaboration continued for a number of years as the case wound its way through the appeals court. Also, based upon our success in terms of the initial court decision, we were asked to be expert witnesses for a series of other auto dealer cases. Not only did this allow us to learn more about this complex industry, it also introduced us to another major channel issue, namely how does the sale of cars to leasing and rental companies (e.g., Hertz, Avis, etc.) impact the retail auto market and the franchised dealer system? Stated more academically, is there a link between these "non-competing" markets, and if so, what is the impact of this link on both the new and used car markets?

Over these first two or three years we realized, that if we were to adequately understand the above mentioned channel issues, we needed to develop parsimonious models that

1) reflect competition at both the retail and manufacturer level,
2) correctly specify the objectives (strategies) of each player (more technically the information available to each player and the rules they use to make their decisions),
3) correctly specify the demand functions that capture the aggregation of potential customers' choices, and
4) acknowledge that a durable good sold in one channel can impact the demand in another channel in a subsequent period of time.

In many ways I have spent much of my academic career addressing these four modeling issues.

One of our first modeling insights was to limit our attention to a four-player game with two manufacturers distributing their competing offerings through two competing retailers. As easy and straightforward as this may seem now, such a decision did not come easy for us. My initial impulse was to postulate a more complex system with numerous competing retail outlets. (Remember, I am basically a "marketer." Thus, relevance and realism were as important to me as parsimony.) However, after getting advice from such noted economists as Bob Lucas and Ed Prescott it became clear that if we were to make any progress we needed to "keep it simple." Still, our four-player model was more complex than most channel system models that existed in 1971 and it captured competition at both levels of the distribution system. Moreover, by capturing both retail and manufacturer competition, we were ultimately able to derive new insights into why a manufacturer might want to use a privately owned dealer instead of a factory outlet.

A second major advancement (at least for us) was to solve this four-player game. Again, such an advancement seems trivial based on today's knowledge. However, in the early to mid-1970's the concepts of Stackelberg leader, Nash equilibrium, etc. were not commonly applied to vertical channel structures. Perhaps more importantly, solving our two and four person games (by hand) was not an easy task. I can remember the numerous handwritten notes that Tim and I generated over the course of our work together. One small "math" error could greatly affect the final solution. Now one just uses a symbolic language computer program such as Mathematica to "solve" these equations.

A third modeling issue that occupied much of our attention was how to best capture consumer behavior via a set of demand functions, one demand function for each product offering. Again, the solution did not come easily. My gut feeling was that we needed to specify as general and flexible a set of functions as possible. Tim kept on insisting that we keep it simple. Ultimately, we compromised by showing our analysis based on the parsimonious, one parameter linear demand function, was as general as if we used the more complex 5 parameter linear demand functions. Specifically, we showed that there was a one to one mapping of the results obtained using the functions

(1) $q_i = 1-p_i + \theta p_{3-i}$ $i = 1,2$

where q_i denotes the quantity sold at retail outlet i, p_i denotes the price charged and θ, $0 \leq \theta \leq 1$, represents the degree of similarity between the two offerings, and the more general demand functions,

(2) $q_1 = \mu S\,(1-b_1p_1 + \theta p_2)$

$q_2 = (1-\mu)S\,(1+\theta p_1-b_2p_2)$,

where μ denotes brand one's market share, S the industry market potential and b_1 and b_2 capture the effects of own price sensitivity. For years, I was very satisfied with this result. However, recently I realized that such a demand system may still be quite restrictive. I later discuss this issue at more length.

By 1974, we had completed the first draft of our 1983 paper.[1] In 1976, Tim presented our model at an economics conference and soon after we submitted the paper to the American Economics Review.[2] After two rounds of reviews, the paper was rejected. We revised it based on reviewer comments and resubmitted it over the next two years to the Bell Journal of Economics (now called the Rand Journal) and one other economics journal. The net result was the same each time, i.e., the paper was rejected. Still, we did not give up. I gave the paper at Berkeley in their distinguished speaker series and received some favorable responses. Tim and I, working with a doctoral student, Krish Doraiswamy, wrote a companion paper that looked at how cooperative advertising impacts the channel system. This paper used much of the same structure as our initial dual distribution paper and was ultimately published in the AMA proceedings in 1979 (Doraiswamy, McGuire and Staelin, 1979). Interestingly, the discussant for the paper admonished the audience that our model was too abstract and that our findings should be completely disregarded. Soon after, Krish decided to leave the PhD program (he already had one PhD in Chemistry) for a job at Dupont where Paul Root, who later became President of MSI, was his boss. By 1980, Tim was turning his energies elsewhere and I was on my way to Australia and AGSM for a year's sabbatical. In a nutshell, our work on channel systems was

[1] While cleaning up my office this last fall, I came across the original typed version (1974) of our paper. Since this was before word processing or even widespread use of photocopying, the paper reflected numerous "cut and paste" corrections and plenty of white-out changes. Although I threw out all of my other old files, I decided to keep this original draft for sentimental reasons.

[2] One might ask what took us so long to submit the paper. First, the problems were not easy (at least for us) to solve. Second, Tim and I were working on a series of other papers on latent variables, some of which appeared in marketing journals and others of which appeared in statistics journals.

going nowhere. The net output of all our efforts was one AMA proceeding publication and two or three court decisions, one of which stated:

> "Plaintiffs' attempt to satisfy this requirement rests exclusively on the report of their expert, Professor Richard Staelin. Professor Staelin's report is a general analysis of the forces at work within the automotive fleet market, and it attempts to show that, according to basic economic theory, the fleet allowance programs challenged herein should tend to depress the retail price and increase the wholesale price for Chrysler products. In this way, Professor Staelin theorizes, plaintiffs' profit margins should tend to decrease as a result of the introduction of the allowance programs. At no time does Professor Staelin provide any statistical support for his theory. In fact, by his own admission, he reached his conclusion without having referred to the record in this case or even having looked at the financial statements of the two plaintiffs. Accordingly, since his opinion is based solely on speculations and hypotheses and is unsubstantiated by any evidence in the record, we accord it little weight."

If the 1971 dealer case caused me to start my channel journey, a second set of events that took place while I was in Australia in 1980 gave the stalled trip a jump start. Although reasonably isolated while in Sydney, I still was doing some reviewing for the journals. One of the papers I reviewed was for the newly formed journal, *Marketing Science*. This particular manuscript (authored by Abel Jeuland and Steve Shugan) was on channel coordination, i.e., how can a manufacturer get its downstream partner to price its product at the channel-optimizing price instead of the double marginalization price. After reading the paper, I realized that if *Marketing Science* was open to publish the Jeuland and Shugan paper, then perhaps the Journal would also be interested in Tim's and my paper since both used a game theoretic approach. This led me to suggest to Tim that we revise our paper with the goal of sending it to *Marketing Science* for possible publication.

Coincidentally, I also received a long letter from Anne Coughlan, who at the time was an economics Ph.D. student at Stanford. She had taken a class from Theresa Flaherty, a recent graduate from GSIA's Ph.D. program, who was at the time on Stanford's economics faculty. Anne explained to me that she learned about our channel model when she took Theresa's Ph.D. seminar and she wanted to write her thesis using an extension of our (unpublished) channel model. She asked me if I would be willing to read a handwritten copy of the first part of her thesis. I agreed and in the process learned more about the general tools needed to solve complex game theoretic models. All of a sudden my channel research had an "audience."

By the time I returned from Australia, Tim and I had a new version of the paper ready for submission. I used this revised paper as my job talk at Duke in the fall of 1981. Soon after, the paper was accepted for publication and I was offered a job at Duke. Tim and I immediately started work on two extensions to our channel model. The first dealt with the implications on prices, profits, etc. of factory-owned and privately-owned dealerships having different selling cost structures (McGuire and Staelin, 1983b) and the second (McGuire and Staelin, 1986) was a long book chapter that dealt with a number of issues concerning transfer pricing, incentive compatible contracts and channel efficiency. Both, however, were direct derivatives of our 1983 paper in that they used linear demand functions, a channel structure of two manufacturers selling through competing franchised retailers and a game theoretic approach based upon the assumption of full information.

By this time, i.e., the mid 1980's, other marketing academics were publishing papers using the same general game theoretic framework. The first to appear was the Jeuland and Shugan (1983) paper on channel coordination, i.e. the paper that inspired me to renew our efforts in the area. Soon after Anne Coughlan published her thesis paper (Coughlan 1985) that used a slightly more general demand function than ours and applied our franchise model to the electronic industry. She also paired up with Birger Wernerfelt (Coughlan and Wernerfelt, 1989) to develop an analysis that indicated delegation is never the optimal strategy for a manufacturer. More technically, they developed a model that showed, contrary to McGuire and Staelin (1983a, 1986), that the manufacturer always wants to vertically integrate. A third active player was Sridhar Moorthy, who provided a more general solution to the channel coordination problem via a two-part tariff (Moorthy 1987). He also wrote two papers (Moorthy, 1988; Moorthy and Fader, 1990) that linked the value of decentralization to the concept of strategic interaction. (Eunkyu Lee and I build upon these last two referenced papers when we explored the issues of price leadership and product line pricing (Lee and Staelin, 1997), but that's getting ahead of my story.)

While others were publishing these papers, Tim and I were hard-pressed to find time to move forward with our work. Both of us were Associate Deans at our respective institutions. I had started a new research partnership with Bill Boulding looking at a very different issue, i.e., quantifying the impact of market share on firm profits. Still, I continued to work in the channel area with my PhD students, first with Jim Jeck (1992), then Eunkyu Lee (Lee and Staelin 1997) and more recently Song Kim (Kim and Staelin, 1999). I also hooked up with Debu Purohit soon after he joined Duke's faculty (Purohit and Staelin, 1994). In each case I went back to one of the four key modeling challenges I mentioned earlier with the goal of providing a deeper understanding of the issues. With this as the backdrop, I would like to next discuss each of these four issues, specifying what I have learned since we published the original channel paper in 1983. This discussion will concentrate on how to formulate and solve complex channel problems and the general insights that have come from these analyses.

Elements of the Game

In order to solve our game theoretic model, we made a series of assumptions concerning what each player knows and how and when each of the players uses this information. More succinctly, these assumptions specified the informational environment and the rules of the game needed to "play out" the sequence of moves and counter-moves that lead to the equilibrium solution. Our 1983 paper follows "standard economic practice" by assuming all the players have full information about such things as each player's demand and cost functions and that each player selects the appropriate marketing variables with the goal of maximizing profits. It also assumes the manufacturers have foresight and are able to anticipate the retailers' reactions to any wholesale price changes.

I am not sure how others reacted to such assumptions when they first read our 1983 paper. I know, however, that my initial reaction was to say that even though these assumptions capture some aspects of the "real world", managers' mental models of the environment are often less complex (and less well informed) than those we used to derive our equilibrium results. For example, although manufacturers often consider the reactions of their downstream dealers, they probably do not know their retailers' demand functions. Likewise, competing dealers often don't observe what their competition is doing in terms of pricing. In fact, in the industry that we spent most of our time studying (i.e., autos), the true transaction price is almost impossible to measure since each price is individually negotiated and often not reflected in the dealer's financial records. Consequently, it was hard for me to believe that dealers set prices by explicitly taking into consideration their opponents' pricing counter moves. In fact, I had a hard time even assuming that dealers had explicit information on their own demand function, let alone the competitors' response functions.

This led me to question the robustness of our equilibrium findings to our assumptions of full information and the decision rules based on this assumption. Although I am somewhat embarrassed to admit it now, I had no particular knowledge of prior work in on this question. After the fact, I can point to two different lines of research that addressed the issue of markets converging without full information and a third line of research that addressed the issue of the appropriate set of rules used by managers. One line is typified by the work of organizational theorists such as Day (1967) and Day and Tinney (1968). They were able to prove that two interdependent units of an organization ultimately reach the optimal organizational solution even though each unit uses a non-optimal heuristic to set its decision variable. A second line of research is based on the paradigm of experimental economics and studies if "simulated" markets converge when participants are provided less than full information. For example, a laboratory study by Morrison and Kamarli (1990) indicated that "on average subjects converge to Cournot-Nash price or a price slightly below the Cournot-Nash level." The third research stream is found in the empirical I/O economics literature. For example, Slade (1988) estimated gasoline costs, prices and demand in a particular market. She then compared the Nash prices (i.e., the full information prices) determined using her empirical estimates of demand and cost with the observed prices. She found a strong correspondence between the two. From this she inferred the decision rules that managers were using were well represented by a full information model.

At the time I started to investigate the impact of full information and decision rules on market equilibrium I was only aware of the work by Margaret Slade. My first impulse was to conduct a series of laboratory experiments where I manipulated the information available to each player in a channel system and then observe the outcomes (i.e., I wanted to "replicate" others' work by using the experimental economics paradigm within a vertical channel structure). My overriding objectives were to see how players react to different levels of information and to determine if the prices converge to our Nash solution, or some other equilibrium. I mentioned this to Tim and he questioned whether I really could accomplish either of my goals given the large anticipated errors associated with individual differences and the difficulty of determining each player's ad hoc decision rules. He suggested that I consider constructing a series of decision rules that reflect how managers with limited information might decide on prices and then write computer code that would simulate the sequential application of these rules. I could then determine if the market reached equilibrium under this controlled setting. This led me to encourage Jim Jeck, who was then a Ph.D. student at Duke, to write his thesis (Jeck, 1992) on whether markets reach equilibrium (and if so, what is that equilibrium) when the players have "very little" information about their competitors and the environments within which they are operating.

Jim and I presented some of this work at a Marketing Science conference in 1989 and later we completed a draft of a paper that summarized our work. Unfortunately, due to personal constraints, we never completed this work. Consequently, none of our results have been published. Given this, I next provide a brief summary of our work.

We explored three generic rules that we believe capture the spirit of how managers make decisions in an informational environment of less than full information. In developing these rules, we made three basic assumptions:

1. A firm will continually experiment (modify its price) in an attempt to adapt to its perceived stochastic environment;
2. A firm always prefers more profit to less profit; and
3. A firm will seek to better its current position in a patterned manner, i.e., by the use of a systematic (but ad hoc) decision rule.

These assumptions led us to define three simple heuristics which were meant to represent possible characterizations of how managers might go about setting prices. The first of these rules we referred to as "if it ain't broke, don't fix it" and denoted as ABDF. The basic logic behind this rule came from the work of Day (1967) and Day and Tinney (1968) and reflects the fact that many firms keep to the same course of action unless something bad happens. Simply put, ABDF states that a firm will continue to move (take actions) in the same direction as long as it observes an increase in profits. More specifically, assume firm i increases its price from P_{it} to $P_{it} + \Delta$. Call this new price $P_{i,\,t+1}$. The firm then looks at the profits associated with P_{it} (denoted Π_{it}) and $P_{i,\,t+1}$ (denoted Π_{t+1}). If $\Pi_{it+1} \geq \Pi_{,it}$, then ABDF states that the new price $P_{i,t+2}$ equals $P_{i,t+1} + \Delta$, otherwise $P_{i,\,t+2}$ equals $P_{i,t+1} - \Delta$. In words, the firm continues to increase price by Δ as long as profits increase. If profits decrease, it decreases its price by Δ. Similar logic follows if the firm had originally lowered its price from time t to t+1.

The second rule that we analyzed was intended to capture situations where firms do extensive experimentation prior to making a decision. We referred to this rule as Muddling Through. Specifically, each firm runs N independent pricing experiments about its current pricing position. The firm then looks at the price associated with the experimental outcome that yielded the highest profit and uses this price for its new average price. The firm then repeats the experimentation process around this newly selected price.

Our final rule acknowledges that managers often try to learn more about their environment from past history. Specifically, this last rule states that each time the firm runs N experiments, the manager runs a simple linear regression to determine the intercept and slope parameters of the assumed linear demand function $q_i = A_t - B_t P_i$. (Remember the firm never observes the prices of its competitor so it cannot include these prices in the model.) Moreover, the knowledge of the own price coefficient (i.e., B_t) is updated via Bayesian learning (Cyert and De Groot, 1973). The firm then sets next period's price assuming its demand function is

$$(3) \qquad q_{it} = \hat{A}_t - \hat{\beta}_t P_{i_t}$$

where $\hat{A}_t$ and $\hat{\beta}_t$ are the most current beliefs about the intercept and slope parameters.

This leads to the monopolist decision rule

$$(4) \qquad P_{t+1} = \frac{\hat{A}_t + C_i \hat{\beta}_t}{2\hat{\beta}_t}$$

where C_i is the firm's unit cost. We refer to this rule as Bayesian Learning.

All of these rules are fallible in that they ignore the actions of the other player. For example, in Muddling Through, since both firms are experimenting at the same time, the variation in firms i's profits comes not only from the observable changes in its own price, but also from the unobservable changes in the price of firm i's competitor. Similarly, in the Bayesian Learning rule the manager ignores the direct influence of the competitor's price when calculating the firm's demand. In ABDF, a firm could garner higher (lower) profits not because of the wisdom (incorrectness) of its current pricing actions, but because of its competitor's actions. However, in defense of all three rules, since the manager never observes the competitor's price, he/she never knows the cause of these variations. Thus, the decision-maker is forced to establish some procedure, which ignores this influence, and the three different rules provide three plausible ways of doing this.

Although our assumed information environment mirrors the situation facing many managers, it also implies that firms never have the opportunity to fully understand all the forces that affect their demand. It also means that from the firm's perspective, their demand curve is constantly shifting in some unexplained fashion. Consequently, it is not surprising that all our rules have the firms constantly re-evaluating their price. As a result, markets do not settle to an equilibrium price, but instead at best converge toward some equilibrium price. I will refer to this convergence point as equilibrium but in reality it is a point about which the market prices fluctuate with no tendency to increase or decrease over time.

Following Tim's suggestion, Jim and I started our exploration by writing computer programs where we assumed (linear) demand functions of the form given in equation 1 and where we had two opposing players both using one of the above three non-normative pricing rules. We then simulated what would happen if each player started out a given price and sequentially set a new price according to the pre-specified rule. In this way we could observe if these prices "converged" overtime. As such, we replicated the experimental economics paradigm using the computer as our subjects. Interestingly, we found that when both firms used either the Bayesian Learning or Muddling Through heuristic, prices tended to converge toward one set of prices, while the ABDF heuristic tended to converge to a different set of prices. In all three cases, these convergence results were independent of the firms' initial prices. This led us to see if we could develop a set of proofs that would specify the points of convergence.

After some effort, we were able to prove the following three statements:

> <u>Premise 1</u> – In situations where both firms are randomly experimenting about their mean prices and use the Bayesian Learning heuristic to set next period's price, market prices quickly converge to the Nash solution.
>
> <u>Premise 2</u> – When firms use the Muddling Through heuristic to set next period's prices, the point around which the market converges depends in part on the number of experiments the firm conducts prior to making its next pricing move. If they make only one pricing experiment before making their next price move, the market converges to the Nash solution. If they make more than one experiment move before establishing a new mean price, the market converges to a solution somewhat higher than Nash with this difference increasing in the number of experiments conducted prior to making the next pricing move.

Premise 3 – If firms follow the ABDF decision rule the market prices converge to the collusive solution.

I find the implications of these three premises to be extremely powerful, since they give me more confidence that markets converge even though managers don't have full information. Consequently, I now am less concerned about the restrictions of the full information assumption. More generally, I now believe markets will converge toward a point if managers make decisions based on plausible heuristics and this convergence is well described by either the Nash solution or the collusive solution.

Clearly, Jim's and my work is not the only work that addresses this topic area. I will not review all of relevant work here, but I think it is useful to mention a few pertinent studies. Over the last decade or so, advances in the I/O literature (often referred to as New Empirical Industrial Organization or NEIO) have allowed researchers to empirically infer the types of games being played by firms within an industry. Perhaps the most relevant of these NEIO studies to my channel research is the paper by Kadiyali, Chintagunta and Vilcassim (2000). They estimate a general model that contains all of the standard game theory models as a constrained version of their general model. In this way they can compare and test Vertical Nash, Manufacturer Stackelberg leader and Retailer Stackelberg leader models against a model where both channel members have foresight (i.e., are price leaders).

A second alternative approach is exemplified by the work of Paul Messinger and Yuxin Chen (2000). They use experimental economics to address the following question "Do manufacturers take price leadership or is pricing more symmetric?" More specifically, do manufacturers anticipate the reactions of their downstream retailer when setting the wholesale price or are prices (i.e, wholesale and retail) set jointly? They address this problem by having students play a 30 period sequential game where the manufacturer sets a wholesale price, the retailer sets a retail price and then both parties see the two prices, the resulting demand and their profit for that period. They then explore whether prices tend to converge to the manufacturer Stackelberg leader solution (i.e., manufacturer the price leader) or the Vertical Nash solution (i.e., neither party is the leader and profits are evenly split). I suspect that others will use both approaches to provide more evidence on the rules of the game and whether or not our standard game theory models adequately represent channel behavior.

Developing the Proper Demand Functions

A second major issue associated with using analytic models to analyze channel systems revolves around correctly specifying the demand functions. As I mentioned earlier, Tim and I were able to show that it is possible to analyze a simple one parameter linear demand function in a duopoly situation and yet be able to apply the results of such an analysis to situations where the linear demand functions have up to five parameters. Our basic approach was to rescale both the quantities and prices and in the process "suck up" four of our five parameters. One of the major implications of such an approach is that it is not possible to directly compare solutions across different values of our one remaining parameter (θ in equation 1), where θ captures the degree to which consumers perceived the two available product offerings to be substitutable. Thus, for example, we were not able to directly assess the effects of changes in θ on profits by looking at how our profit solution changed as a function of θ. This meant that we were not able to directly analyze the effects of competition on prices, profits, etc. without transferring our results from the rescaled units into the original units. Perhaps more importantly, even though our demand formulation was quite general, had nice properties in terms of being downward sloping in own price and upward sloping in other price and was mathematically tractable, it was not rooted in first principles. By this I mean we did not derive it using assumptions on how the buyers and market behave. Thus, we had no "proof" that the demand is linear or that the coefficients of the demand function could take on any specific values.

Given this lack of generalizability, it is not surprising that reviewers of subsequent analytic papers began asking the authors to show that their results were not sensitive to the assumption of linearity. Such a request invariably was met by some resistance since non-linear functions are much less tractable when determining equilibrium. However, in most instances, the authors were able to show (often using numerical analyses) that their results were robust to the assumption of a non-linear demand function. (In hindsight, this is not surprising since we now know that the issue is often not whether the demand function is linear or non-linear, but instead whether, in situations where there is no shift in the demand function, the retailer's response to changes in the upstream member's wholesale price changes is to pass more or less of this change on to the end consumer (Moorthy and Fader, 1990; Lee and Staelin, 1997). In fact, Eunkyu Lee and I suggest that perhaps the primitive for a given situation is not the shape of the demand function but whether the retailers believe it in their best interest to increase or decrease margins when faced with a wholesale price change and no change in the demand function.

A second objection to our linear demand formulation is more subtle, but is probably more important. Marketers, including Tim and I, often treat demand functions as if they appear out of the blue. For example, most empirical modelers, especially in the 70's and 80's, would postulate a linear or multiplicative demand model and then estimate its parameters. Almost no attention was spent on deriving these functions from first principles. One might argue that this practice wasn't all bad since others (in economics) had shown that it is possible to derive linear demand functions starting with a simple utility formulation (Hotelling, 1929; Dixit, 1978; Shubik and Levitan, 1980). Still, examples began to appear in the channel literature indicating that the issue of linearity was not all that clear cut. For example, Lal and his co-authors (Lal 1990, Lal and Rao 1997, Lal, Little and Villas Boas 1996) started with a basic Hotelling formulation and derived demand functions that, although linear in specific regions, were often kinked and thus not continuously differentiable. As a consequence, they were forced to conduct separate analyses for each of the linear regions and then compare solutions over each of these regions.

My initial reaction to this work might be classified as benign neglect. I was certainly aware of the fact that demand functions "came from some underlying behavior." In fact, every year I would force my doctoral students to struggle through a very difficult but elegant paper by Hausman (1979) where he derives the demand function for energy efficient air conditioners. I would then pontificate to my students that starting from first principles was the correct approach and that marketers historically ignored this approach and instead specified (and then estimated) some convenient demand function. Still, when faced with the task of developing an analytic channel model, I ignored my own advice and continued to rely on four "facts."

1) It is possible to derive from first principles linear demands in a duopoly, albeit using very simple models of buyer behavior.
2) Linear demand models often provide good fits when used to capture real world price, quantity data.

3) Non-linear models are often not very tractable in terms of getting closed-form solutions.

4) Many of our closed-form results that are obtained using linear functions seem to hold even when the functions are allowed to be non-linear.

All of this rationalization came to a halt, however, about two years ago. Within the space of a couple of weeks, I read two analytic papers where the authors were comparing the equilibrium outcomes from one channel structure carrying x offerings with the equilibrium outcomes from a second channel structure carrying y offerings. For example, in the paper by Raju et al. (1995), the authors compared a situation where a retailer sells two national brands (and thus they use two demand functions in their analysis) with the situation where the same retailer sells two national brands and a store brand (and they use three demand functions). The logical question then became "How does one know that the two different sets of demand functions used to represent these two different situations come from the same set of customers and the same underlying behavior?" More generally, if one modifies a parameter in the demand function to say reflect increased substitutability of the product offerings, does this new demand function only reflect a change in the substitutability or does it also reflect some change in the underlying buyer behavior? Unfortunately, it is impossible to answer these questions without having a specific link between a utility model and the demand functions. In models that start by assuming a demand function, we do not have such a link.

The realization that one needs to be able to link demand functions to some underlying behavior led me to join forces with Eunkyu Lee and develop a general theory of how to derive a demand function for any multi-product, multi-outlet situation. Our basic approach is to start with an underlying utility model that reflects five different drivers of purchase behavior:

1) Each consumer prefers to pay less versus more for a product.

2) Each consumer has an ideal set of characteristics that he/she is looking for in any product within a product class. If a consumer buys a product that provides a different set of attributes from the consumer's ideal set the consumer incurs a disutility. The magnitude of this disutility is a function of the distance between the person's ideal point and the location of the product in some attribute space.

3) People have to travel to a given outlet and incur search costs. These travel and search costs yield some disutility. The magnitude of this disutility is a function of the spatial distance between the person's location and the retail outlet's location.

4) People incrementally value getting the xth dollar of wealth more than getting the (x+1)st dollar, i.e., their utility for wealth monotonically increases, but at a decreasing rate.

5) People have a reservation price above which they will not buy the product. This price is the same for everyone and is designated as V.

We combined these five basic assumptions with two assumptions concerning the heterogeneity of the underlying population of potential customers. Specifically, we assumed:

1) Customers are uniformly distributed in attribute space, i.e., with respect to their tastes as reflected by their ideal points.

2) Customers are uniformly distributed along the line representing spatial distance.

From these first five assumptions (and our specific quantification of these assumptions) we are able to show that the potential market for any product offering can be represented by concentric circles in two space, where the x-axis represents spatial locations and the y-axis represents attribute space. For example, Figure 1 depicts three concentric circles for a given product offering, where each circle is associated with a specific price. The x-coordinate of the center of the circles represents the physical location of where this product offering is being sold and the center's y-coordinate represents the attribute location of the offering. Likewise customers can be located in this space. The x-coordinates represent their spatial locations and the y-coordinates their ideal points. Any customer who lies within a circle has a non-negative utility net of price for the product offering, with those on the boundary having zero utility and those located at the center having the largest utility. As the price increases the concentric circles get smaller, i.e., the number of potential customers decreases. Also, the utility for everyone within the circle decreases.

This graphic representation of potential demand is extremely useful for deriving the demand function for different multi-product/multi-outlet situations. For example, Figure 2 illustrates the situation captured in our 1983 paper where there are two competing retailers, each carrying one competing product. The degree of overlap of the two circles reflects the degree to which customers find both products yield positive utility. In marketing parlance, the degree of overlap reflects the size of the market segment that has a consideration set of size two and the two areas where there is no overlap represent customers loyal to the brand.

Using this basic graphic formulation, and our two assumptions about the distribution of customers, we are able to show the following:

1) Monopoly demand is linear in own price, and the parameters of this linear function are only influenced by V, the reservation price.

2) Duopoly demand is non-linear in both prices and at times not continuously differentiable. However, as long as the two offerings are in competition (i.e., there are some customers who consider both offerings and neither offering is dominated) demand is extremely well approximated by a linear function. Specifically, when we regress the true (derived) demand against own and other price, where the prices are restricted to those that result in competition, we get fits with R^2's between .97 and .999 with averages close to .99. Thus, for all intents and purposes, duopoly demand is linear. Moreover, the coefficients for the intercepts and the two price variables vary as a function of V and the degree of overlap.

3) The reaction functions for the true duopoly demand are not linear and they are not always monotonically increasing. However, these reaction functions produce a unique equilibrium and this equilibrium is very close to the equilibrium obtained by using the above mentioned general linear demand functions that approximate the true underlying demand.

4) The above findings are easily generalizable to situations with more than two outlets and/or more than two competing products.

I find these results to be extremely powerful in that they provide substantial evidence that it is okay to use linear demand functions as long as one makes sure that the parameters of these linear demand functions reflect the competitive environment facing the consumer. Specifically, if the degree of overlap (at zero prices) is captured by θ, then the appropriate linear demand equations are of the following form:

(3) $q_i = S_i\,(1-b_i p_i + b_2 p_{3-i}) \qquad i = 1,2$

where

$$S_i = \frac{\pi V_i^2}{1+\theta^2}$$

$$b_1 = \frac{1}{V_i}(.9 + V_i b_2)$$

$$b_2 = \frac{1}{2.5V_i}\left(\frac{\theta}{1-\theta^2+\theta(1-\theta)}\right).$$

Similar results can be derived for three and four product offering situations and are reported in Lee and Staelin (2000).

Two major implications flow from these results. First, if one wants to compare channel structures that involve the sale of different numbers of product offerings, it is now possible to derive linear functions for each situation and be assured that the underlying behavior is held constant. Thus, any differences in solutions across the different structures can be attributed to the channel structures and not changes in buyer behavior.

Second, as seen from equation 3, all of the parameters of the linear demand functions are a function of the competitive environment parameter θ. Thus, if one wants to investigate how changes in the competitive environment affect profits, etc. it is necessary to reflect this link between θ and the demand parameters. Currently, the standard approach to investigate how changes in θ affect equilibrium solutions is to use comparative statics, i.e., determine how prices change with a change in θ, holding fixed everything else. Note, however, that a change in θ results in a change in each of the parameters of the demand function. Since the optimal price is often a function of each one of these parameters, it is necessary to reflect the simultaneous changes in each parameters. Most analytic papers, including some of my own, do not do this since they assume the other parameters of the demand function remain fixed.

In summary, I now have more confidence in results that use linear demand functions. Moreover, we know that these functions must have parameters that vary with the degree of overlap. Finally, it is now possible to specify compatible linear demand structures for situations reflecting differences in the number of product offerings. This will greatly enhance our ability to analyze complex strategic questions such as what happens to prices, etc. if a retailer or manufacturer decides to augment the channel by also offering the product via a catalog or an internet outlet.

Interlocking Markets

In the introduction I mentioned that Tim and I were involved in a legal case that addressed the issue of how fleet sales (i.e., sales to rental companies and other commercial firms) might ultimately impact the new and used car markets of the franchised dealers. We constructed a verbal argument on how dealer margins are affected based upon the assumption that new and used cars are in "competition." However, as is evident from the above referenced court decision, we were not particularly successful in influencing the Court about the veracity of our theories.

Almost 15 years later, I was teaching in an executive program specifically designed for Ford managers. Concurrently, all the domestic car manufacturers were experiencing a major downturn in their retail sales even after offering substantial discounts in the form of customer cash (i.e., those $1000 off ads that we see periodically). As a consequence, Ford was faced with the choice of either closing some of its factories for a while or increasing sales to its non-retail markets. This led them to "move the iron" by offering substantial sales incentives to the rental market (e.g., Avis, Hertz, etc.). The net result of these actions was to lower the average duration of a car in the rental fleet from about 15 months to just over 4 months. As a consequence, they "sold" many more new cars but soon after many more slightly used cars entered the used car market. I asked the Ford managers what they thought were the implications of these events on their dealer system. Although many of them had an opinion, none was able to provide a coherent story for his/her conclusions.

As with the initial dual distribution problem, I attempted to develop a model that would provide some insights with respect to the channel management issues of interest. This time I hooked up with Debu Purohit. Our approach was, in many ways, similar to that taken in the 1983 paper, i.e., we specified demand functions (we specified linear functions), the informational environment (full information) and the rules of the game (Stackelberg leader). However, we also needed to develop an approach that would allow us to a) link today's sales to the rental companies (who did not compete in the retail market) to subsequent used car sales that resulted when these rental cars were sold, and b) specify how these used cars competed with the new retail cars. Fortunately, Debu had worked on a similar problem involving the sale of durable goods (Levinthal and Purohit, 1987). The basic idea was to model the situation as a multi-period game where customers in period 1 anticipate what will happen in period 2. In our situation, we had customers forming expectations of how the subsequent sale of the returned used cars would lower the price of any partially substitutable new cars sold in period 2. Based on these expectations we had customers trading off waiting until the second period to buy a new car at a lower price with buying a new car in period 1. The net result is that retail demand for the new car in period 1 is reduced and thus, the auto manufacturer must lower its retail price in period 1. In this way we were able to have future events affect today's prices. We then used this basic model formulation to analyze the impact of three different possible channel management strategies available to the manufacturer, i.e.,

1) Don't "push the iron" onto the rental companies, but instead have an incentive scheme that causes the rental companies to keep the cars until they are so used that they do not compete with new cars. (The separate channel strategy.)
2) Push the iron onto the rental market and then allow the rental companies to sell the nearly new rental cars in the open used car market in period 2. (The overlap channel strategy.)
3) Push the iron but also contract with the rental companies to buy back the nearly new cars. The manufacturer then sells these slightly used cars to the dealers, who in turn sell both the new and used cars in period 2. The price of these slightly used cars is determined either through an open auction or via a transfer price that insures the dealer finds it profitable to buy the used cars. (The buy-back strategy.)

We were able to show that the optimality of these different strategies depended in part on the degree to which the new and slightly used cars were viewed to be viable substitutes. We also found that the dealers were best off if the manufacturers used one of the buy-back strategies versus the overlap strategy. Interestingly, our results indicate that manufacturers can always increase total sales by providing an incentive to rental companies to give up their rental cars before they want to, i.e., use either the overlap or buy-back strategies although the overlap channel strategy yields larger increases than the buy back strategy. Thus, it is not surprising that auto manufacturers use the rental channel to distribute new cars when retail demand is down. The only question then is "Do they want to minimize the impact on the dealer system by using a buy-back strategy or increase total sales by using the overlap channel strategy?"

Subsequent to publishing this paper, Debu published an award-winning paper that more completely analyzed this situation (Purohit 1997). Not only was he able to derive the demand functions from first principles but he also extended our 1994 model to allow the rental companies to decide on how much they wanted to order. Fortunately, most of our initial conclusions were robust to these extensions.

In 1997 I got a call from someone at Ford who had read Debu's and my 1994 JMR paper. He wanted to know if I would help them determine the effects of rental sales and other new car incentives on the used car market, i.e., the converse of the problem Debu and I attacked. Ford's profit was highly influenced by the used car market as a result of increased popularity of their leasing business and their prior practice of buying back rental cars. Said somewhat differently, they were now in the business of producing "used cars", i.e., cars that they "rented" to someone for a couple months or years and then sold on the open wholesale market via auctions. Since this final sales price affected the price they needed to get when they "rented" the car initially, they wanted to be able to accurately predict the value of the used car.

My approach to this problem was fairly predictable. I again hooked up with a smart companion who could complement my set of skills. This time it was Preyas Desai who had just joined our marketing group. We developed a two period "model" that showed how Ford's actions in the new car market both last period and this period could (should) impact the stock of used cars this period. Using a very large database that Ford constructed specifically for this purpose, we obtained empirical estimates of these effects. As a result, we were able to quantify the effects on today's used car prices of such actions as stimulating today's retail sales via customer cash and initially equipping the rental cars with specific features. These results were disseminated throughout Ford and strongly influenced the actions of this firm in terms of giving short-term promotions to retail customers and specifying specific features for leased and rental units. In this way my work went full circle. My original work was triggered by a need to understand actions taken by the auto manufacturers. Based upon increased understanding, I was able to provide assistance to this industry concerning a related problem.

Alternative Channel Structure

Tim's and my initial interests were in the automobile industry. Although this industry has a major impact on our economy, there are numerous other important industries that use different channel structures. Over the years, our original model of a franchise system with two retailers and two manufacturers has been modified and expanded by numerous scholars. For example, Choi (1993) developed a model where one common retailer carries the products of two competing manufacturers, thereby representing a mass merchandising channel. Eunkyu Lee and I expand on Choi's model by allowing retail competition between two common retailers (Lee & Staelin 1997). I also used a four-player structure to investigate the effects of short term trade promotions within the CPG industry (Kim & Staelin 1999). Lal (1990) used a three-player game to study the use of price promotions by manufacturers to inhibit the introduction of a store brand. Raju et al. (1995) also studied the general issue of when a retailer would want to carry a store brand, this time by extending the Choi model to allow the one common retailer to carry a store brand in addition to two competing national brands. Trivedi (1998) compares our original franchise model with a model where both retailers carry both products. From this she is able to assess the impact of getting better coverage via mass merchandising versus eliminating in-store competition via a franchised system. I am currently working on a paper with a Duke contingent looking at the impact of disintermediation on prices and profits for both the retailers and the manufacturers (Staelin, Boulding, Lynch & Bruce, 2000). This paper has three retail outlets, i.e., two internet stores and one brick and mortar common retailer store selling the product of manufacturers. Given the recent development of the internet and the emergence of new channel structures, I expect to see a number of new papers that explore many of the issues raised by these changes.

The above referenced papers all deal with one period models. Another way to extend channel structure issues is exemplified by the work of Desai and Purohit (1999), who use a multi-period game to explore the impact of leases and other marketing activities in channels selling durable goods. They are able to show that the distribution between leases and sales is more than an issue of price. Specifically, they show the proportion of leases and sales also affects the firm's ability to compete in a durable market and is a function of the durability (depreciation rate) of the product. Thus, the firm with the higher rate of deterioration leases less than a firm with a lower rate of deterioration. Such analyses can help us understand differences in marketing programs across different firms or across time.

Summary

I hope my rambling has provided you with some useful insights into my 30 year journey. To further re-enforce these insights, I list below some of the major lessons that I have learned while traveling this twisted and sometimes discontinuous trip.

Personal Lessons

1) Link up with smart co-authors who can complement your interests and abilities. Not only does this allow you to learn new skills and knowledge, it also makes research more fun.
2) Get out of your office and learn the institutional details of the situation that you are interested in studying. This helps identify the key factors affecting the situation and thus enables you to better represent the phenomena you are trying to model.
3) Internalize the concept so elegantly described by Moorthy (1990), i.e., that an analytic model is really a one-cell mind experiment (versus, say the standard 2x2 experimental design). This will help you think of new ways to extend existing work, both in terms of relaxing and/or changing assumptions and in terms postulating new settings and/or structures.
4) Take a long-term view of your research. It often takes a long time for others to appreciate new approaches/ideas. (Sometimes they never do gain such an appreciation.) Still, good ideas normally are eventually recognized. Thus, persistence usually pays off.
5) Always look for ways that you can link the knowledge gained from talking to practicing managers and teaching back to your research interests. Said differently, don't view your academic career as a bunch of unrelated activities. Instead, think of them in terms of activities which feed off each other. This means not only bringing your research into the classroom but bringing what your learn from your contracts with the business community and students back into your research.

Technical Lessons

6) When studying channel structure problems, the issue generally is not whether the demand is linear or non-linear, but whether the demand function is flexible enough to represent different underlying competitive environments.
7) When comparing solutions across different competitive environments and/or different numbers of product offerings, it is necessary to link the different demand functions to one set of buyer behavior assumptions. Otherwise you cannot be sure that any observed

differences in results are not due to differences in buyer behavior (versus differences in channel structure, etc.) This implies that it is necessary to start with first principles, i.e., a utility function, buyer behavior, etc.

8) It is still an open question as to how firms set prices (or any other marketing variable) in a competitive environment. However, it appears that many of the full information equilibrium results will go through even if managers do not have full information. With this said, there is significant opportunity to learn more about these issues, not only in channel settings but also in more general horizontal and vertical settings.

9) There are many situations where markets are linked via consumer expectations. In such instances, one needs to use a multi-period model.

10) Many marketing actions are taken within a vertical channel structure. For example, many promotional decisions involve not only the manufacturer and the end customer, but also the retailer. One needs to model the actions of all three of these players to get a good understanding of what is going on.

11) It may be more important to know how downstream channel members respond to wholesale price changes than to know the demand facing these members. More technically, the sign of the slope of the response function may be the operative primitive in many channel analyses.

Managerial Lessons

12) Franchised systems can lead to higher profits for manufacturers than vertically integrated channel systems if the manufacturer's products are not well differentiated, (McGuire & Staelin, 1983a). Thus, it is not always best for the manufacturer to try to coordinate the channel system.

13) Distribution through mass merchandisers (i.e., common retailers) is more profitable to manufacturers than an integrated system when there is little competition between retailers and products (Lee and Staelin, 2000). Thus there is another instance where channel coordination is not the optimal solution.

14) Consumers might be better off (i.e., set lower retail prices) if the FTC allows competing manufacturers to vertically integrate (McGuire & Staelin, 1983a).

15) It can be in the firm's best interest to reward each level of a vertically integrated organization on its own performance, versus the performance of the firm as a whole. More technical, in a competitive setting having individual units use local optimization can result in higher firm profits than providing them with an objective of maximizing total firm profits (McGuire & Staelin, 1986).

16) It is not always best to use foresight when setting prices. In this way 'ignorance is bliss." (Lee and Staelin, 1997)

17) It is often in the best self-interest of a CPG manufacturer to offer large side-payments to a retailer (e.g., trade promotions) even though this retailer does not pass through much of the trade allowance. (Kim & Staelin, 1999)

18) It is in the best self-interest of CPG manufacturers to help the retailer build up store loyalty, i.e., stop consumers from switching stores because of specials. (Kim & Staelin, 1999).

19) Durable manufacturers can increase their profits (sales) by providing special incentives to one segment of their market (e.g., rental companies). However, even though these markets do not directly compete with the other segments, they eventually may compete in the used market. When this occurs, manufacturers need to find ways of softening these interaction affects. (Purohit and Staelin, 1994)

20) The introduction of store brands always decreases the profits of the manufacturer. However, consumers will not notice much difference in retail prices for the national brands, since the profit maximizing retailer does not pass the savings associated with a decreased wholesale price on to the consumer. (Lee and Staelin, 2000)

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Figure 1
Monopoly Market

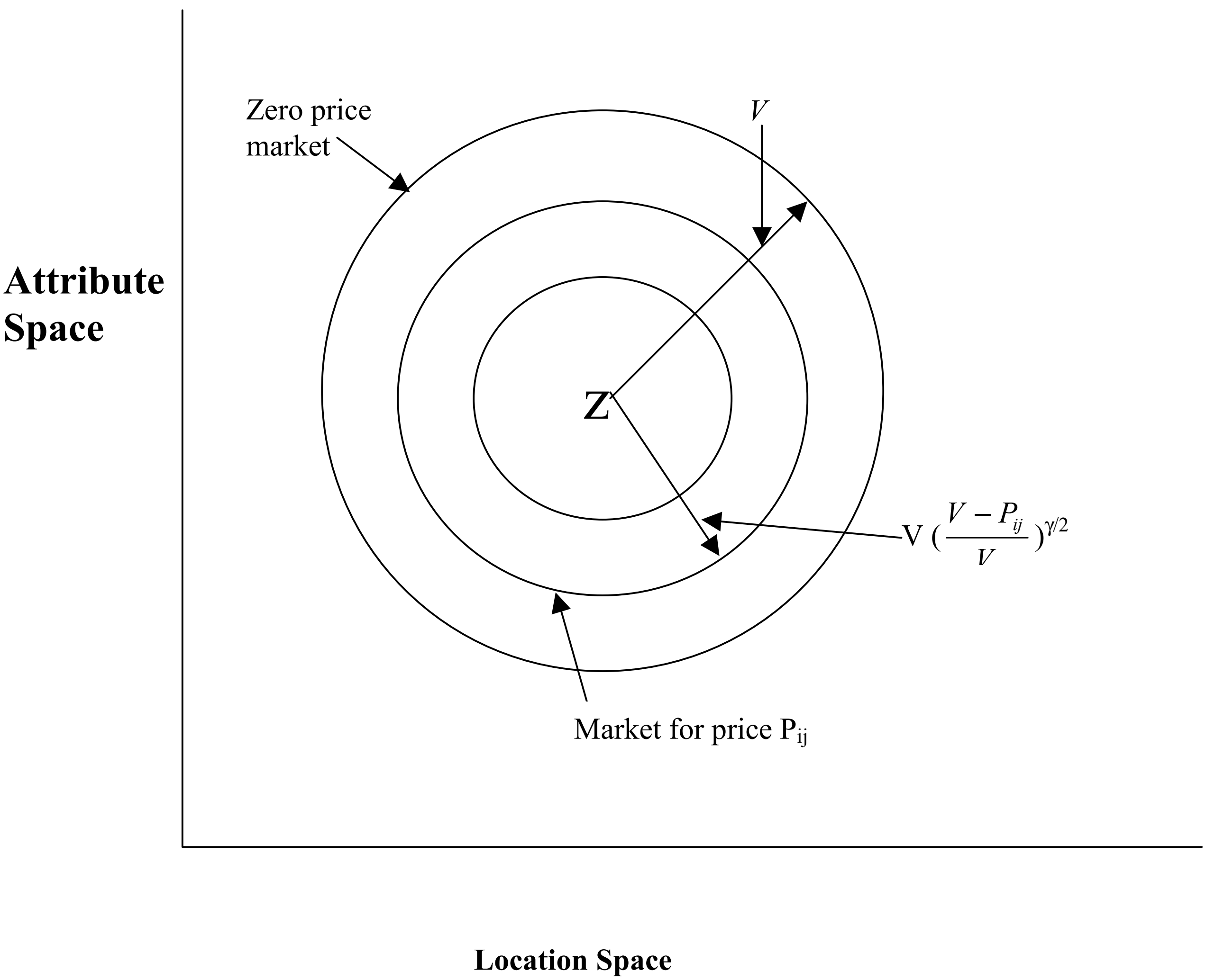

Figure 2

Spatial Representation of the Duopoly
As Stated by McGuire and Staelin (1983)