DO PRICE STRATEGIES WORK IN BUSINESS SIMULATIONS?

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ABSTRACT

This paper presents the results of theoretical experiments involving four price strategies. The purpose of the research was to determine which strategy would prevail given a different elasticity zone for initial price. In the first experiment price was set in an elastic zone of firm demand. In the second experiment the initial price was set where the elasticity of demand was equal to 1 and in the third experiment the initial price was set in the inelastic zone. The four different strategies employed were: (1) increase price by $1 each period, (2) decrease price by $1 each period, (3) Let Price remain the same and (4) Follow the leader. Without a knowledge of demand parameters the experiments clearly demonstrated that the choosing of a winning strategy was a matter of luck.

I. INTRODUCTION

Business simulations are presumed to be a valuable tool for teaching the fundamentals of business strategy. The type of strategy which is the subject of this paper is the price decision. Do business simulations allow a meaningful price strategy to be developed, and then successfully implemented or is workable strategy simply a chance event subject to trial and error decision making? Is it possible that the total enterprise simulation has inherent design features that cause the development and implementation of price strategy to be an exercise in futility?

The research reported in this paper suggests that a successful price strategy in business simulations may be due more to chance than careful planning, analysis, and decision-making. The element of luck has long been considered a possible important factor in business simulation performance (Gosenpud and Meising, 1983). The subject matter of this paper is highly technical and involves some rather rigorous research and model building. Surprisingly, no papers were found that addressed the topic of how to develop and successfully execute a price strategy in business simulations.

Of all the decisions in a business simulation perhaps the one most intriguing is the price decision. The foundation of price theory and the related fundamentals of market demand is primarily found in economic literature. In a similar manner, the foundation of the total business enterprise simulation is the demand algorithm. In this algorithm, the demand of a each firm is determined for the price set by each firm. Other things equal, the firm that has the lowest price has the greater demand but not necessarily the greatest net income. The theory of price in economic literature is quite complex, particularly when different market conditions such as pure competition, duopoly, oligopoly, and monopolistic competition are introduced.

The firms that compete in a total enterprise simulation are generally considered to operate in a market condition called an oligopoly. In an oligopoly, there exists a relatively small number of sellers selling a homogenous or somewhat differentiated product. In a business simulation, the number of firms in an industry tend to not exceed 10. The critical problem in this type of market is to determine how price is set and ultimately comes to an equilibrium. Various theories abound and even today a generally accepted theory does not exist. (http://en.wikipedia.org/wiki/Oligopoly)

II. THE PRICE PROBLEM IN BUSINESS SIMULATIONS

Generally, from three to four students are assigned to a team and a team of students represents one of the firms in the industry. The major question being address in this paper is: what strategies may a team use to make the price decision and what demand algorithm conditions must exist to allow this strategy to prevail?

Economic theory seems to suggest that if one firm lowers price, then the other firms will also lower price. However, a firm that raises price is not likely to be followed with price decreases by other firms. Do the demand algorithms in business simulations support this generally held belief? Under what demand algorithm conditions should a firm lower price and under what conditions should a firm raise a price in the course of simulation play? This papers presents the results of theoretical research in which answers to these questions were sought.

It is beyond the scope of this paper to consider the nature of a business strategy for all decisions. However, it is intent of this paper to explore whether or not a meaningful price strategy can be developed in a total business enterprise simulation.

III. TYPES OF PRICE STRATEGIES

The purpose of a price strategy in a business simulation is not entirely clear. It commonly believed in an oligopoly that collusion among competing firms is likely to happen. The fact that all firms eventually set the same price, it is believed, is evidence of collusion. However, as later will be demonstrated in this paper, this is not necessarily the case. The question concerning simulation play is whether the objective is to find the price that maximizes industry net income or whether the objective is for one firm to outperform the other industry firms? There is always a selfish interest involved in an individual firm concerning price, and if one firm can out perform another firm by having a lower price, then that firm in its own interest will act independently of other firms.

However, the profit benefits from departing from the industry price most likely will not be permanent and, as will be shown in later this paper, will only be a temporary advantage.

Consequently, for purposes of this paper two price strategy conditions will be explored.

1. Price collusion among firms
2. Price independence among firms.

The condition of firm price independence exists when one or more firms attempt to gain a temporary net income advantage by either raising price or lowering price. Normally, the advantage comes from lowering price. The condition of price collusion exists when all firms agree to the same price and agree to change price by the same amount in the same direction.

To facilitate the nature of this research on price independence among firms , it was necessary to develop the following four specific strategies:

1. High-price/ low volume
2. Low price/high volume
3. Follow the leader
4. Maintain the same price

Under conditions of price collusion, these four strategies do not apply when the objective is to maximize industry net income. Given these price strategy choices when firms seek price independence, which of these strategies will prevail and under what conditions will they prevail? These conditions are discussed in detail in section IX.

Anyone who uses simulations as an educational tool is naturally inclined to conclude that after a number of periods of decision-making, the firm with the greatest net income has performed better than the other firms If grades are based on superior profit performance, then it is important that this assumption is correct. However, as will be proven and discussed later, the team that prevails in terms of the highest net income may have actually caused the industry as a whole and the other teams individually to operate at a price level that is in the long run causes net income to be sub par. The winning team may have forced other teams including itself to set price far below the optimum industry price. It may be true that the winning firm has the greatest amount of net income but when this amount is far below the optimum amount that could have been earned for this firm and other firms, it is difficult to reward this firm=s first place standing. The question is: to what extent do we reward a firm in simulation play that attempts to serve its own selfish interest contrary to the interest of its own investors?

To understand the nature of research and it s findings presented here in this paper, a solid understanding of the nature of the demand algorithm in a business simulation is required. Also, a good understanding of the theory of elasticity of demand is necessary. Sections IV and V of this paper presents a review of these fundamentals. If the reader has a good understanding of these demand elements, then the reader may skip immediately to section VI.

IV. THE DEMAND ALGORITHM IN BUSINESS SIMULATIONS

A business simulation contains a number of algorithms or integrated mathematical models that create the dynamic environment in which business decisions are executed and consequences determined and reported. The algorithm that drives all other algorithms is the demand algorithm. The most basic decision in this algorithm is the price decision. The demand algorithm has as its foundation the basic theory of economic price theory. In the demand algorithm of business simulations, there are two demand curves in the demand algorithm. (Gold and Pray, 1983; Goosen, 1986):

1. Firm demand curve
2. Industry demand curve (Market demand)

It is the interaction of these two demand curves that give the business simulation its dynamic economic characteristics and allows the production function and the finance function to make the necessary production and financial calculations.

In economics, the theory of price centers around the demand curve. The traditional demand curve models of price theory are the models shown in Figures 1 and 2.

Demand Functions

The demand curve shown in Figure 1 is usually used to explain the theory of price because the demand line is linear and easier to work with mathematically. In this paper, only the demand curve shown in Figure 1 will be used. At each price, the demand curve shows the quantity that consumers are willing to buy. The theory is that as price is lowered, the quantity consumers are willing to buy is greater.

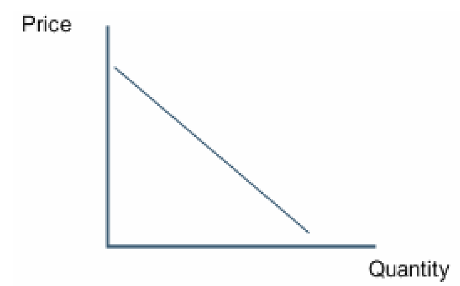


Figure 1 Linear Demand Curve

The demand curve in Figure 1 may be mathematically defined as follows:

$$P = P_o - k(Q) \tag{1}$$

$$Q = \frac{(P_o - P)}{k} \tag{2}$$

The demand curve in Figure 2 may be mathematically defined as follows:

$$Q = \left(\frac{1}{p^N + E} \right)(S) \tag{3}$$

Q - Quantity Demanded
E - Elasticity factor
N - An exponent
S - Demand scale factor

Only equation 1 was used for the research reported in this paper to develop a demand algorithm. A complete discussion of how the demand algorithm was developed for the research in this paper appears in the appendix to this paper.

Revenue and Cost Functions

Since the primary purpose of finding the best price is to maximize net income, there then must exist within the simulation a revenue and cost function. For purposes of this research a cost function was created as follows:

$$TC = F + V(Q) \tag{4}$$

TC	-	Total cost
V	-	Variable cost rate
F	-	Fixed cost
Q	-	Quantity

Based on this equation and equation (3) the following equation for net income was derived:

$$NI = P\left(\frac{P_o - P}{K(S)} \right) - V\left(\frac{P_o - P}{K(S)} \right) - F \tag{5}$$

NI	-	Net income
Po	-	Y-intercept
P	-	Price
K	-	Slope of demand line
S	-	Scale factor

How equation (5) was derived is explained in detail in the Appendix to this paper. The price that maximizes net income can be easily found by using calculus (Goosen, 1990)

V. ELASTICITY OF DEMAND

In economic price theory, the elasticity of demand has been given considerable attention. While the elasticity of demand concept might seem to be of nominal importance, the research reported on in this paper provides a basis for saying that it is of profound importance in developing a pricing strategy. Without a good understanding of the nature of elasticity, student participants are likely to make haphazard price decisions. Also, without an adequate knowledge of demand elasticities relationships, the game designer could easily assign incorrect parameter values to the properties of the firm and industry demand curves.

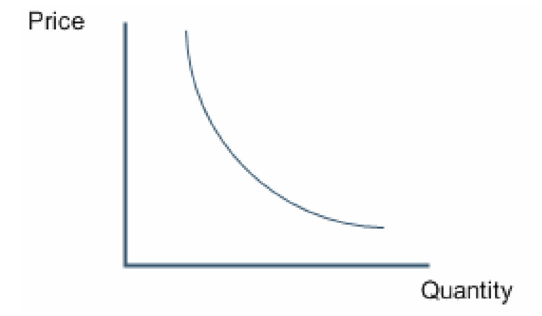


Figure 2 Curvilinear Demand Curve

Demand elasticity is a measure of the sensitivity of a change in price to the change in quantity. It is a fundamental economic fact that as price is lowered, quantity demanded will increase. The approach to measuring the sensitivity of a change in price is to simply divide the revenue increase from a price change by the revenue lost due to the price change.. The result is a percentage measurement. The primary purpose of a price decrease is for the revenue increase to exceed the revenue lost. When the result is a ratio of 1 (in other words, revenue gained equals revenue lost), the elasticity value is 1. A elasticity of 1 is a signal that further decreases in price will reduce the dollar amount of sales. In other words, revenue lost from a price decrease will exceed the revenue gained.

To illustrate the concept of elasticity numerically, let us assume we have the following demand information,

Price	Quantity	Revenue
$10.00	100	$1,000
$ 9.00	200	$1,800

When price is decreased from $10.00 to $9.00 there will be a loss of $1 per unit on the quantity demanded at $10.00. Revenue loss is calculated as follows:

$$RL = (\$10.00 - \$9.00) * 100 = \$100$$

However, the price decrease of $1.00 results in an increase in quantity from 100 to 200. This increase in quantity then results in a revenue increase. Revenue gained then may be computed as follows:

$$RG = (200 - 100) \times \$9.00 = \$900$$

Elasticity of demand at a price of $9.00 is:

$$E = \frac{RG}{RL}\frac{\$900}{\$100} = 9 \quad \text{or } 900\%$$

The formulas used here to compute elasticity of demand is known as arc elasticity. The value computed by this method may differ slightly from elasticity of demand computed by other formulas.

Economists have made the following generalizations about demand elasticity:

1. When elasticity is greater than 1, then price is in the elastic zone. As long as a price change is in the elastic zone, a decrease in price will increase sales revenue.
2. When elasticity is less than 1, then price is in the inelastic zone. Any decrease in price will decrease sales revenue
3. The price that is optimum revenue is where elasticity is 1. At this price, the optimum level of sales has been found.

In fact, however, finding the best price is a bit more complex that this. The goal normally is not to maximize sales but to maximize net income. While finding the optimum price that maximizes sales is of interest at times, the primary research goal of this paper is to explore the effect that price changes have on net income. Initially, the first concern of this paper will be to focus on sales or revenue by assuming that the variable cost rate is zero. Therefore, unless otherwise specified, total sales and net income will be equal. Then later this assumption will be relaxed.

As will be demonstrated later in this paper, the concept of two elasticity zones is of critical importance to an understanding of price strategy: There are two zones of elasticity The (1) elastic zone and (2) the inelastic zone. In addition, where the elasticity is equal to 1 is also of considerable interest.

One of the problems a game designer has is setting the initial price. Based on the above discussion, it is apparent that the game designer has three choices.

Price may be set in the elastic zone where elasticity is greater than 1.
Price may be set in the inelastic zone or where elasticity is where elasticity is less than 1.
Price may be set where the elasticity is 1.

Because there are two demand curves, a firm demand curve and an industry demand curve, a combination of firm demand and industry elasticity zones exist:

As will be reported later in this paper, the elasticity zone in which initial price is set determines in large part the price strategy that a firm in the simulated industry should adopt. Also, as the results of this research will reveal, certain of the above elasticity combinations creates price anomalies that should be avoided by the game designer in setting initial price. While it would be ideal for simulations designers to not arbitrarily set the initial price, in a number of cases simulation designers apparently have not been aware of the consequences of elasticity zones on demand allocation. Consequently, these inappropriately set parameters caused abnormal demand allocation results. For example, if the Y-intercept of firm demand exceeds the Y-intercept of industry demand, then as price is decreased, the other firms allocated demand will increase (Goosen, 2007).

Since there are normally two types of demand curves in the simulation demand algorithm, we actually then have two types of elasticity: (1) firm demand elasticity and (2) industry demand elasticity. The relationship of firm demand elasticity to industry demand elasticity can be quite important as indicated in Figure 3. Three relationships may be recognized:

1. Firm demand elasticity is greater than industry demand elasticity.

This case exists when the Y-intercept of firm demand curve is less than the Y-intercept of industry demand curve.

2. Firm demand elasticity is equal to industry demand elasticity.

This case exists when the Y-intercept of firm demand curve is equal to the Y-intercept of industry demand curve.

3. Firm demand elasticity is less than industry demand elasticity.

This case exists when the Y-intercept of firm demand curve is greater than the Y-intercept of the industry demand curve.

The only valid relationship of the three listed above is item 1. The other two, if they exist, will create demand allocation anomalies that can not be supported in theory. The elasticity of firm demand curve should always be greater than the elasticity of industry demand (Goosen, 2007) The concept of elasticity zones and ranges is shown in Figure 4.

Assume for the moment that the objective of each firm is price independence. The best firm demand price for any single firm will vary between $18.00 and $9.00. The problem, however, is that the firm seeking an income advantage does not know what the price of the other firms will be. The firm can only make an assumption which could easily be wrong. At an initial price of $12, the best price strategy would be to lower price, assuming the other firms leave price at $12.000 How much price should be lowered depends on the price of other firms.

In terms of firm price independence, it is the placement of price in elasticity zones of firm demand that is of critical importance rather than the elasticity zones of industry demand The fact that the price falls in the inelastic zone of industry demand curve is only important if the objective if to find the price that maximizes total industry net income. The research results reported in this paper demonstrate that recognizing in which elasticity zone price is set is critical in developing a price strategy.

VI. IDENTIFYING THE BEST PRICE STRATEGY

Goosen in his 2007 paper found that when all firms charged the same price (price collusion), the firm demand curve basically became irrelevant in price strategy. The best industry price was identified by the equation, $(P_o + V)/ 2$ (Goosen, 1990). However, when collusion is not a factor and when one or more firms set a different price, finding the best price becomes more difficult. To find the best price in the absence of collusion, three theoretical experiments were conducted involving four different price strategies. The results are reported later in this paper.

As discussed earlier in the paper, two types of price strategy conditions may be identified:

1. Price collusion among industry firms
2. Price independence among firms.

For each of these conditions the simulation model mention earlier was used to investigate and determine how price strategy should be approached.

VII. THE PRICE STRATEGY DILEMMA: COLLUSION OR FIRM INDEPENDENCE

Winning has always been an important objective in simulation play. Most simulations encourage competition and winning by reporting team standings and scoreboard reports. Outperforming other teams seems to give the superior performing teams a measure of satisfaction. However, in order to have competition, a collusive price strategy can not be an objective of simulation play. Firm price independence is required.

The primary objective of firm price independence to set a price that gives the firm a net income advantage. It can easily demonstrated that as long as a price is in the elastic zone of the firm demand curve that a decrease in price will give the firm decreasing price a net income advantage, assuming the other firms do not change their price.

The strategy of changing price, however, is fraught with danger because of a basic problem for which there appears to be no solution. The problem is that the student participants, and, consequently, each firm in the simulation competition do not know the demand parameters. The probability of gaining a net income advantage is greater if the demand parameters are known. Otherwise, if all firms are equal in their ignorance, then all firms have an equal chance of being right or wrong in changing price. Making the right choice initially is important because the firm that makes the correct change first will tend to have a permanent net income advantage.

VIII. BEST PRICE STRATEGY EXPERIMENT

If price collusion is not a factor and if each team is basically making decisions independent of other firms, then basing price on costs is might appear to be a price strategy. This approach, however, is not considered to be a here a price strategy for the purpose of gaining a net income advantage. For purposes of the research questions raised in this paper, the following four strategies were used:

1. High-price/ low volume
2. Low-price/ high volume
3. Follow the leader (net income)
4. Maintain constant price

The simulation literature is virtually void of research on how students in simulations develop a price strategy or if they in fact develop one at all. There are only three choices concerning price each period: increase, decrease, or leave price unchanged. In the first period of play, all firms have an identical starting position and history; consequently, no team can look at the performance of the other teams for any help. For whatever reason, the decision makers of each firm must choose one of the above strategies. The strategies could be all different or could be all the same. The major question at the forefront of this research is: which of the strategies is best and worst and under what conditions do these strategies work or not work? In order to experiment, an industry of four firms were created and then these strategies were assigned as follows:

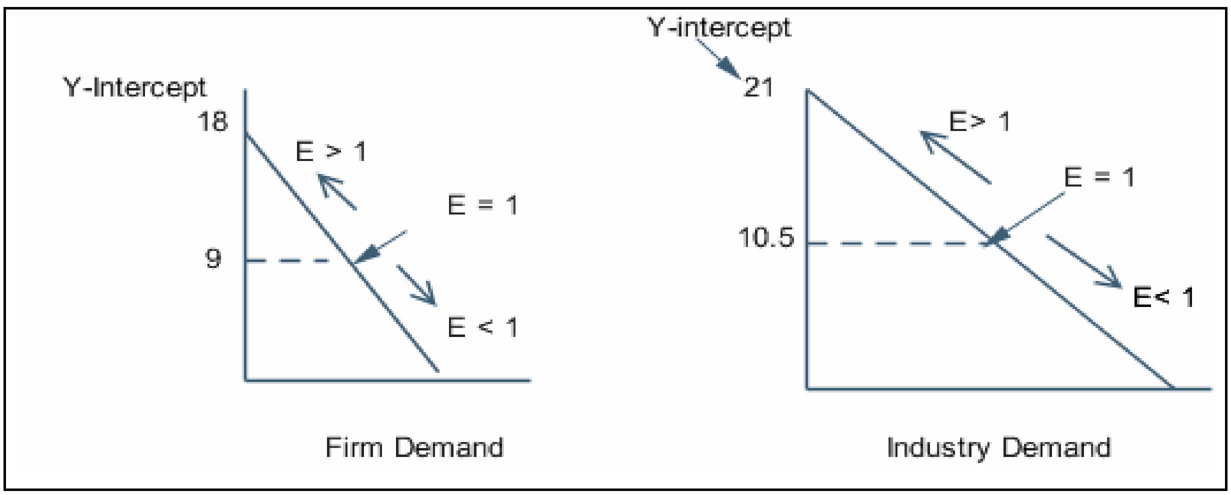
Firm 1 - High price/ low volume
Firm 2 - Low price/ high volume
Firm 3 - Follow the leader
Firm 4 - Constant price

The strategy of Firm 1 was to increase price by $1.00 each period and the strategy of Firm 2 was to decrease price by $1.00 each period. In this experiment, the simulation was run for 4 periods The net incomes for each period were noted and at the end of 4 periods, total net income was determined. At the end of four periods the firm or firms with the largest net income was determined. Since each firm had a different price strategy, the strategy that prevailed could easily be recognized. By having three different case scenarios (experiments), it was possible to determine under what conditions a given price strategy would or would not work.

Figure 3 Elasticity Zones

Initial Price and Elasticity Zones				
	Firm		**Industry**	
	Elastic Zone	**Inelastic Zone**	**Elastic Zone**	**Inelastic Zone**
1. Price may be set in	T		T	
2. Price may be set in	T			T
3. Price may be set in		T	T	
4. Price may be set in		T		T
5. Price may be set where	E = 1		E = 1	

Figure 4 Graphs of Elasticity Zones



In this illustration, the elastic zone ranges are as follows:

	Firm Demand Curve	Industry Demand Curve
Elastic zone range	$18.00 - $9.00	$21 - $10.50
Elasticity of 1	$9.00	$10.50
Inelastic zone range	$9.00 - $0.00	$10.50 - $0.00

Experiment 1

In this experiment, initial price was set at $12.00 in the elastic zone of the firm demand curve and also in the elastic zones of the industry demand curve .The Y intercept of the industry demand curve was greater than the Y intercept of firm demand. The price where E = 1 was as follows: Firm demand, $7.50 and industry demand, $10.00

Demand parameters were:

	Firm	Industry
Y-intercept	$15.00	$20.00
Slope	.05	.01

Price strategies were assigned as follows

Firm 1	High price/Low volume
Firm 2	Low price/High volume
Firm 3	Follow the leader
Firm 4	Constant price

The strategy of Firm 1 was to increase price by $1.00 each periods 2, 3 and 4 and the strategy of Firm 2 was to decrease price by $1.00 each periods 2, 3, and 4. In period 1, the price was the same for all firms. The simple simulation model developed for this research was used to process the decision strategies of the 4 firms.

Experiment 2

In this experiment, initial price was set at $7.50 At this price, the elasticity of firm demand was equal to 1. However, this same price was in the inelastic zone of industry demand. The Y intercept of the industry demand curve was greater than the Y intercept of firm demand. The price where E = 1 was follows: Firm demand, $7.50 and industry demand, $10.00.

Demand parameters were:

	Firm	Industry
Y-intercept	$15.00	$20.00
Slope	.05	.01

Price strategies were assigned as follows:

Firm 1	High price/Low volume
Firm 2	Low price/High volume
Firm 3	Follow the leader
Firm 4	Constant price

The strategy of Firm 1 was to increase price by $1.00 each period and the strategy of Firm 2 was to decrease price by $1.00 each period. The experimental simulation was run for 4 periods. The net incomes for each period was noted and at the end of 4 periods, total net income was determined. While the objective was for each firm to gain a net income advantage, in the course of the experiment the price that maximized industry net income was also determined.

Experiment 3

Initial price was set to $4.00. This price was in the zone where elasticity of the firm demand curve was less than 1. This starting price was also in the inelastic zone of industry demand. The Y intercept of the Industry demand curve was greater than the Y intercept of firm demand. The price where E = 1 was as follows: firm demand - $7.50; industry demand $10.00

Demand parameters were:

	Firm	Industry
Y-intercept	$15.00	$20.00
Slope	.05	.01

Price strategies were assigned as follows:

Firm 1	High price/Low volume
Firm 2	Low price/High volume
Firm 3	Follow the leader
Firm 4	Constant price

The strategy of Firm 1 was to increase price by $1.00 each period and the strategy of Firm 2 was to decrease price by $1.00 each period. The experimental simulation was run for 4 periods. The net incomes for each period was noted and at the end of 4 periods, total net income was determined. While the objective of the experiment was to determine which strategy gave the firm a net income advantage. net income, in the course of the experiment the price that maximized industry net income was determined.

It might appear that the objective of each firm should be to maximizes total net income of the industry. However, this is not true because the price that maximizes industry net income requires price collusion. The objective was not necessarily to maximize net income but to find a price that gave a net income advantage over the other firms.

IX. RESULTS OF PRICE STRATEGY EXPERIMENTS

The results of experimenting with different price strategies with three different demand parameters scenarios is are shown in Tables 1, 2 and 3. The results may be summarized as follows:

In the first experiment, the firm that had the largest total net income at the end of period 4 was Firm 2, which had the low-price/high-volume strategy. Because the initial price ($12.00) was set in the elastic zone of firm demand curve, this strategy of decreasing price was predetermined to be the best price strategy. Because Firm 3 was using a follow the leader strategy, this price strategy resulted in firm 3 having the second largest net income. Because the strategies of Firms 1 and 4 did not involve any price decreases, these price strategies were predestined to fail.

In the second experiment where the initial price of $7.50 was set to have a firm demand curve elasticity of 1, the firms that had the largest total net income were Firms 3 and 4. Firms 3 and 4 tied for first place. Because the initial firm price of

$7.50 had a price elasticity of 1, the strategies of increasing and decreasing price by Firms 1 and 2 were predestined to fail. In this experiment, there was no reason for any firm to change price and no advantage could be obtained by any firm changing price. Because the strategies of Firms 3 and 4 did not require any price change, the follow the leader price strategy and the constant price strategy were the right strategies to obtain a net income advantage.

In the third experiment where the initial price of $4.00 was set in the inelastic zone of the firm demand curve, the firm that had the largest net income was Firm 1. Firm 1's strategy was to increase price incrementally. Because the initial price was set in the inelastic zone of the firm demand curve, the strategy of firm 1 was predestined to succeed. The firm that had the second largest amount of net income was firm 3 with the follow the leader strategy. Because the best strategy was to increase price and because this firm was following the lead of Firm 1, Firm 3 came in second place. The price strategies of Firms 2 and 4 were predestined to fail because they involved no price changes or required price changes in the wrong direction. The results for all three experiments are shown in the table on the next page.

It is interesting to notice that the follow the leader strategy never came lower than second place and once came in first place. Except for the constant price strategy, the likelihood of the other strategies to prevail appear to be about the same. The fact that a follow the leader strategy prevailed once and overall performed better may seem surprising. However, this strategy will always prevail as long as the initial price is set to a firm demand curve elasticity of 1

X. GENERAL DISCUSSION OF RESEARCH FINDINGS

The findings of this paper will be summarized under the headings of:

1, Price collusion among firms
2. Price strategies

Price Collusion Among Firms

First of all, price collusion by definition assumes away the competitive nature of business simulations. The only strategy that exists is for the firms to meet and agree upon price. Then, thereafter, the firms can incrementally change price to see if a higher or lower price increases total industry net income.

In terms of price collusion, the best decision is to set price to have a industry demand curve elasticity of 1, assuming zero variable cost. Figure 5 shows the net income results of a collusive price strategy under three different sets of demand parameters. Regardless of the demand parameters, the price that maximizes industry net income is determined by the equation:

$$OP = \frac{(P_o + V)}{2}$$

As indicated by Figure 5, the following general rules apply:

If initial price is set in the elastic zone of the industry demand curve, then price should be decreased until the price elasticity of the industry demand curve is 1.

If initial price is set in the inelastic zone of the industry demand curve, then price should be increased until the elasticity of industry demand curve is 1

If the initial price is set to an industry demand curve elasticity of 1, then price should not be changed.

Collusion in a simulation is very difficult, if not impossible. First, since the elasticity zone of the initial price is not known, the direction of change in price is also not known. Secondly, if any firm decides to depart from the agreed upon price, then a collusive price strategy will fail. When the collusive price strategy fails, it is inevitable that the resulting total industry net income will be less then the industry net income under price collusion. In the long run, each firm will benefit the most, if the firms engage in price collusion. Any benefit from maintaining a price independence strategy and attempting to have a higher or lower price is only a temporary advantage.

Collusion takes the competitive nature and fun and out of a simulation. Simulation play is as though there is only one firm consisting of say 32 decision makers (assuming 8 teams and 4 players to a firm). However, how firms would collaborate concerning price to find and arrive at the optimum price is not clear. A lot of negotiating among the presidents of each firm would be involved. Because of the logistics involved and because an absolute consensus on price is required, the concept of collusion does not seem workable in business simulations, and if workable, perhaps the use of simulation would not be very educational.

Firm Price Independence and Firm Price Strategies

Because price collusion in a simulation is very difficult if not impossible, this leaves the condition of firm price independence as the foundation of price strategy in business simulations. If just one firm engages in price independence to gain a net income advantage, then the other firms have no choice but to also engage in firm price independence. When each firm is maintaining price independence, the best price depends on the competitors price and the firm demand elasticity zone in which price was initially set.

If the initial price is set by the game designer in the elastic zone of firm demand, then a firm can obtain a temporary net income advantage by setting its price below the price of its competitors. At long as price it in the elastic zone, the firm with the lowest price has a net income advantage.

Summary of Results of Experiments 1, 2, and 3 Total Net Income			
Firms	**1st Experiment E > 1 S.P. = $12.00**	**2nd Experiment E = 1 S.P. = $7.50**	**3rd Experiment E < 1 S.P. = $4.00**
Firm 1-rank Net income Incr. NI	(4) $5,022	(2) $8,792	(1) $7,463
Firm 2-rank Net income Decr. NI	(1) $11,785	(2) $8,792	(4) $4,378
Firm 3-rank Net income FTL	(2) $10,678	(1) $9,375	(2) $7,024
Firm 4-rank Net income MCP	3 $9,270	1 $9,375	3 $6,435

Also, if the game designer sets initial price in the inelastic zone of the firm demand curve, then a firm can obtain a temporary net income advantage by raising price. Consequently, the key to adopting a winning price strategy is to know the elasticity zone of the initial price. Without this knowledge, whether to increase, decrease, or leave price the same is a guess.

The problem is that the firm with the lowest price or highest price has only a temporary advantage. The other firms in the next period will lower or raise price to match the firm with the net income advantage. The net income advantage will then vanish. For example, in experiment 1, if Firms 2, 3 and 4 at the end of period 2 had abandoned their strategies and all played follow the leader in periods 3 and 4, the final net income of Firm 2 would have been $10,690 rather than $11,785, and the net incomes of Firms 1, 3, and 4 respectively would have been $8,968, 9,635, and $9,635 rather than $5,022, $10,878, and $9,270. By following the lead of Firm 2, Firms 1, 3 and 4 have improved their net income. For Firm 1, the improvement would be been very substantial.

If the other firms match the price decrease, then the only way for the firm seeking a net income advantage is to lower price again, assuming this firm's price is still in the elastic zone of the firm demand curve. In the case of experiment 1, the only way Firm 2 can maintain its net income advantage is to continue the price decrease. Again the only alternative for the Firms 1, 3 and 4 is to also to lower their price to match the price of decrease of firm 2. Theoretically, what will happen is a price war which will continue until the firm seeking an income advantage lowers its price to be equal to the firm demand curve where the elasticity of demand is 1. Any further price decrease by Firm 2 gives an net income advantage to the other firms

The problem with one firm continually decreasing price (assuming price is initially set in the elastic zone) and the other firms matching that price is that all firms eventually will be operating at a much lower net income level. The best price for a given firm under conditions of firm price independence is likely to be a temporary price. As soon as the prices become equal again, a further price change is required to have a net income advantage. Once price is equal to firm demand curve price where elasticity is equal to 1, there is no way without collusion for the firms to retreat to a better overall industry price. If a single firm tries to increase price, the other firms will not follow because they have now a temporary net income advantage over the firm that increased price.

The factors that affect or determine the price that gives a temporary net income advantage under conditions of firm price independence are the following:

1. Y-intercept of industry demand
2. Y intercept of firm demand
3. The price of competitors
4. Absence of collusion
5. The elasticity zone of firm demand in which starting price is placed.

The best industry collusive price and the ultimate firm independence price are actually predetermined by the game designer either deliberately or haphazardly. In terms of our experiment with the four different price strategies, depending on where price was initially set, some of the strategies were predestined to win and some to lose. Experiments 1, 2 and 3 revealed that no one strategy is necessarily better than another. All strategies used at one time or another prevailed as the best strategy for generating a total net income greater than the total net income of its competitors.

XI. PRICE STRATEGY: RULES AND GUILDELINES

Based on the research of this paper, the only general rules for selecting a price strategy are the following:

Figure 5 Collusive Price that Maximizes Industry Net Income			
	Demand Parameters Y-Intercepts: Firm - $15 Industry - $20 Slope: Firm - .05 Industry - 01 E = 1 at a price of $10.00	Demand Parameters Y-Intercepts: Firm - $15 Industry - $30 Slope: Firm - .05 Industry - 01 E = 1 at a price of $15.00	Demand Parameters Y-Intercepts: Firm - $30 Industry - $15 Slope: Firm - .05 Industry - 01 E = 1 at a price of $7.50
Collusion Price	**Industry net income**	**Industry net income**	**Industry net income**
$14.00	$8,400	$5,600	$1,400
$13.00	$9,100	$5,525	$2,600
$12.00	$9,600	$5,400	$3,600
$11.00	$9,900	$5,225	$4,400
$10.00	$10,000	$5,000	$5,000
$ 9.00	$9,900	$4,725	$5,400
$8.00	$9,600	$4,400	$5,600
$7.50	$9,375	$4,219	$5,625
$7.00	$9,100	$4,025	$5,600
$6.00	$8,400	$3,600	$5,400

Low-price /high-volume works best if price is initially set high in the elastic zone of firm demand.

High- price/low- volume works best if price is initially if set low in the inelastic zone of firm demand.

The follow the leader strategy works best when the price was set at a firm demand curve elasticity of 1.

The follow the leader strategy does not mean blindly following another firm. It means only following the another firm as long as it is maintaining a net income advantage. Because the leading firm may go too far and decrease price into inelastic zone and because the follow the leader lags one period behind, the follow the leader may actually become the net income leader eventually.

The constant price strategy works particularly well when the game designer has set the initial price where the price elasticity of the firm demand curve is equal to 1. There is no advantage for any firm to increase or decrease price. Holding price constant is the correct strategy and this strategy will prevail if the other firms change their pries.

No hard or fast rules can be given for selecting a price strategy. Only if each firm knows the demand parameters can the best strategy be initially selected. In absence of any knowledge of the demand curve parameters, the various firms are no worse off to choose a price strategy by simply tossing coins. Since the right strategy can not be immediately known, then luck is the big factor. However, after one period of play there may be clues to the demand curve parameters. For example, price may be in the elastic zone of firm demand:

1. If income of one or more teams increased because of a price decrease
2. If income of some firms teams decreased after a price decrease by one or more firms.

If a firm has chosen the wrong strategy and it is clear that the strategy is wrong, then this strategy should be quickly abandoned. What strategy then should be adopted? Actually, after the first period of decision making and execution and it is clear that the strategy used should be abandoned, there are only two viable choices concerning price strategy:

A. Play follow the leader
B. Out perform the net income leader by making a larger price change each period

Trying to out perform the firm leading in total net income by making larger changes in price can be dangerous. Since the price at where elasticity is equal to 1 is not known, any large price change can easily fall into the inelastic zone of firm demand. When this happens the net income advantage by default goes to the firm that made the smaller price decreases.

The analysis is this paper was based on a simple simulation model where price was the only active decision. Although this model had the potential for an advertising decision, this feature was not used in the course of experiments 1, 2 and 3. What if other decisions such as advertising may be made? In this event the analysis of price is not easy or perhaps impossible. It may be that an improvement in net income was due to an increase in advertising rather than a change in price. So how does a firm approach a marketing strategy when multiple marketing decisions may be made? Again, an incremental approach again obvious. The strategies might be to increase or decrease price by say $1.00 each period and increase advertising by 10% each period. Such incremental changes should continue to be made until net income is adversely affected.

However, under these conditions determining if the price strategy or the advertising strategy is working would not be easy. For example, if Firm 1 out performs Firm 2, it can not necessarily be concluded that both the price strategy and advertising strategy of Firm 2 was inferior. The price strategy of Firm 2 might have been better while is advertising strategy was poorer. In this event, playing follow the leader becomes difficult. Even with two or more market demand decisions, the element of luck or chance seems to be the overriding factor.

The problem is that it is not known how sensitive individual market decisions are to changes. As the number of marketing decisions increase the more difficult it is to develop a business strategy. Again, given multiple market demand decisions, the success or failure of a business strategy is actually predetermined by the game designer. Regardless of the number of market demand decisions, at the outset it appears that one strategy has the same probability of success as any other strategy. The attempt to win a simulation in terms of net income based on price changes is a shot in the dark and at best a trial and error procedure.

The research findings of this paper seem to suggest that there are few, if any, reasons to reward participating students based on winning or performance. Performance by whatever measures of profitability can largely be an element of luck, even when all participating students are doing their best to perform well. Any firm that gets an advantage at the beginning is most likely to continue to prevail, unless the adoptive strategy is carried too far.

XII. SUMMARY

The concept of a using a well-defined price strategy on the surface seems desirable. However, as the results of the research reported in this paper has indicated that a price strategy that gives one firm an advantage over another is strictly a matter of chance rather than skill, assuming that all firms have an equal understanding of the concept of demand elasticity. Firms that understand elasticity better might have some advantage; however, at the start no firm has a knowledge advantage, because none of the demand parameters are known. The most important person in developing a price strategy, it appears is the game designer who initially sets the demand parameters.

Because the demand parameters are preset and not subject to change during the course of simulation play, the winning price strategy is also predetermined. Winning appears to be a matter of chance, assuming participants have an equal abilities and equal desire to win. An important issue arises concerning the evaluation of simulation performance. When is good performance due to chance and when is it due to superior analysis and decision-making? Does winning because of luck deserve the best grade?

Best performance by whatever measure, whether it be net income, market share, or return on investment seems to be a nebulous concept in business simulations. Based on the result of the research reported in this paper, there is no reason at all to believe that teams that have performed the best have learned the most. Whatever value simulations contribute to learning, this learning should not be necessarily associated with best performance. Perhaps learning should be associated with effort that is more under the control of the instructor and the course objectives. It might then argued that we should attempt to measure the amount of effort put into a simulation under some kind of direction. By a judicious use of enrichment techniques the instructor can compel students to engage in productive simulation assignments that achieve the objectives of the course. How to measure effort then becomes the challenge.

Many simulation users and game designers have recognized that luck may play a role. As the research f this paper has shown, luck plays the major role concerning price as most likely it does with other market demand variables such as advertising and research and development. These two variables like price are parameters under the control of the game designer and the original parameters set for then determine the sensitivity of these variables to change. The questions then becomes: what decisions in a business simulation are subject to analysis and control by the simulation participants?

Because a team has correctly selected the right price strategy immediately such as high-price/low-volume. there is no guarantee that this price strategy will prevail. While the demand quantity generated gives a net income advantage, net income is also dependent on another decision and that decision is production. Net income is dependent also on inventory being available. Assuming no beginning inventory, production must be equal to allocated industry demand. Otherwise, actual sales will be less than allocated industry demand. The consequence of inadequate production is lost sales. Production is one area in a simulation that simulation participants are likely to have adequate information and have the ability to control.

Table 1 Best Price Strategy Experiment 1

Starting price - $12.00 (Elasticity > 1)

	Firm Demand	Industry Demand
Y-intercept	15	20
Slope	.05	.01

Strategy:

- Firm 1 - Increases price by $1.00
- Firm 2 - Decreases price by $1.00
- Firm 3 - Follow the leader
- Firm 4 - Constant price

	P-1	P-2	P-3	P-4	Total
Firm 1					
Price	12.00	13.00	14.00	$15	(4)
Net income	2,400	1,733	888	0	5,022
Firm 2					(1)
Price	12.00	11.002,43	10.00	9.00	
Net income	2,400	3	3,133	2,379	11,785
Firm 3					(2)
Price	12.00	12.00	11.00	10.00	
Net Income	2,400	2.400	2,792	3,036	10,678
Firm 4					(3)
Price	12.00	12.00	12.00	12.00	9,270
Net income	2,400	2,400	2.285	2,186	
Average price	12.00	11.67	11.00	10.33	
Total NI	9,600	8,966	9,138	8,500	36,735

Note: Numbers in ( ) in total column indicates net income rank.

Table 2 Best Price Strategy Experiment 2

Starting price - $7.5 (Elasticity = 1)

	Firm Demand	Industry Demand
Y-intercept	15	20
Slope	.05	.01

Strategy:

- Firm 1 - Increases price by $1.00
- Firm 2 - Decrease price by $1.00
- Firm 3 - Follow the leader
- Firm 4 - Constant price

	P-1	P-2	P-3	P-4	Total
Firm 1 Price Net income	7.5 2,344	8.5 2,302	9.5 1,969	10.5 1,969	(2) 8,792
Firm 3 Price Net income	7.5 2,344	7.5 2,344	7.5 2,344	7.5 2,344	(1) 9,375
Firm 4 Price Net income	7.5 2,344	7.5 2,344	7.5 2,344	7.5 2,344	(1) 9,375
Average price	7.5	7.5	7.5	7.5	
Total NI	9,376	9,292	9,092	8,626	36,334

Note: Numbers in ( ) in total column indicates net income rank.

Table 3 Best Price Strategy Experiment 3

Starting price - $ 4.00 (Elasticity < 1)

	Firm Demand	Industry Demand
Y-intercept	15	20
Slope	.05	.01

Strategy:

Firm 1 - Increases price by $1.00
Firm 2 - Increase price by $1.00
Firm 3 - Follow the leader
Firm 4 - Constant price

	P-1	P-2	P-3	P-4	Total
Firm 1					
Price	4	5	6	7	(1)
Net income	1,600	1,818	1,978	2,067	7,463
Firm 2					
Price	4	3	2	1	(4)
Net income	1,600	1,309	952	507	4,378
Firm 3					
Price	4	4	5	6	(2)
Net income	1,600	1,600	1,831	1,993	7.024
Firm 4					(3)
Price	4	4	4	4	
Net income	1,600	1,600	1,612	1,624	6,435
Average price	4	4.25	4.5	4.5	
Total NI	6,400	6,307	6,373	6,191	

:

Note: Numbers in ( ) in total column indicates net income rank.

Participants generally know existing plant capacity and have the information necessary to expand to expand plant capacity. To generate sufficient production, the simulation participants need to carefully evaluate safety stock and, required capacity, Sales forecasting and production budget planning is required. While some element of luck no doubt resides in the production function area of decision-making, careful attention and planning to production can easily override the luck element. Furthermore, to the extent that the simulation allows decreases in material and labor costs, good production decisions also permit a lower price to be set.

If we assume, however, that all firms make production decisions appropriate to their strategy, then the winning firm in a business simulation is primarily a matter of luck. This conclusion does not mean that business simulations are not a valuable teaching and learning tool. It does means, however, that assuming winning and profit performance learning are synonymous is a questionable premise.

APPENDIX: CREATING A DEMAND ALGORTHM FOR BUSINESS SIMULATIONS

In business simulations, demand is also affected by other decisions including advertising, research and development, quality control expenditures. In this paper, the focus of research is the price decision and, consequently, the advertising and other marketing decisions are not directly considered.

A demand curve in essence is a mathematical equation and for this reason demand curves have several mathematical properties. The mathematical properties useful in this paper may be summarized as follows:

Linear Demand Curve	Curvilinear Demand Curve
Y-intercept	Price Exponent
Slope of line	Scale factor
Scale factor	Elasticity factor

In Figure 1 the Y-intercept is 20. In Figure 2, there is no Y-intercept because the demand curve is asymptotic to the X and Y axis of the demand curve graph.

The mathematical equations for figures 1 and 2 are as follows:

Linear **Curvilinear**

$$P = \left(P_o - KS(Q)\right) \quad (1)$$

$$Q = \left(\frac{1}{\left(\left(p^N + E\right)\right)(S)}\right) \quad (2)$$

$$Q = \frac{(P_o - P)}{(KS)} \quad (3)$$

Where:

P	-	Price
Po	-	Y-intercept
K	-	slope of the line
N	-	exponent value
E	-	Elasticity factor
S	-	Scale factor

How the Demand Algorithm in Business Simulations Works

The first set of calculations made in a business simulation model involves firm demand and market demand. How this works generally will now be summarized:

Step 1 Firm demand is computed based on the firm demand curve. Initially all firms in the simulated industry have identical firm demand curves.

Step 2 Based on the average price of the firm prices, industry demand is computed.

Step 3 Based on the demand of each firm, allocation percentages are computed.

Step 4 Based on the allocation percentages, industry demand is allocated to each firm.

The interaction of firm demand and industry demand is quite complex. If the demand curve parameters are not properly set, then critical anomalies can happen. Changes in price can cause changes in allocated industry demand that are contrary to theory and normal expectations. (Goosen, 2007)

Revenue and cost functions

The objective of making a good price decision is more than creating gross revenue. The ultimate objective of a firm is to generate net income. A fundamental tenet of economic price theory is that there exists, other things equal, a price that will maximize net income. One of the basic question of this research is: It is possible for students in the course of simulation play find the this optimum price? To answer this question, the nature of net income in economic theory needs to be developed further here.

Revenue in both accounting and economic theory is simply price times quantity

$$R = P(Q) \quad (4)$$

Where:

R	-	Revenue
P	-	Price
Q	-	Quantity

Cost or expenses is defined in economic theory as consisting of two components:

1. Variable cost
2. Fixed cost

Mathematically:

$$TC = V(Q) + F \tag{5}$$

where:

TC	-	total cost
V	-	variable cost rate
Q	-	quantity
F	-	fixed cost

Net income may also be simply defined as follow:

$$NI = R - TC \tag{6}$$

Using equations 4 and 5 net income may be restated as follows:

$$NI = P(Q) - V(Q) - F \tag{7}$$

Using equation 3 $Q = \frac{(P_o - P)}{(KS)}$ equation 3 may be further refined as follows:

$$NI = \left(P \frac{P_o - P}{(K)(S)} \right) - V \left(\frac{P_o - P}{(K)(S)} \right) - F \tag{8}$$

By using calculus we can determined the equation that allows us to make the optimum price

The equation that results is:

$$OP = \frac{(P_o + V)}{2} \tag{9}$$

The derivation of this equation has been previously described in a paper presented at AB SEL (Goosen, 1986)

The tools are now in place to develop a simple simulation which involve:

1. Equation for a firm demand curve
2. Equation for an industry demand curve
3. Equation for computing net income

Based on these equation a simple three decision was developed was developed. The simulation was developed to be used as a research tool in doing what-if analysis for changes in price.

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