The Effect of Simulation Starting Decisions and Optimum Decisions on Firm Profit Dominance

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ABSTRACT

The purpose of this paper is to present the results of experiments involving the relationship of starting decisions to optimum decisions and in particular the effect on firm strategy and profit. Each experiment involves starting decisions being significantly different from optimum decisions or equal to optimum decisions. The primary object of the experiments was to determine if starting decisions could predetermine which decision strategy would be the dominant strategy. The results of the experiments clearly supported the hypothesis that the placement of starting decisions had a major impact on dominance and also the amount of profit.

INTRODUCTION

Every business simulation has a set of starting decisions. At time zero, these starting decisions are the same for all firms. Starting decisions are the final set of decisions made by the game designer. As explained by Goosen (2016, Teach 1990, Rogue 1997), there also exists in most simulations, if not all, a set of optimum decisions unknown to students and most likely not even known to the simulation creator. The purpose of this paper is to present the results of experiments involving the relationship of starting decisions to optimum decisions and in particular the effect on firm strategy and profit. Each experiment involves starting decisions being significantly different from optimum decisions or equal to optimum decisions. The reader is encouraged to read Goosen's 2016 paper concerning how optimum decisions can be found.

The reason starting decisions are important , as the results of the reported experiments in this paper show, is because they can have a significant impact on the effectiveness of different firm strategic decisions and also have a significant impact on firm profit. Also as will be demonstrated, starting decisions can cause one set of strategic decisions to be more effective than another set and, consequently, result in one firm being the dominant profit firm. One of the major issues in business simulation usage concerns the question of whether it is acceptable for one firm to be the dominant profit firm in all or most periods of play. Teach (2007) has argued that persistent dominance is unfair. Others Wolfe, Biggs, Gold (1013) have argued that dominance is not as prevalent as some perceive. This paper will present evidence that not only is dominance fair but also should be expected.

DOMINANCE IN SIMULATION PLAY

Dominance in simulation play became an issue when Patz (1999) raised the issue.

> All of this raises several key issues. First, why bother with a semester long competition when the final results can be predicted after a few trials? Second, are there flaws in the algorithms that drive these simulations, flaws that prohibit the recovery of teams with poor early performance? Third, what, if any, learning occurs after a few trials? This last question can be asked for all teams.

Teach (2007) raised the same issue.

> But there are other issues in scoring participants performance based upon profits. If the same firm constantly has the greatest cumulative profits, round after round, something is amiss. That would indicate that performance in the first (or second or third) round dominates the remainder of the competition. This could be interpreted by the players (except for the first place team) that the game is unfair. It would clearly indicate that early leaders have an unfair advantage when the course grades are posted.

The existence of dominance in Patz's use of business simulation may have existed only with his students and how he administered his use of the simulation. The question of whether dominance existed in other simulations and perhaps all usage of simulation was explored by in depth by Bernard and Souza. Ed Souza and Bernard (2009) researched 495 simulations and 3,953 simulated companies.

Their conclusion was:

> The dominance is present in all competitions analyzed; that is, academic competitions, general competitions, both using manufacturing and retailing simulations. Further, no significant differences were found in terms of dominance in academic competitions versus general competitions and in manufacturing competitions versus retailing competitions. Combined

results indicate that dominance does exist in the business games competitions analyzed.

However Wolfe, Biggs, Gold (2013) examined the issue of dominance in the use of the Capstone Simulation. They concluded that dominance in this simulation was not as serious as contended by Teach.

Figure 8 shows that none of the first-place finishes were determined until 40% of the game had reached their seventh round. The remaining finishes had to wait until the game's last round for first place to be determined.

Biggs and Fritzsche in a study of dominance in business simulations by simulation firms involved in the Business Policy Game Competition did not find any significant dominance as found by Teach (2007) Biggs and Fritzsche (2010).

Expressed as a hypothesis, the objective of the research presented in paper may be stated as follows: The values assigned to the set of starting marketing decisions predetermine which firm's strategy will be the profit leader when supporting production decisions are free of errors. The profit leader either in the majority of simulation periods or in total profit is designated the dominant firm.

RESEARCH METHODOLOGY

In order to conduct experiments concerning the relationship of starting decisions to strategic decisions, a research oriented business simulation was developed. The details of this simulation including parameters and the demand algorithm are presented in the Appendix. This simulation is a moderately simple simulation consisting of twelve decisions in which three are marketing decisions: price, advertising, research and advertising. The decisions are interactive and, consequently, the four firms operate in an oligopoly industry. Only the marketing strategy decisions were investigated and changed because production and financial decisions depend on the basic marketing decisions. Production decisions are not a determinant of industry demand; however, the reverse is true. In all experiments, the production decisions were made appropriate to the sales forecast. Consequently, no errors existed regarding material purchased and labor hired. Production errors were eliminated in order to not distort the effect of starting decisions on profit.

The basic difference between this research oriented simulation and a typical total enterprise simulation is that the output was presented in a comparative way. The side by comparison of results of all firms made it easier to analyze the results (see Figure 3 in the Appendix). Also, the simulation generated output data not normally found in most typical simulations. The simulation is interactive and based on a demand algorithm that is appropriate to an oligopoly industry. The demand algorithm used is explained in some detail in Goosen (2016).

Each firm made the same strategic decisions in the three experiments. In any simulation regarding price, advertising and R & D, the only options are: increase, decrease, or leave the same. The decisions made in the experiments are labeled strategic because after the decision to increase or decrease has been made, the next decision is to determine by how much to increase or decrease the decisions each period. For example, if Firm 1 decides to decrease price by $2 each period of play and starting price is $390, then price in period 6 would be $378 ($390 - (2 * 6). The strategy then is to determine whether to increase or decrease and then by how much.

If the decision is made to not change a marketing decision, then, of course, there is no decision to be made regarding how much to change. It is generally agreed that a strategy should not be quickly abandoned (Teach 2007) and for this reason in the experiments, no firm made a switch to another set of strategy decisions. In the experiments, each of the four firms had a different strategy which ranged from conservative to aggressive. In experiment 1-3, no changes were made in the strategy of each firm. The only change made in each experiment was the starting decisions of the simulation. As will be seen, the change in starting decisions had a dramatic effect on profits and also on which firm became the dominant firm.

The optimum decisions for all three experiments were determined to be: Price- $407; Advertising-$200,000, Research and Development-$200,000. For an explanation of how optimum decisions can be found see Goosen (2016).

	Firm 1	Firm 2	Firm 3	Firm 4
Price strategy	($2)	($4)	($6)	($8)
Advertising strategy	$5,000	$10,000	$15,000	$20,000
Research and Development	$5,000	$10,000	$15,000	$20,000

EXPERIMENT 1

In this experiment, the starting price, advertising, and research and development were set at $450, $50,000, $50,000 respectively. Firm strategies were as shown above. The marketing decisions of Firm 1 in period 1 were: Price- $448, Advertising- $55,000, R & D- $55,000. If desired, the decisions for al l firms for six periods can easily be computed by strictly observing the

strategy of each firm.

The profit results of experiment 1 are shown in Exhibit I. The decision strategy of Firm 4 which was the most aggressive strategy proved to be the dominant strategy in all periods and also in total profit. Because the starting decisions were significantly different than optimum decisions (price $407.50; advertising and R & D $200,000), the placement of starting decisions allowed the aggressive strategy of Firm 4 to be the dominant profit leader in all periods. The conservative decisions of Firm 1 resulted in this firm placing 4th in all periods. In addition to placing last, Firm 1 also experienced declining profit each period. This is primarily because its market share declined from 25% to 17.5%. A firm with greater advertising and a lower price will have a higher market share but not necessarily a larger profit. Firms 3 and 4 in this experiment, the two firms with the most aggressive decision strategy, had increasing profits each year.

EXHIBIT I
STARTING DECISIONS:
PRICE ABOVE OPTIMUM PRICE; ADVERTISING AND R & D BELOW OPTIMUM

(Numbers in parenthesis represent profit rank)
Decisions for Firm 1 in period 1 were as follows: Price-

Quarter 1		Firm 1	Firm 2	Firm 3	Firm 4	Total
	Net income	$819,026 (4)	$850,266 (3)	$886,591(2)	$919,187 (1)	$3,475,070
Quarter 2						
	Net income	$771,639 (4)	$832,122 (3)	$902,277(2)	$965,696 (1)	$3,471,734
Quarter 3						
	Net income	$749,653 (4)	$841,994 (3)	$923,225(2)	$1,016,01 (1)	$3,530,883
Quarter 4						
	Net income	$737,826 (4)	$841,697(3)	$955,858 (2)	$1,053,89 1(1)	$3,589,272
Quarter 5						
	Net income	$708,711 (4)	$844,626(3)	$957,981 (2)	$1,058,829 (1)	$3,660,157
Quarter 6						
	Net income	$697,814 (4)	$846,603 (3)	$960,8856(2)	$1,035,411 (1)	$3,540,713
		$4,475,667 (4)	$5,057, 308 (3)	$5,586,818 (2)	$6,049,025 (1)	

EXPERIMENT 2

In this experiment, the starting decisions were set to be equal to optimum decisions: Price - $407, advertising - $200,000; and R & D - $200,000. The marketing decisions strategy remained the same as in experiment 1.

As explained by Goosen (2016), industry profit is at a maximum when all firms all make optimum decisions; that is, all firms make the same optimum decisions, assuming each firm has the same variable cost rate. In this experiment, all firms maintained the same decision strategy used in experiment 1. The only change made in this experiment was the change in starting decisions.

A close examination of the results of this experiment (see Exhibit II) show that Firm 4, the dominant firm in experiment 1, was the dominant profit leader only in period 1. In the remaining periods, Firm 4 was last in profit for each of the remaining five periods. In this experiment, each firm was the dominant profit firm at least once. Firm 2 was the dominant profit firm in periods 4 and 5 and Firm 3 was the profit leader in periods 2 and 3. In period 6. Firm 1 became the overall profit leader even though it was the period by period leader only once. In the first experiment, Firm1's strategy resulted in the firm placing last in every period, but now the change in starting decisions allowed Firm 1's strategy to become the dominant firm in total profit. The most unusual result from this experiment was that all firms were a dominant profit leader at least once. Technically, Firm 1 wasn't a dominant firm because it was not the profit leader in the majority of periods. It would appear that in order to not have the same firm being the profit leader each period that starting decisions should be made equal to optimum marketing decisions.

The reason profit of all firms decreased in all six periods is because the strategic decisions when implemented resulted in the decisions becoming increasingly farther from the optimum decisions. As explained by Goosen (2016), when all firms make departure decisions in the same period, the profit of each firm will decrease. An exception occurs when only one firm makes departure decisions and the other firms do not. In this event, the departure firm may increase its profit under certain conditions. However, for the solo departing firm, there exists a floor and ceiling to departure decisions. A floor exists for price and a ceiling for advertising and R & D. If the departing firm sets price below this floor and makes advertising greater than the ceiling, the decisions of the departing firm will cause a decrease in its profit. However, this strategy works only if the other firms in the same period do

not make departure decisions from the optimum decisions. Increases in profit from decision-making are the expected norm by students.

In this experiment, all firms each period made departure decisions each period. Consequently, the favorable departure zone for an individual departing firm no longer existed and the result of all firms making departure decisions from optimum decisions was decreasing profits each period...

Because the starting decisions were set equal to optimum decisions, the decision strategy that worked for each firm in experiment 1 was the wrong strategy in experiment 2. The right strategy would have been to hold all decisions the same for all six periods. However, holding decisions constant would defeat the advocated purposes of using business simulations. In actual simulation play, student teams have no knowledge of optimum decisions nor would have understood the consequences of making departure decisions from optimum decisions. The natural inclination of simulation participants would be to decrease price and increase advertising as was the case in this experiment

EXHIBIT II
STARTING DECISIONS ARE MADE EQUAL TO OPTIMUM DECISIONS

(Number in parenthesis represent firm profit rank)

		Firm 1	Firm 2	Firm 3	Firm 4	Total
Quarter 1						
	Net income	$853,854 (3)	$855,200 (2)	$ 849,769 (4)	$860,566 (1)	$3,419,389
Quarter 2						
	Net income	$785,847 (3)	$795,707 (2)	$ 796,949 (1)	$785,400 (4)	$3,239,068
Quarter 3						
	Net income	$754,738 (2)	$753,525 (3)	$ 757,604 (1)	$727,886 (4)	$3,993,753
Quarter 4						
	Net income	$726,932 (2)	$728,297 (1)	$ 688,358 (3)	$ 649,427 (4)	$2,793,014
Quarter 5						
	Net income	$701,255 (2)	$702,902 (1)	$ 672,649 (3)	$ 634,403 (4)	$2,711,200
Quarter 6						
	Net income	$677,568 (1)	$660,299 (2)	$ 628,409 (3)	$ 617,012 (4)	$2,483,348
		$4,500,193 (1)	$4,495,930 (2)	$4,393,788 (3)	$4,174,694 (4)	

EXPERIMENT 3

In this experiment the starting decisions were as follows:

Price- $390 Advertising - $250,000 R & D - $250,000.

Optimum decisions remained the same the same as in experiments 1 and 2.

The purpose of this experiment was to determine the consequences of the same decision strategies used in experiments 1 and 2 when the starting decisions are not in the optimum zone. The starting price in this experiment is less than optimum and advertising and R & D are greater than optimum.

In this experiment, Firm 1 was the dominant profit leader in each period; however, being the leader is greatly diminished by the fact that the profit of Firm 1 decreased each period. Firm 4, the profit leader in experiment 1, placed last in each period. All firms experienced successive profit decreases. Clearly, the decision strategy of each firm again was the wrong strategy. When starting decisions are placed in non optimum decision zones and the strategy is to continue to decrease price and increase advertising and R & D, then the inevitable consequences are decreasing profit. The reason why Firm 1 was eventually the profit leader is because its strategy resulted in smaller decreases in price and less increases in advertising and R & D.

What makes this experiment different is that all three starting marketing decisions were beyond the range of optimum decisions . Theoretically, if actual students were aware of this fact, then no team would realistically decrease price more or increase advertising and R & D further. The more logical strategy would be to increase price and decrease advertising and R & D.

The primary objective in simulation play is normally to make decisions that increase profit from period to period. Students

are usually advised that simulation participation is rewarded based on profit or some measure of profit such as return on investment. Obviously, the results of experiment 3 show that the strategies of the four firms were ineffective in this regard. Clearly, the change in starting decisions in this experiment had a profound negative consequence on profit.

EXHIBIT III
STARTING PRICE BELOW OPTIMUM; ADVERTISING AND R & D GREATER THAN OPTIMUM

(Numbers in parenthesis) represent profit rank)

		Firm 1	Firm 2		Firm 3	
Quarter 1						
	Net income	$717,347 (1)	$715,014 (2)	$709,435 (4)	$713,007 (3)	$2,855,803
Quarter 2						
	Net income	$679,842 (1)	$669,707 (2)	$651,881 (3)	$638,126 (4)	$2,714,437
Quarter 3						
	Net income	$660,516 (1)	$635,361 (2)	$614,438 (3)	$581,302 (4)	$2,491,616
Quarter 4						
	Net income	$624,982 (1)	$600,975 (2)	$561,712 (3)	$516,203 (4)	$2,303,672
Quarter 5						
	Net income	$589,301 (1)	$554,360 (2)	$511,578 (3)	$443,978 (4)	$2,099,217
Quarter 6						
	Net income	$574,712 (1)	$523,684 (2)	$422,116 (3)	$371,459 (4)	$1,891,970
		$3,846,699 (1)	$523,684 (2)	$3,471,159 (3)	$3,264,074 (4)	

SUMMARY

In experiment 3, Firm 1 was the profit leader in all six periods and Firm 4 was the profit leader in for all periods in experiment1. In the Teach and Patel study (2007) and also in the Wolfe, Biggs, and Gold study, the cumulative profit leader was not the profit leader in every period. According to Wolfe, Biggs, and Gold (2013) the profit leader emerged on the average in the 4th period. In two of the three experiments, the dominant profit firm led in every period. In experiment 3, all firms made decisions in the non-optimum zone. Firm 1's price in period 6 was $378 ($390 - ($2 * 6)) and its advertising and R & D was ($250,000 + 6 * $5,000). Even though the price of Firm 1 was well below the optimum price, its price was higher than the price of the other three firms and advertising and R & D was less.

The most unusual results happened in experiment 2. Every firm was the profit leader at least once. The starting decisions in experiment 2 were made equal to optimum decisions and were it possible for all firms to have known this relationship, the best decisions to make would have been to leave all decisions equal to optimum decisions each period. However, in the experiment, all firms faithfully followed their strategic plan. As a result, Firm 1 with the most conservative strategic incurred the least decline in profit. It would appear that to make it difficult for any firm to be a dominant firm the best approach would be to make starting decisions equal to optimum decisions. However, as experiment 2 revealed, it then would be difficult for any firm to show increasing profits.

A question may be asked as to why Firm 4 was the dominant leader in experiment 1. Firm 4 had the most aggressive strategy. Starting price of $450 was significantly greater than the optimum price of $407 and the starting advertising of $50,000 and the starting research and development of $50,000 was significantly below the optimum advertising and R & D. In period 6, the price of Firm 4 was $402 (450 - (6 * 8)) and advertising and R & D were $170,000 ($50,000 + (6 * $20,000)). Because of the favorable relationship of starting decisions to optimum decisions, the opportunity for Firm 4 to have an aggressive strategy for price, advertising, and R and D existed.

In actual simulation play, the best set of strategic decisions may fail because the necessary production decisions were poorly made, If demand is forecasted correctly as 10,000 units but production is set at 7,000 units, then profit will suffer greatly because of a large stock-out. In actual simulation play. it may be difficult to determine whether a strategy is sound when production decisions are poorly made. The decision strategy may be sound, but other decisions may have a negative effect on profit. In order to determine the effectiveness of the decision strategies in each experiment, the production decisions were not allowed to be other than correct.

The three experiments presented here support the hypothesis that the placement of starting decisions predetermine which

strategy will lead a firm to be the dominant profit firm given that appropriate production decisions are made.

In experiment 3, Firm 1 became the dominant firm even though its profits declined each period as did the profit of the other three firms. It is difficult to understand why any dominant team should be given a grade reward based on profit when in fact profit has been declining. Welling and Faria (2007)in their paper "Are Good Decisions Consistently Good? A Real Time Investigation" presented a table showing average profit of 423 teams over eight periods:

Period	Profit	Period	Profit
1	$202,689	5	($179,670)
2	$47,866	6	($275,443)
3	$31,580	7	($272,174)
4	$71,677	8	($277,819)

As the above data shows, the average profit decreased each period and then beginning in period 5 significant losses incurred in each period. While their paper showed that the best strategy in an industry would again prevail in another industry, no explanation was given why the strategies of the non-optimal firms failed to improve profit. Were the strategies of the non optimal teams that bad or was there something in the simulation used like starting decisions being in a non optimum zone? The results of experiments 2 and 3 could be the explanation for the decreasing profit in the Wellington's and Faria's paper (2008).

CONCLUSION

The basic finding of this research is that dominance by a firm in simulation play should be considered normal when the firm has the superior strategy. However, a decision strategy will be superior only when the relationship of starting decisions to optimum decisions is favorable. Depending on the positioning of starting decisions relative to optimum decisions, a firm's strategy may result in the firm being the profit leader and at other times be the last place firm.

Given that students as well as instructors never know what the optimum decisions are the issue that arises now is: should simulation creators be required to compute optimum decisions and also explain the distance between starting decisions and optimum decisions? If starting decisions are important in making strategic decisions, then simulation performance evaluation should be improved by an understanding of this relationship.

A second issue of fairness still exists. According to Teach (2007), profit dominance by a firm is unfair and may result in other firms giving only token interest in simulation play. If this happens then as Teach asks: "what learning can occur?" The three experiments in this study clearly indicate that when a firm has the superior decision strategy it can and will be the profit leader. The issue of unfairness should not be made against firm dominance when the firm is the profit leader because of a superior strategy. The business simulation literature, particularly in ABSEL, are replete with statements that business simulations are important to students in teaching the fundamentals of business strategy. When a strategy proves to be superior and the firm has dominance, it would appear that this proves the underlying fundamentals of business strategy theory. The importance of using business simulations in business strategy courses was made clear in a study by Faria and Wellington (1996). In this study it was revealed that 67% of all business strategy courses involve the use of a business simulation. Students that understand business strategy theory should be expected to perform better in simulation play. Based on the results of the three experiments presented in this paper, a strategy that results in profit dominance should be accepted as normal and fair.

The use of a business simulation may be used for a variety of purposes. Because a student team placed last or low in the profit rankings does not mean "learning" has not occurred. However, given the emphasis on profit or net income in accounting and economics and other business administration courses, it is hard to deemphasize profit as the primary goal of simulation play. The desire to outperform other teams may be inevitable even if simulation play is not rewarded based on profit.

The research presented in this is seminal in nature. Additional theoretical research of the type reported here should be done to confirm the conclusions presented in this paper.

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APPENDIX

The main features of the research oriented simulation used in this paper are shown in Exhibits 1 and 2. Exhibit 1 shows all the parameters of the simulation. All parameters may be changed at any time. Also, Exhibit 1 shows the values assigned to the advertising function and the research and development function. Advertising percentages and R & D percentages between assigned advertising and R & D are found by interpolation.

The equation used for computing industry demand is:

Industry demand = ((Po - P)/K) * (1 + RD %)

Po = 600
K = .01
P - Average industry price

At advertising of $50,000 the advertising percentage would be 15%
At research and development of $50,000 the RD% would be 10%.

FIGURE 1

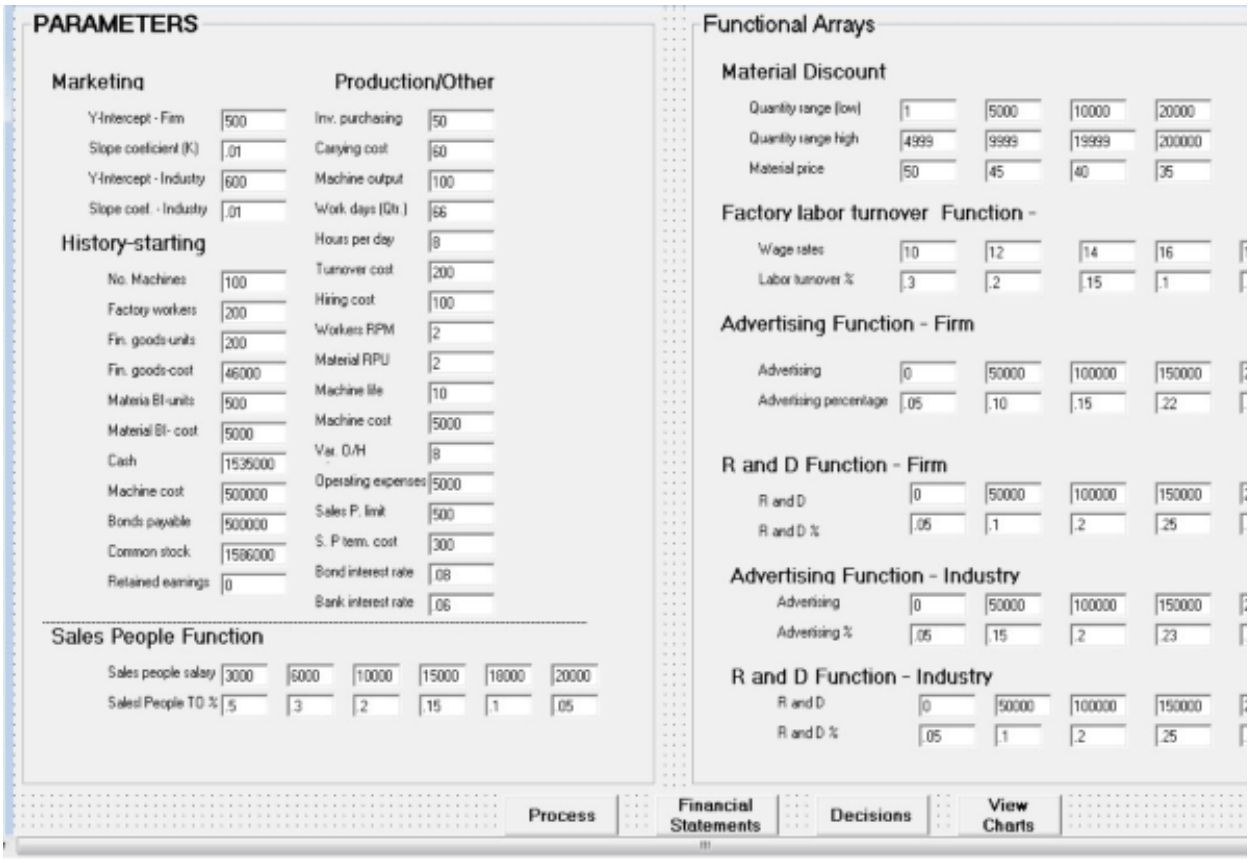

FIGURE 2

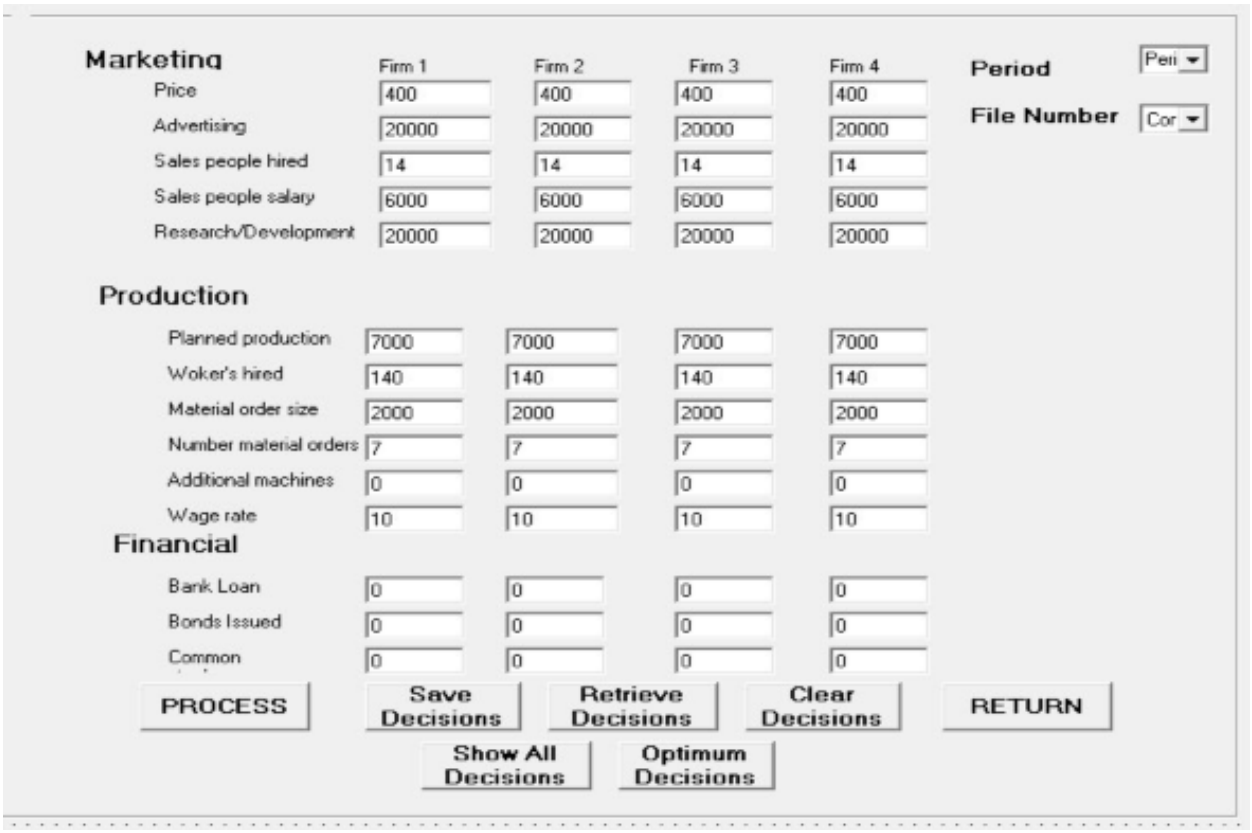

FIGURE 3