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VALIDATING BUSINESS SIMULATIONS: DO SIMULATIONS EXHIBIT NATURAL MARKET STRUCTURES?

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ABSTRACT

Studies of the size distributions of business firms to assist in the understanding of market structures have been undertaken for a number of years. The leading such study, undertaken by Buzzell (1981) as part of the ongoing stream of research reported on as part of the PIMS project, indicated that the market share size distributions of business firms within an industry followed a skewed distribution and firms had a size ratio, on average, of 0.6 relative to their next largest competitor. A major concern of simulation game users through the years has been how realistic are business simulation games and this has lead to numerous validation studies of business simulations. The market share size distributions of 509 different simulation companies competing within three different industry competitive structures (6, 9 and 12 firm competitions) within a business simulation game were examined to test conformity within this simulation environment to the real world findings as reported from the PIMS data. It was found that competitive structures within the business simulation industries exhibited a skewed market share distribution and exhibited a consistent size ratio as suggested by the PIMS findings. A notable difference was that the size ratios in the simulation were at the higher range as compared to real world industries (in the range of .90). It was also found that the size ratios increased modestly as the number of industry competitors increased.

INTRODUCTION

It has now been nearly 50 years since the first use of a business simulation game in a university class in 1957 (Watson 1981). Since that time, the number of business simulation games and their use in university classes has grown enormously. Presently, in the U.S. alone, over 200 business games are in use at over 1,700 universities and community colleges by approximately 11,000 business teachers (Faria 1998). In an e-mail survey administered to 14,497 business faculty members at American Assembly of Collegiate Schools of Business institutions, it was reported that 47.7 percent of all respondents are currently using or had used a business simulation game during their teaching careers (Faria and Wellington 2004). Empirical research in the area of business gaming has been extensive. Comprehensive reviews can be found in Greenlaw and Wyman (1973), Keys (1976), Wolfe (1985), Miles, Biggs and Shubert (1986) and Randel, Morris, Wetzel and Whitehill (1992).

Despite the widespread use of business games, an ongoing issue of concern is whether or not participation in a simulation game is a meaningful experience. This paper introduces another measure that might be used for assessing the relative merit of business game participation that relates to the outcomes reported over the past forty years from the ongoing PIMS project as now administered by the Strategic Planning Institute. Specifically, this study examines the outcomes from a marketing simulation game to determine whether, as reported by PIMS, simulation industries exhibit consistent market structures as found in real world industries.

PAST RESEARCH

Meaningfulness, as applied to the business simulation gaming experience, has taken on a number of interpretations as reflected in past gaming research including: (1) the learning, or skills training, aspects of business games; (2) the relative merit of business games versus other teaching approaches; (3) the external validity of business simulation games; and (4) the internal validity of business games.

Research into the skills training or learning aspects of business simulations dates back to the first uses of business games in university classes. The reported types of learning brought about by the use of business games includes goal setting and information processing; organizational behavior and personal interaction skills; sales forecasting; entrepreneurial skills; financial analysis; basic economic concepts; inventory management; mathematical modeling; personnel skills such as hiring, training, leading and motivating; creative skills; communication skills; data

analysis; formal planning and report preparation; and much more. Faria (2001) provides a history and complete list of references covering research on skills training through the use of business simulation games.

The merit of simulation games versus other teaching approaches has been investigated by a number of researchers (Greenlaw and Wyman 1973; Keys 1976; Snow 1976; Waggener 1979; Wolfe 1985; Miles, Biggs and Schubert 1986; Hall 1987; Spect and Sandline 1991; Washbush and Gosenpud 1991; Randle, Morris, Wetzel and Whitehill 1992; Wolfe 1997). Several comprehensive reviews, as cited earlier, have summarized the bulk of these comparative studies. Across all of the reported studies, simulation games were found to be more effective teaching tools, as measured by performance on common course final exams, than conventional instructional methods (generally cases and lectures) in 75 of the research comparisons, conventional methods of instruction were found to be superior in 27 of the comparisons, while no differences were reported in 58 of the comparisons.

The external validity of a business simulation game has generally been viewed as a measure of how well the business game models the real-world industry in which the simulation takes place (Carvalho 1991). In a classroom setting, two approaches have been used to examine the external validity of business games. The first approach has focused on the correlation between a business executive's simulation game performance and his/her real-world performance. If the simulation game is externally valid, a successful business executive should also be successful when participating in the simulation competition. A number of studies of this nature have supported the external validity of business games. The best of these studies can be found in Wolfe and Roberts (1986).

The second approach to measuring external validity employs a longitudinal research design. In this approach, a student's business game performance is compared to some measure of subsequent business career success (e.g., number of promotions, salary level, etc.). Using this approach, two comprehensive studies have reported such a correlation (Wolfe and Roberts 1986; Wolfe and Roberts 1993).

The internal validity of business simulations has also been measured in two ways. The first approach basically states that if a simulation exercise is to be considered internally valid, better students should outperform poorer students. Several studies have supported this view of the internal validity of business games (see Wolfe 1987 for one of the better studies and an overview of other research on the internal validity of business games). A second, and possibly more reasonable view of internal validity, examines whether participant decisions in a simulation competition, over time, conform to the environment of the simulation. While the dynamics of the simulation and the actions of competing companies will influence participants' decisions, the simulated environment must be considered and, *ceteris paribus*, participant decisions should adapt to the simulation environment. If this type of adaptive decision-making takes place, the simulation exercise may be considered internally valid. Past research of this type has been only moderately supportive of the internal validity of business games. The most thorough study of this nature, which contains an overview of all past research on internal validity, can be found in Wellington and Faria (2001).

ARE THERE NATURAL MARKET STRUCTURES?

The PIMS (Profit Impact of Marketing Strategies) project was initiated in the 1960s within the General Electric Company. In order to expand the program, the project was moved to the Harvard Business School in 1972 and, to facilitate the further expansion of the program, the Strategic Planning Institute was formed in 1975 to administer the project.

The PIMS program is a multi-company research project designed to gather marketing and financial information on a number of different business firms for analysis purposes. Each member company of the PIMS project submits information about its business conditions to the Strategic Planning Institute each year. The PIMS' staff members analyze the data to search for general laws that seem to govern the business environment (Henderson 1980). Currently, there are over 3,800 businesses contributing data to the Strategic Planning Institute each year.

Based on many years of research, and through hundreds of publications using data from the PIMS project, a number of generalizations, sometimes referred to as "laws of the marketplace", have been reported. The reported finding that we are concerned with in this paper deals with natural market structures (Buzzell 1981).

In the most common format of classroom simulation gaming, participants are grouped into companies, and companies are grouped into industries. Companies within a given industry compete against one another for a share of the served market and the resulting profitability. Given this situation, within any interactive business simulation game, it would be easy to examine the industry market structure that results from the competition and to check whether the outcomes conform to the PIMS findings. If they do, the simulation exercise can be deemed to be meaningful and realistic with respect to real world business findings.

In a similar type of study to the present one, Green and Faria (1995) examined the results from a simulation competition with regard to another PIMS principle. Among other conclusions reported as part of the many studies published by the Strategic Planning Institute, a central principle states that business strategies are successful if their fundamentals are good, unsuccessful if they are not. The implication from this is that strategies that are successful in one marketplace/economic environment will continue to be successful in a similar environment even if the firm's competitors are changed (Buzzel and Gale 1987).

To test this principle in a simulation environment, Green and Faria (1995) removed the winning companies

(highest earning companies) in 25 separate, five team, simulation industries, after the completion of a three year (twelve period) competition, and moved them (the leading companies) to a different industry which still contained the remaining four companies. All twelve (three years) of simulation decisions were then re-run. In 18 of the 25 (72%) of the re-runs, the original winning team and, hence, unchanged winning decisions/strategy, once again emerged as the winner. And the winning team once again emerged as the winner even with four new competitors who were, presumably, following different strategies. In another three industries within the Green and Faria (1995) study, the original winning team came in second. These results strongly supported the view, within the simulated competition utilized, that a fundamentally sound strategy remains a fundamentally sound strategy in a similar environment even if competitors are changed as suggested by the PIMS findings.

Another PIMS principle reported states that "Market share and profitability are strongly related" (Buzzel and Gale 1987, p. 8). To test this principle in a business simulation environment, Faria and Wellington (2004) examined the performance results of 440 simulation companies, divided into 96 industries, playing two separate simulation games. The market shares of all 440 competing companies and their end of game profitability were examined. The results reported by Faria and Wellington (2004) showed that market share, whether measured as unit market share, dollar market share, or relative market share, was strongly correlated (at the .00 level) to profitability. Thus market share and profitability were found to be highly correlated in the two simulation games used in the Faria and Wellington (2004) research. This, again, conforms to the real world findings from the PIMS project.

In yet another study, Faria and Wellington (2005) examined whether product quality was correlated to profitability as reported from the PIMS findings. The product quality and profitability levels of 451 product-based SBUs from 152 different simulation companies competing in 33 industries within a business simulation game were examined. It was found that product quality and profitability levels were significantly and strongly correlated (.576) as suggested by the PIMS findings.

While not the purpose of their research, House and Taylor (1991) reported a number of findings from a review of student performance in two different simulation games. Among the conclusions stated by House and Taylor (1991, p. 137) were that, "It was found that market share and plant expansion were important determinants of profitability in the executive game….In the business game environment, market share has a negative, short term impact on profitability…." This suggests one example of conformity to the PIMS findings and one example of nonconformity across two separate simulation game environments. The bulk of past research, as such, tends to support the external validity of the business simulation games that have been studied. The current study will add to this body of knowledge.

HYPOTHESES

Based on the research cited above, the following general hypotheses are put forth for testing.

H1: The size distribution of companies competing in different industries of the ***MERLIN*** Marketing Simulation will fit a logarithmic distribution for relative market share versus market share ranking.

H2: The size distribution of competitors competing in different industries of the ***MERLIN*** Marketing Simulation will produce a consistent size ratio pattern with regard to competitive market shares.

Past simulation research has suggested that business simulation games possess external and internal validity. The available research to date suggests that selected business simulation games conform to several of the major PIMS findings. Given the results from past simulation gaming research, and the findings reported from the ongoing PIMS project, it would seem, then, that simulation games should produce consistent "market size" distributions as suggested by the two hypotheses to be tested and in conformity to reported PIMS results.

DATA COLLECTION AND ANALYSIS

Data were collected from 509 simulation companies operating in an Introduction to Marketing class. The business game companies were divided into 59 industries (20 six team industries, 20 nine team industries and 19 twelve team industries). The simulation game used was ***MERLIN: A Marketing Simulation*** (Anderson, Beveridge, Lawton and Scott 2004).

The data from the ***MERLIN*** competition were collected from companies that were involved in one competition administered by the same instructor spanning the time period from September 2004 through December 2004. Each participating ***MERLIN*** company is composed of six product market units (PMU's) formed by two products being sold in three geographic regions. The simulation itself designates the products generically as Product 1 and Product 2 but the instructor told students that Product 1 was a Clock Radio and Product 2 was a DVD Player. The data used to examine market shares was cumulative dollar sales of each company product in each geographic market.

The market share data gathered were analyzed using the curvilinear Regression program from SPSS P.C. Version 13. R-square goodness of fit measures were computed to compare the distribution of the relative size of firms in a market (their relative market share) as a function of each

Table 1: Curve Fit of Relative Market Share Distributions By Industry Size

	12 Teams (N=217)		9 Teams (N=173)		6 Teams (N=119)	
Curve Distribution	R square	Sig	R square	Sig	R square	Sig
Logarithmic (PIMS)	.747**	.000	.646	.000	.699**	.000
Linear	.731	.000	.682**	.000	.667	.000
Quadratic	.745	.000	.664	.000	.689	.000
Cubic	.759*	.000	.689*	.000	.708*	.000
Compound	.713	.000	.618	.000	.602	.000
Power	.660	.000	.593	.000	.579	.000
S-Curve	.497	.000	.488	.000	.499	.000
Growth	.713	.000	.618	.000	.602	.000
Exponential	.713	.000	.618	.000	.602	.000
Logistic	.713	.000	.618	.000	.602	.000

* Best Fit ** 2nd Best Fit

firm's size rank (market share ranking) for each industry size (6, 9 and 12 team industries). As per the results reported in Buzzell (1981), it was expected that a "semi-logarithmic" distribution would produce the "best curve fit" regardless of product, geographic region or industry size. However, as Buzzell (1981) reports that alternative skewed distributions produce fits that are as good as the semi-logarithmic, a number of alternative curve distributions were assessed to examine which produced the best fit for this particular data set. In addition to fitting the relationship of relative market share and market share ranking to a set of curve distributions, the size or market share ratios between firms were examined by industry size. As such, size ratios for 6 team industries, 9 team industries and 12 team industries were computed.

FINDINGS

The findings from the data analysis are reported on in Tables 1 and 2. The findings shown in Table 1 indicate that for the ***MERLIN*** simulation game, the cubic distribution produced the best fit curve to describe the relationship between relative market share and market share ranking, and this proved true for each of the three industry size groups. The logarithmic curve was a very close second for the 12 and 6 team industries, a finding consistent with the findings reported by Buzzell (1981). However, for the 9 teams industries, a linear curve distribution came second to that of the cubic distribution with the logarithmic distribution coming in third. The power to detect the resultant effect sizes with a .01 level of significance was .99 or better for all industry size groups (Cohen and Cohen 1983, p. 528). These findings support the hypothesis (H1) that the relative market share versus market share ranking of the simulation companies fits a logarithmic distribution very well (although it was not the best fitting distribution curve). The difference between the logarithmic distribution and the cubic distribution that produced the best fitting curve was very small. As such, H1 cannot be refuted and the findings from this study indicate that for the ***MERLIN*** simulation game, natural market structures evolve just as they do in the real world.

In addition to the natural market structures found, there was a strong similarity in size ratios among firms in the various sized industries as shown in Table 2. The typical size ratio for ***MERLIN*** simulation competitors was 0.9, meaning that teams ranked second in market share had sales levels which were 0.9 that of first place teams, that third place market share teams had sales that were 0.9 of second place teams, and so on. These findings support H2, and are consistent with PIMS findings. The ***MERLIN*** market share data exhibit a consistent size ratio regardless of industry size. The finding that size ratios had a consistent value is in line with PIMS data although Buzzell (1981) indicates that the size ratio from the PIMS database averaged 0.6 while ranging "from a low of 0.42 for the automobile industry to a high of 0.89 for beer and gasoline" (Buzzell, 1981 p. 42). As such, the findings in this study on market structure are consistent with the findings as reported from the PIMS project.

Table 2: Size Ratios by Share Rank by Industry Size

	12 Teams (N=217)			9 Teams (N=173)			6 Teams (N=119)		
Share Rank	Mean Share	N	Size Ratio	Mean Share	N	Size Ratio	Mean Share	N	Size Ratio
1	12.40	19	-	16.00	20	-	22.12	20	-
2	11.06	20	.89	14.03	20	.88	19.48	21	.88
3	10.48	18	.95	12.96	20	.92	17.48	19	.90
4	9.95	19	.95	12.29	21	.95	15.60	20	.89
5	9.50	19	.95	11.34	19	.92	14.09	20	.90
6	8.88	19	.93	10.73	20	.95	11.27	19	.80
7	8.30	20	.93	9.63	20	.90			
8	7.77	18	.94	8.24	20	.86			
9	7.16	20	.92	7.27	13	.88			
10	6.43	18	.90						
11	6.07	15	.94						
12	5.03	12	.83						
Chance Share	8.33			11.11			16.66		
Mean Size Ratio			.92			.91			.87

DISCUSSION AND CONCLUSIONS

Based on the findings from this study, the performance outcomes of the 509 simulation participant firms examined provides evidence of the existence of natural market structures within the ***MERLIN*** simulation competition just as these structures have been found in the PIMS data base. In addition, the market share distributions among competitors were skewed in accordance with findings reported from the sample of PIMS' companies.

In conclusion, the ***MERLIN*** simulation game produced market structures that resemble those of "real-world" competitors although the size ratios were generally on the high end. An added interesting finding, beyond the hypotheses examined for this study, was that as the number of competitors increased, the size ratios seemed to increase. This would certainly fit with the model of "perfect" competition from economics. As the number of competitors increases, the markets would become "more perfect" and sales levels would even out amongst competitors (no one would have a competitive advantage).

Finally, as most simulations begin with competitors essentially "even" in terms of market structure and market potential, it should take time for market structures to evolve. This study only shows a "snapshot" of market structures. It can be questioned whether the markets in this competition had achieved "equilibrium". While market structures may have continued to change with a lengthier competition, it appears that the ***MERLIN*** marketing simulation, and likely many others used within our business classes, conforms to yet another of the PIMS standards. This once again provides further validation of the use of business simulation games for teaching purposes.

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