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A STUDY OF BUSINESS GAME STOCK PRICE ALGORITHMS

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ABSTRACT

A number of studies have examined the algorithms business games use to simulate real-world company functions. This study extends that research tradition into the area of the firm's stock price algorithm while increasing the range of validaties considered. An investigation of the stock price algorithms associated with six computer-based management games revealed diversity in the number and treatment of the variables used to create company stock prices. This diversity created radically different firm stock prices. These valuations also differed under company conditions of economic growth and decline. Most stock price results would meet a face validity test under conditions of improving firm performance but most would be challenged under conditions of company decline.

INTRODUCTION

For a great number of years computer-based game users had little direct knowledge of the quality of the algorithms their games used to model the firm's functions and outputs. Although there were early minor exceptions to this rule, such as the American Management Association's *Top Management Decision-Making Simulation* (Ricciardi, et. al., 1957) and *The Executive Game* (Henshaw & Jackson, 1966). In these two cases the authors divulged their algorithms to demonstrate company operations could be quantified and thereby promote the agenda that the business decision making process could be made more rational. It was not until the early-1980s, however, that the field began to examine and question the theoretical validity of the algorithms used in their games. Under Goosen's (1981) prodding various studies have subsequently investigated the algorithms game designers have used to model various game-related functions.

A recent paper by Gold and Pray (2001) summarized ABSEL's interest in game algorithms. It cited 19 papers dealing with marketing routines, 12 pertaining to finance and accounting, three associated with product quality, eight dealing with operations management/production and two connected with human resources. To this list of 44 papers there must be added a recent paper by Thavikulwat (2002) on modeling currency exchange rates as well as his contribution (Thavikulwat, In Press) on game design which is part of *Simulation & Gaming*'s Symposium Issue on business games. Missing from this research array, however, is work on how a company's stock price is created as Goosen, Foote and Terry (1994, 63) have observed "How simulation designers model the complex cost of capital issues is a well kept secret*."* This is an especially unfortunate state of affairs because a firm's stock price has various uses and performance implications within business gaming contexts. Most top management games generate the firm's stock price as an indicator of the firm's effectiveness (Keys & Biggs, 1990). Stock prices also indicate a major part of a company's cost of capital, interact with debt as a part of its financial structure and therefore rates-of-return, and are often used directly or indirectly by instructors to determine the company's performance for course/player grading purposes. This paper seeks to remedy this situation by examining the stock price routines employed by a sample of computer-based games and will make judgements as to their employment of sound financial markets theory, face validity or "reasonableness" and the presence of any particular reporting bias under conditions of firm stability, growth and decline.

LITERATURE REVIEW

This review covers two main topics intimately related to simulation design. The first topic deals with the role theory plays in the development of a computer-based game's algorithms. The second topic concerns itself with the amount of fidelity and concomitant complexity an algorithm must possess within a teaching/learning business game if it is to be effective. If a game designer wishes to capture the part of the real world being simulated, that part of the world must be amenable to descriptive capture and be reproducible in mathematical form. Some real world phenomena, such as a firm's production function, supply markets to firms in a simulated industry, and pricing effects industry-level and firm-level demand have been successfully modeled in various business games. Others, such as morale, dedication and R&D creativity have only been modeled by derived proxies. The easiest algorithm to create is one where a dominant theory explains the phenomena. If there are conflicting theories, or if no actual theory exists the modeler is basically free to create whatever model meets a face validity test.

Regardless of whether the model relies on a commonly-agreed upon theory, or is one that springs from the designer's imagination, the complexity paradox noted by Cannon (1995) must also be dealt with. As an algorithm becomes more complex, and therefore closer to the real-world complexities being modeled, the algorithm's ability to exemplify clear causal relationships becomes more obscure. When this occurs it becomes more difficult to explain or understand results. Therefore, depending also on the level of sophistication possessed by the game learner and instructor, it is possible that simpler and incomplete algorithms are preferred.

STOCK PRICE THEORY

The finance field has generated many asset valuation methods. This review, nonetheless, will limit itself to the field's "classic" methods while additionally recognizing the recent trend towards the use of behavioral finance and stock market psychology. A widely accepted stock valuation theory has been summarily expressed by English (2001, 21-22). "The market value of any firm is the sum of its capital and the present value of its future abnormal earnings…Simply put firms with superior investment opportunities, perhaps forged through competitive advantage or gained as a first mover, have higher valuations." Damodaran (2002) bundles the various approaches to equity valuation into three broad categories, and argues that each of these approaches may generate significantly different results. They are:

1. Discounted cash flow
2. Relative valuation
3. Contingent claim valuation

With the discounted cash flow theory cash flows are discounted at a risk-adjusted discount rate to arrive at an estimate of value. In this case, the equity value depends on expected future cash flows and the investor's required return. The growth of future cash flows depends on the company's return on investments and growth, which is based on a company's business opportunities and competitive advantage. With the relative valuation theory the value of a firm's stock price, and therefore its equity, depends on the pricing of comparable firms based on such fundamental factors as price-to-earnings, price-to-book , or price-to-sales ratios. Other less common relative valuation measures include price-to-cash flows, price-to-dividends, and Tobin's Q. The third approach, the contingent claim valuation theory, argues the present value of cash flows is dependent on the likelihood of a set of events. This approach is similar to determining "option values" in finance. An example is the realization of FDA approval of a drug and the value of that approval. In this case, the value of the firm may be greater or less than the expected cash flows. However, the explanatory power of contingent claim valuation is limited. Small or new firms may have very high option values that are contingent upon the realization of certain events, like a technological breakthrough in product development. But for large, established firms, which comprise the bulk of the market for commonly traded stocks, option values are generally a relatively small part of the overall portfolio of the firm's developed products.

These three approaches are based on economic values subject to the rule of rationally objective markets. Under this supposition the premise is that all economic returns and risks expectations have been assessed by rational investors. There is ample evidence, however, that this simplifying assumption of rationality is does not accurately reflect true market behavior. Thus a newer approach, which has been supported by a growing body of evidence, is based on psychology and is in the realm of behavioral finance. According to Fernandez (2002) behavioral finance theory suggests that share prices do not follow any rational valuation rule but rather depend on the state of euphoria or pessimism existing at the time in the financial markets. This is consistent with Schiller's (1999) hypothesis that the market is based not only on fundamentals factors but that psychological factors, such as Alan Greenspan's celebrated "irrational exuberance", may be a major driver of stock market prices. Interestingly for the game modeler, Schiller (1999) has found stock purchaser behavior is truly irrational but conveniently irrational in predictable ways. It was noted that as stock prices rise, the level of exuberance increases in a circular and self-feeding fashion due to the previous rise in stock prices. In this case, one can expect that successive share prices will be correlated or will repeat in similar cycles, thus giving credibility to the approach taken by the technical analysts who chart patterns to predict returns. The "speculative bubble" theory supports this point of view in the short-run, but argues that in the long-run share prices will return to their fundamental values. As observed by Fernandez (2002, 52) states: "Bubbles tend to grow during periods of euphoria, when it seems that the market's only possible trend is upward. However, there comes a day when there are no more trusting investors left and the bubble bursts and vanishes: shares return to their fundamental values".

Yet the supporters of modern portfolio theory question the use of technical or fundamental analysis for predicting stock returns (Malkiel, 1990), and this debate continues today. Modern portfolio theory contends that daily stock price changes are random and cannot be predicted by past information. The future is unknown and stock prices change very quickly to company disclosures, public news releases, and other economic events. To shed more light on this debate the performance of professional money managers has been studied for over three decades. The result of these studies, as reported by Gray, et. al., (1999), found money managers have underperformed the market by 2.0%-3.0% per year. In an average year, only one-third of the equity mutual fund managers beat the market. These results hold no matter the method of equity valuation is used, thus supporting the random walk theory and the efficient market hypothesis. But there has been some success in the use of fundamental analysis. Investment professionals using fundamental analysis have been able to beat randomly selected stocks in the *Wall Street Journal's* "Investment Dartboard" column. Between 1990 and 1998 the *Wall Street Journal* tested the performance of investment professionals compared to random dartboard selections. During this time period, the "fundamentalist" investment professionals beat the darts in 60 out of 100 contests. It is also clear from the finance literature that fundamental analysis is more widely supported than technical analysis as a method of equity valuation.

THE BASIS OF A VALID LEARNING EXPERIENCE

Feinstein and Cannon (2002) have recently reviewed three major constructs bearing on a simulation's validity. Those constructs are fidelity, verification and validation. A game's fidelity is the degree the game or experience duplicates the real-world situation it is modeling. Verification deals with the degree the game's structure or its algorithms operate in the manner intended by the game's designer. Validation is concerned with the degree to which the game actually brings about the planned results which are usually changes in the attitudes, knowledge levels or behaviors of its participants. In the context of this paper we are concerned with the fidelity or the amount of verisimilitude a business game's stock price model and its algorithms must possess as it is assumed the algorithms studied have been both alpha-tested and beta-tested and are therefore bug-free and completely operational.

The game designer, when constructing any simulation, must decide what must be modeled, the amount of detail or depth the model must possess and how to cast the modeled phenomena into a mathematically operational form. The ultimate goal for management education and development game is to create a model that is appropriate for the game's teaching or course content purposes keeping in mind the level of sophistication and preparation possessed by the simulation's intended players (Wolfe, 2001). Using teaching effectiveness as the criterion variable perfect fidelity may or may not be necessary or even appropriate as various studies have found higher fidelity levels do not translate into higher educational achievement (Greenlaw, Herron & Rawdon, 1962; Kibbee, 1961), high fidelity actually hinders learning with some groups (Martin & Waag, 1978) and lower fidelity levels can lead to greater educational achievement (Alessi, 1988; Gagne, 1954).

In bringing this to the instructional level the instructor's task, when players go through the experiential learning process created by the business game, is to act as an aid or coach to the players. In doing so questions inevitably arise as to how something in the game works. It is at that point learning can occur as the instructor must first understand the knowledge level the player brings to the situation and then fill the gap between the player's knowledge level and that which is portrayed by the game's model (Bransford, Brown & Cocking, 2000; Wellman, 1990). As the model's fidelity level, and its associated complexity increases, it naturally becomes increasingly more difficult for the instructor to explain how the phenomena operates. This can make it very hard to draw out any lesson(s) that can be learned. In this instance we are dealing with what we term is a game's *explanatory* validity, which is the ease with which various phenomena can be explained or rationalized to players. As an immediate aid to obtaining explanatory validity the routine being modeled should operate in a fashion that is readily apparent, or if not immediately apparent, ultimately grasped through greater exposure to the routine's operations or coaching by the instructor. In the context of this paper as applied to a firm's stock price, players expect stock prices to increase when company economic performance improves. If one firm outperforms another firm the better-performing firm should obtain the better stock price. If such relationships do not eventually occur the game's face validity can suffer unless there is some alternate explanation for the lack of expected results.

METHODOLOGY

A number of game authors whose games outputted stock prices were contacted and were asked to reveal the routines they used to model company stock prices. The following games became this paper's convenience sample:

BPG—*The Business Policy Game,* D.J. Fritzsche, www.eskimo.com/~fritzsch/.
CAP—*CAPSTONE,* Management Simulations, Northfield IL: Management Simulations, Inc.
COR—*Corporation*, J.R. Smith and P.A. Golden, Englewood Cliffs NJ: Prentice Hall.
GBG—*The Global Business Game,* J. Wolfe, Mason OH: South-Western College Publishing.
MAS—*The Management Accounting Simulation,* K.R. Goosen, Little Rock AR: Micro Business Publications.
MMG—*The Multinational Management Game,* B.L. Keys and R.A. Wells, Little Rock AR: Micro Business Publications.

Each game's stock price routine was captured by reading authorized versions of the game's computer code and/or simulating the game's routine in spreadsheet form via game author interviews. This research step generated Exhibit 1 which lists the variables or identities used by the sampled games.

Given the variables employed by each game, and the financial results required to operationalize the variables used by the games, sets of universal balance sheets and income statements were generated to cover three test conditions. One set covered each firm's stock price behavior for one period of play. This set was a "static" or instantaneous stock price test. A second set used the results of a firm experiencing improving economic results over a four-period time span. This set, labeled "Positive", was a dynamic test to determine the degree to which each game's stock price algorithm reflected positive results, and thus which of the games demonstrated stronger upward biases. The third set of economic results, labeled "Negative", employed a firm that was experiencing increasingly unfavorable economic outcomes. This set was used to determine the degree each game's stock price algorithm reflected the firm's deteriorating performance. The profit trends for the firms that obtained positive and negative results over the four periods are presented in Exhibit 2.

RESULTS

A review of the variables used by the games to create their stock prices was previously presented in Exhibit 1. There was universal agreement on the need to use the firm's current profits, number of outstanding shares and owner's equity as part of any algorithm that created a company's stock price. Almost all games used various devices or "traps" to insure that stock prices would not fall too low, or that company solvency was assured. These traps took to form of not allowing players to declare liquidating dividends, which would artificially inflate the firm's stock price, and not allowing them pay out dividends that would be financed through emergency funds and one which would be otherwise financially unsound. Another common trap kept stock prices from falling below a certain level. This type of safeguard, while not recognizing the firm's true market value under cases of poor economic performances, allows a firm to remain "in play" in the game's equity market thus permitting them to remain in the game's competition although at a very low performance level. COR used the greatest number of such traps while also rewarding certain strategic moves with stock price increases. Overall a rather short-term view was taken in determining stock prices. This was evidenced through the use of determining the current period's stock price based on the

EXHIBIT 1
Stock Price Variables Employed

Variable	Game						Percent
	BPG	CAP	COR	GBG	MAS	MMG	
Pervious Period Stock Price	-	-	X	X	-	X	50.0
Short-Term Price Smoothing	-	-	X	-	-	-	16.7
Current Period Profit	X	X	X	X	X	X	100.0
Previous Period Profit	-	-	-	X	-	-	16.7
Near-Term Period Profit	X	-	-	-	X	-	33.3
Outstanding Shares	X	X	X	X	X	X	100.0
Short-Term EPS Trend	-	-	-	X	X	-	33.3
Short-Term Per/Share Dividend	X	X	X	X	-	X	83.3
Long-Term Per/Share Dividend	-	X	-	-	-	-	16.7
Retained Earnings	-	-	X	X	-	X	50.0
Owner's Equity	X	X	X	X	X	X	100.0
Cash Account	X	-	-	X	-	-	16.7
Liquidity	--	X	-	X	-	-	33.3
Emergency Loan	--	X	-	-	-	-	16.7
Credit Rating	--	-	-	X	-	-	16.7
Stock Market Index	X	-	-	X	-	-	33.3
Seasonal Index	X	-	-	-	-	-	16.7
Consumer Price Index	X	-	-	-	-	-	16.7
Exchange Rate	-	-	-	-	-	X	16.7
Debt/Equity (Leverage)	-	-	-	-	X	X	33.3
Cost of Capital	-	-	-	-	X	-	16.7
Market Research	-	-	X	-	-	-	16.7
Lost Sales	-	-	X	-	-	-	16.7
Liquidating Dividend Trap	-	-	1	1	-	-	33.3
Excessive Dividend Trap	-	1	2	-	-	-	66.7
Depressed Stock Price	1	1	2	1	-	1	100.0
Strategic Factor Recognition	-	-	2	-	-	-	33.3
Total	10	9	16	14	7	9	39.5

EXHIBIT 2
Company Profits by Period

Economic Performance Trend	Period				Percent Change
	1	2	3	4	
Positive	$411,822	$480,580	$496,811	$530,419	+28.8
Negative	-$1,340,663	-$1,557,669	-$1,912,286	-$1,990,954	-48.5

previous period's price, near-term profit and the previous period's earnings/share and any dividends declared based on earnings/share. If the number of algorithmic traps are eliminated from the analysis GBG used the greatest number of variables in its stock price routine with MAS using the fewest.

The effects of the diversity in the variables used to generate each game's stock price is witnessed in Exhibits 3-5. Exhibit 3 presents a one-time, static analysis of stock price results. Even though common operational results, income statements and balance sheets were employed and were the materiel from which all stock prices were derived, the results were not uniform. Thus a COR firm's valuation resulted in a $12.99 stock price while the same firm in CAP was worth $3.54 a share. A GBG firm was worth about the average of the two at $8.01. In this analysis, BPG and MAS were closely valued, ranging from $5.49 to $5.81. The stock price generated by MMG's algorithm was much lower, with a value of only $3.54, while COR's was much higher with a price of $12.99. COR was the highest because it assumed a much higher standardized price-to-earnings ratio than the BPG model. The MAS model does not standardize for price-to-earnings ratios but adjusts for expected increases in future earnings. The MMG model generates a very low stock price because it does not consider either the firm's price-to-earnings ratio or expected increases in future earnings.

EXHIBIT 3
Static One-Period Stock Prices

Game	Stock Price
BPG	$ 1.54
CAP	$ 3.54
COR	$12.99
GBG	$ 8.01
MAS	$ 0.05
MMG	$ 0.08

Exhibits 4-5 display the stock prices generated by each game under the dynamic conditions of relative company success or failure over four later periods of play. This analysis indicates that both upward and downward stock price biases exist between the games surveyed. In Exhibit 4 when positive results were obtained COR's stock price increased 11.8% from $52.14 to $58.29 per share although they flattened between Periods 3 and 4 despite an increased economic performance. CAP's stock price increased from $4.04 to $4.75 per share or a 17.6% increase. Respective stock price increases of 44.3% and 19.3% were generated by BPG and MMG. On the other hand, the GBG firm's stock illogically fell 4.0%. Such was also the case for MAS whose stock price fell 35.5%. For those games whose stock prices increased the increase can be attributed to the weights put on earnings growth in their algorithms and, in MMG's case, the lower cost of capital outlays. In that game the cost of capital depends on the debt-to-equity ratio which declines when earnings increase. The decline in the MAS's stock price, despite the favorable economic results its firms were obtaining, can be attributed to the decrease in the growth-rate of its earnings. Although the firm's earnings were increasing, the growth rate was decreasing thus the lower earnings growth rate decreased the expected value of future earnings. Similarly, the decline in GBG's stock price may be attributed to the fact the algorithm uses the "change" in earnings per share, as well as the "change" in other economic performance factors, to determine the firm's stock price. In the first period the change in earnings per share is

Exhibit 4
Stock Prices Associated with Positive and Negative Economic Results

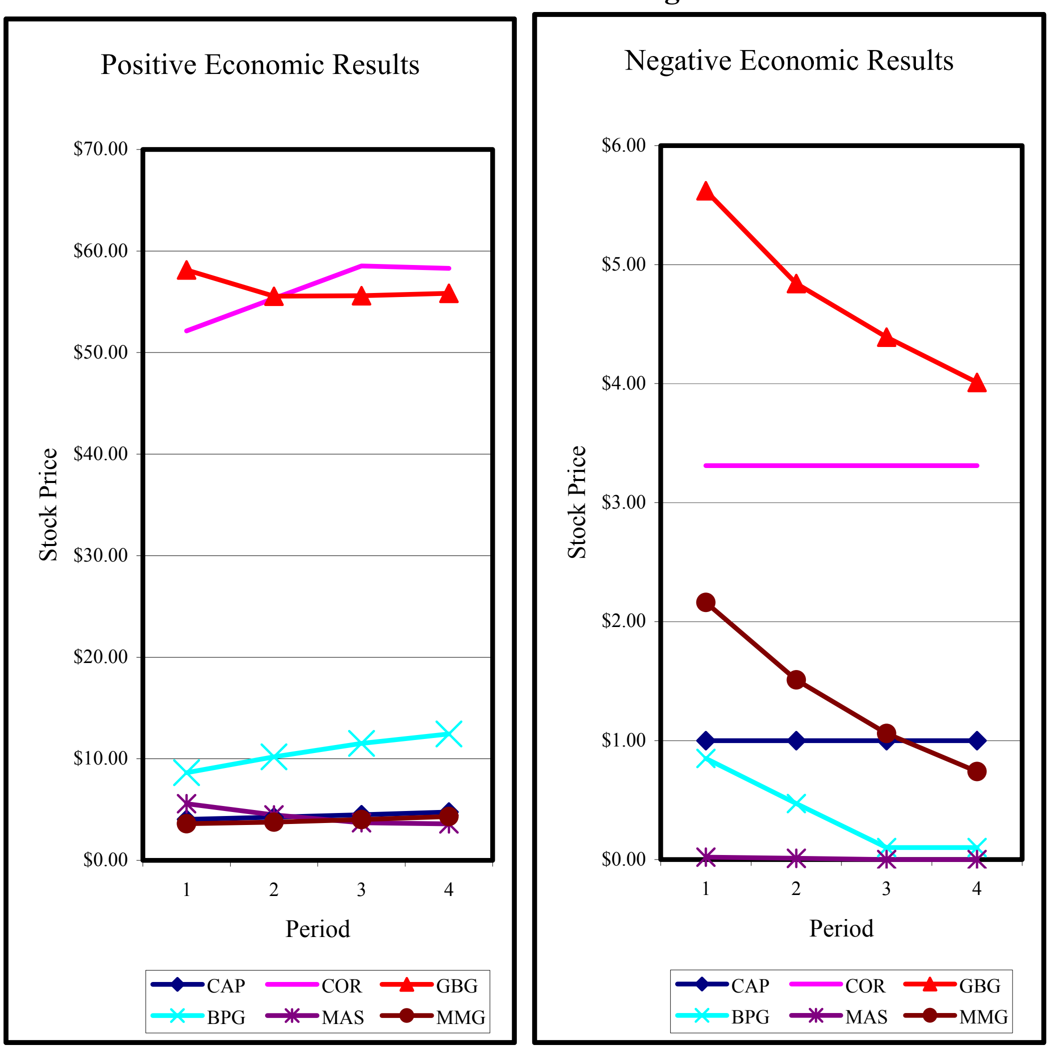
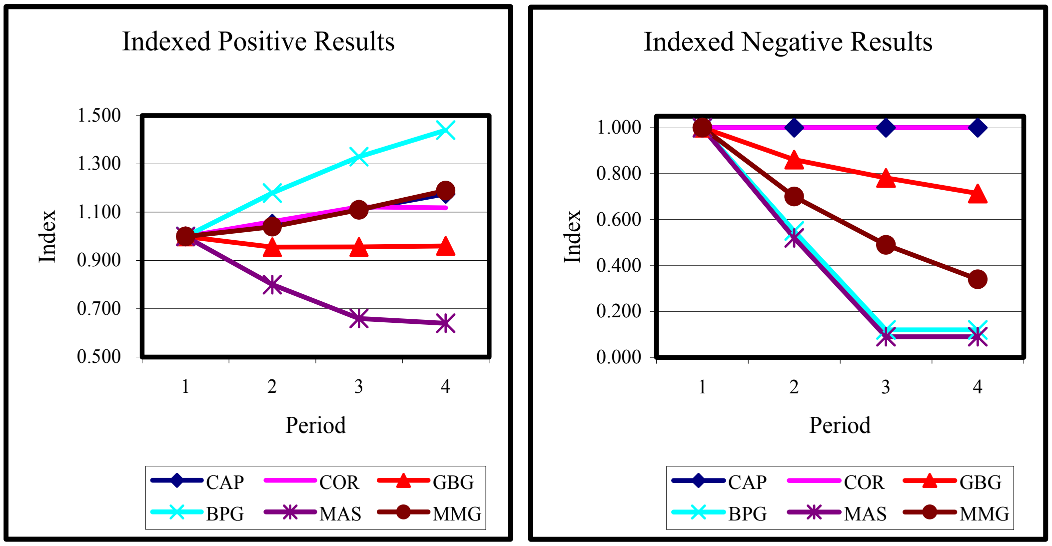


Exhibit 5
Indexed Stock Prices Associated with Positive and Negative Economic Results



very large and then declines. The large initial "change" in earnings may be viewed as causing an optimistically large increase in stock price, which is ultimately corrected when the change in earnings declines, despite the fact that total earnings are increasing. The algorithmic feature of using changes or growth rates in earnings could be found only in the MAS and GBG models. The GBG algorithm also diminished the firm's stock market value because in this test case dividends were not increased when profits and retained earnings similarly increased.

When negative results were experienced in the games surveyed, the presence of low stock price traps became readily apparent. For COR the stock price decline could never fall below \$3.31. In CAP the floor was \$1.00 while in MAS the bottom was \$0.00 thus eliminating future stock sales as a funding source when this price was reached. BPG employed its trap during the third period of play at \$0.10 per share. Stock prices fell logically given the falling earnings involved for GBG and MMG with respective decreases of 28.6% and 65.7%.

Because game players pay attention to how their stock prices "trend" over time, any upward or downward biases inserted into this trending by the game's designer may have strong motivational implications. As presented in Exhibit 5 the biases possessed by the games can be more-readily seen when their values are indexed at a common base period. Under the conditions of improving economic performance both COR, MMG, BPG and CAP generated increasing stock prices although COR trailed off during the fourth period despite continued profit increases. Both MMG and GBG again generated falling stock prices under the same financial results, owing in part to the decline in the growth rate of earnings. GBG's fall in stock price values are also due to a number of algorithmic factors not related to profits, including: the firm's comparative performance within its own industry, as well as in this case, being punished by the market by the firm's unwillingness to issue dividends even though it possessed high liquidity and sizeable retained earnings.

DISCUSSION

Because of the lack of a predictive theory regarding a firm's stock price, the valuation of any company is not a precise science. As noted by Damodaran (2002, 2) "The models that we use in valuation may be quantitative, but the inputs leave plenty of room for subjective judgments. [Therefore] it is unrealistic to expect complete accuracy." The lack of that science is readily apparent in both the elements chosen for inclusion in each game's stock price algorithm, and the results produced by those algorithms. In most cases stock prices logically rose although the magnitude of the increases was sometimes minimized while at other times it was exaggerated. Under the conditions of a firm's deteriorating performance, the use of equity "safety nets" became readily apparent. While it is possible under real game-playing conditions, due to initially high stock prices a "distressed" company would never approach the game's stock price floor, the presence of this floor gives that firm artificial support when the simulated stock market actually wants to put the firm into insolvency. In this case, or one where a firm's comparative stock price increase has been minimized compared to the results earned by another firm in the industry, the game's explanatory validity can be seriously threatened.

The inclusion of the role of subjective stock price valuation in the design of a stock price algorithm recognizing and/or rewarding a company's strategic intent (Hamel & Prahalad, 1989), or the suspected outcomes associated with a particular decision, can be found in one of the games surveyed. In COR \$1.00 is automatically added to a firm's stock price each time a Venture is purchased and \$2.00 is added each time a strategic business unit (SBU) is purchased. While it could be inferred from these decisions that good use will be made of the purchases, it can only be assumed under COR's stock price "reward" system these purchases will be well managed and will result in greater profits. But such may not be the case. Moreover, if the players of this game learn their stock prices can be manipulated by engaging in

Venture and SBU purchases they will do so without actually creating shareholder value through the economic use of those purchased assets.

While the discernment and reward of a firm's strategic intent has been incorporated into COR's stock price algorithm, another important subjective element that influences a firm's stock price is missing in all the games surveyed. The role of irrational optimism and pessimism is lacking and is an element worthy of inclusion. The MAS game, which attempts to scientifically model stock price behavior based on rational fundamentals, was the most volatile performing routine surveyed with questionable explanatory validity in its outcomes. This game, along with all the others could greatly benefit by modeling the market psychology associated with stock price Bull/Bear behavior.

CONCLUSION

The finance field has unfortunately provided business game designers with a wide array of divergent and controversial theories upon which to base the stock price algorithms they employ in their games. This gives game designers, for better and for worse, personal discretion regarding the equity valuation models they create, and accounts for the significant differences produced by the simulation models studied. Although a common set of financial results served as the data base for examining six business game stock price results, large valuation differences occurred for both one period, and for longer-term results under the conditions of improving or deteriorating firm performance. In most cases, stock prices possessed explanatory validity under improving company performance. Such was not the case at the extreme when a firm produced declining results.

It is suggested future stock price algorithms attempt to model the subjectivity associated with stock purchase behavior. This subjectivity should involve both evaluations of the firm's strategic intentions based on its major moves, as well as an industry's and economy's "boom/bust" features and investor expectations with respect to earnings, risks, and dividends. It is also suggested, as a way to bring about higher levels of explanatory validity to their games, game authors create descriptive sections in their Game Administrator Manuals that explain of how various game routines operate. This can be done through either flow charts, program code (Henshaw & Jackson, 1990) or prose narratives (Cotter & Fritzsche, 1995; Wolfe, 2003).

REFERENCES

Alessi, S.M. 1988. Fidelity in the design of instructional simulations. Journal of computer based instruction. *15*: 40-7.

Bransford, , J.D., Brown, A.L., and Cocking, R.R. (eds.) 2000. How people learn: Brain, mind, experience, and school.. National Academy Press, Washington DC.

Cannon, H.M. 1995. Dealing with the complexity paradox in business simulation games. Developments in business simulation and experiential learning. 223: 96-102.

Cotter, R.V., and Fritzsche, D.J. 1995. The business policy game: Instructor's manual. Prentice Hall, New Jersey.

Damodaran, A. 2002. Investment Valuation– Tools and Techniques for Determining the Value of Any Asset. John Wiley, New York.

English, J.R. 2001. Applied equity analysis– Stock valuation techniques for Wall Street professionals. McGraw-Hill, New York.

Feinstein, A.H., et al. 2002. Constructs of simulation evaluation. Simulation & gaming. *33*: 425-40.

Fernandez, P., 2002. Valuation methods and shareholder value creation. Academic Press, San Diego.

Gagne, R.M. 1954. Training devices and simulators: Some research issues. American psychologist. *9*: 95-107.

Gold, S.C., et al. 2001. Historical review of algorithm development for computerized business simulations. Simulation & gaming. *32*: 66-84.

Goosen, K.R. 1981. A generalized algorithm for designing and developing business simulations. *In* W.D. Biggs and D.J. Fritzsche (eds.), Developments in business simulation & experiential exercises. p. 41-7. Illinois State University, Normal.

Goosen, K. R. 1994. Increasing the effectiveness of performance evaluation through the design and development of realistic finance algorithms. Developments in business simulation and experiential learning. 21: 63-69.

Gray, G., et al. 1999. The streetsmart guide to valuing a stock. McGraw-Hill, New York.

Greenlaw, P.S., Herron, L.W., and Rawdon, R.H. 1962. Business simulation in industrial and university education. Prentice Hall, New Jersey.

Hamel, G., and Prahalad, C.K. 1989. Strategic intent. Harvard Business Review. *67*: 63-76.

Henshaw, R.C., and Jackson, J.R. 1966. The executive game. Richard D. Irwin, Illinois.

Henshaw, R.C., and Jackson, J.R. 1990. The executive game. Irwin, Illinois.

Keys, J. B., and Biggs, W. D. 1990. A review of business games. *In* J. W. Gentry (ed.), Guide to business gaming and experiential learning. p. 48-73. Nichols/GP New Jersey.

Kibbee, J.M. 1961. Model building for management games. *In* A. Newgarden (ed.), Simulation and gaming: A symposium. p. 8-15. American Management Association, New York.

Martin, E.L., and Waag, W.L. 1978. Contributions of platform motion to simulator training effectiveness: Study I—Basic contact. Brooks Air Force Base, Air Force Human Resources Laboratory, Texas.

Miller, M.H., and Modigliani 1961. Dividend policy, growth and the valuation of shares. Journal of business. *31*: 411-33.

Ricciardi, F.M., Malcolm, D.G., Bellmon, R., Clark, C., Kibbee, J.M., and Rawdon, R.H. 1957. Top management decision-making simulation: The AMA approach. E. Marting (ed.). American Management Association, New York.

Schiller, R. 1999. Irrational Exuberance. Princeton University Press, New Jersey.

Thavikulwat, P. 2002. Model for currency exchange rates and its validation. Simulation & gaming. *33*: 5-27.

Thavikulwat, P. (In Press). Architecture of computerized business gaming simulations. Simulation & gaming.

Wellman, H.M. 1990. The child's theory of mind. MIT Press, Massachusetts.

Wolfe, J. 2001. Who needs validity? Perspectives from the field of management education and development, *In* A. Heemink, L. Dekker, H. de Swaan Arons, I. Smit and T. van Stijn (eds.), Shaping the future with simulation. p. 116. TU Delft, Delft.

Wolfe, J. 2003. The global business game: Administrator's manual. South-Western, Ohio.