

REPLICATING THE FUNCTIONS OF A CORPORATE CEO: AUTHENTICITY AND THE GRADING OF PERFORMANCE

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ABSTRACT

We replicated the functions of a corporate CEO in a game of 160 episodes and five rounds where every participant has an opportunity to be CEO of a new investment company for at least one round. We explain the incentive system of the game, the roles available to participants, the privileges and duties of the game's CEOs, and the basic, progressive, and log methods of linking performance outcomes to points towards grades. Data from a one-semester administration of the game to a population of 32 undergraduate students show that the frequency distributions of performance scores are as expected, and that the three performance measures of the game, namely lifespan extension, relative shares sold, and logged relative profit, are correlated with each other. The results suggest that the game is authentic in replicating the functions of a corporate CEO, thereby allowing participants to practice formulating corporate strategies, making presentations to investors, executing strategies by acquiring and disposing of business operations, and employing executives to manage subsidiaries.

Keywords: CEO, GEO, business policy, grading, incentive system, performance measure, strategic management

INTRODUCTION

The job of corporate CEO is one to which many aspire, for it is at the highest authority level of the corporate executive hierarchy. The job involves stating the corporate strategy, presenting the strategy to investors, acquiring and disposing of business operations, employing executives to manage subsidiaries, among others. Our interest is in replicating the job through a game, so that participants will have a low-risk setting within which to practice these functions and hone relevant skills.

Within the business curriculum, the course most concerned with the job of corporate CEO is commonly a capstone course originally entitled *Business Policy*, but usually entitled *Strategic Management* today. The course became popular with the publication of a series of case-intensive textbooks (e.g., Learned, Christiansen, Andrews, & Guth, 1969; Uytterhoeven, Ackerman, & Rosenblum, 1977; Christensen, Berg, Salter, & Stevenson, 1985; Bower, Bartlett, Christensen, Pearson, & Andrews, 1991) authored by the faculty of the Harvard Business School. These textbooks included many business cases and a few essays. Faculty teaching the courses directed students to study the cases, write analyses of the cases, present the cases to the class, and discuss in class the issues embedded therein. Essays of the textbooks were advisory; their contents usually not materials subject to testing for recall. Student preparation for discussion was assured by requiring students to submit written analyses before each case was presented. At business schools that employ doctoral-level students as teaching assistants, the written cases would be graded by teaching assistants, who might also attend classes to score students' performance in presentations and discussions. The professor's task was limited to an introduction, occasional questions and comments, and a concluding statement.

At business schools that do not employ doctoral-level teaching assistants, however, the case-intensive method of teaching remains uncommon. To adopt it, professors would have to read and grade many case-analysis papers, too many for the many professors who teach without capable assistants to accept. Accordingly, the course may be taught either concept intensive, with students expected to study essays, hear lectures, and memorize their contents for exams; or game intensive, with students expected to collaborate in teams on playing a competitive total-enterprise game; or mixed. The conundrum of using a total-enterprise game for the purpose is that total-enterprise games are typically administered as team games with students playing the role of collective presidents (Teach, 1993; Wolfe & Rogé, 1997). Yet, the job of corporate CEO is almost always a solitary one at the apex of a hierarchy of superior-subordinate relationships.

The conundrum has not been ignored. Bernard (2004) reports on a pilot project that resolved the collective-president conundrum by asking participants to select among four executive functions (CEO, marketing, finance, and production/personnel) after which the participants are randomly assigned to teams of four composed of one executive for each function. He bases a quarter of the points allotted to the simulation activities on measures of performance specific to each function. His assignment method, however, does not replicate the superior authority of the CEO, for the CEOs are neither able to select the members of their teams, nor to change the functional assignments of team members, nor to dismiss any member.

In the exposition that follows, we explain how we have gone beyond Bernard's work. We also address the issue of grading performance in business games and report a study of game authenticity.

ROLE ROTATION

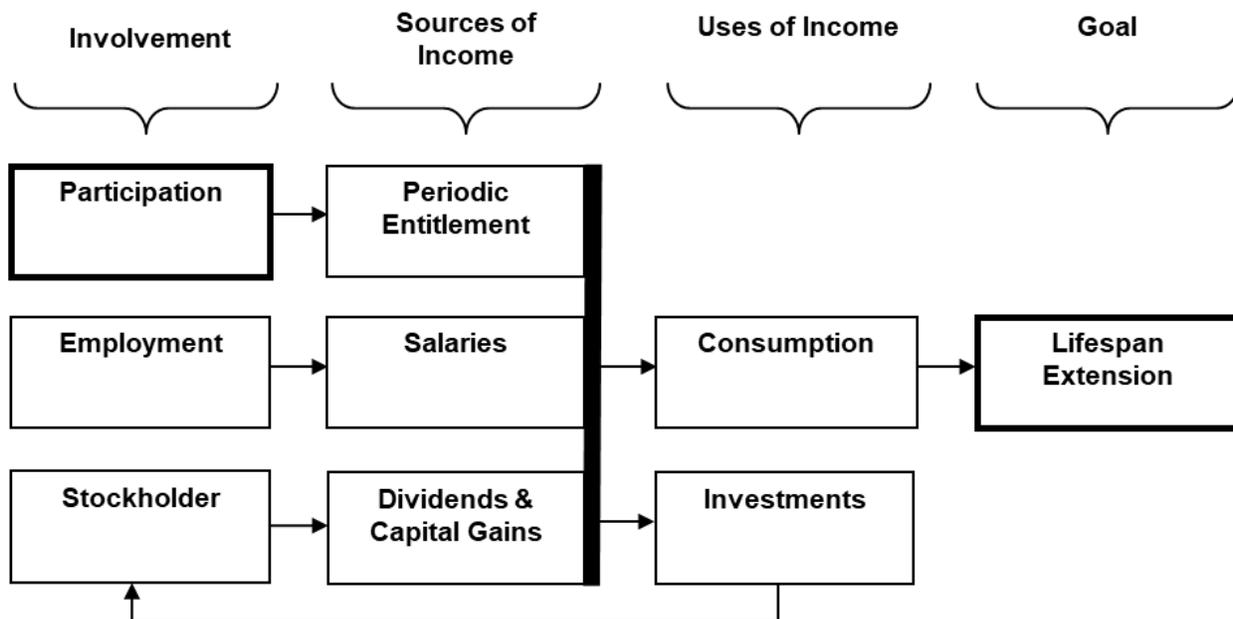
The second limitation of Bernard's (2004) functional-assignment method is that it enables only a fraction of the participants to experience the role of the CEO. This limitation can be remedied by role rotation, an example of which has been reported by Shipley and Govahi (2004) in their administration of Omega, a simulated video-game company, whereby half of the participants played the role of a single collective client and half, the role of three collective consultants competing for the business of the client. Within the approximately two-hour duration of the exercise, the collective client would explain the issue to the consultants, the consultants would deliver competitive presentations to the client, and the client would decide the winner. Although the exercise is essentially a single-episode role-playing of a fictitious case, rather than the administration of a multi-episodic game, the method of rotating roles could be applied to a team game.

Thus, the authority to enter CEO decisions could be rotated among team members by giving a different member of the team a private access code that changes from round to round, enabling only that member to enter decisions of the round. In this case, a round could consist of several episodes spread over two or three weeks. If the number of rounds scheduled equal the number of members in a team, then every member will have an opportunity to experience the authoritative role of CEO.

Even so, by itself role rotation is a stunted form of the desired superior-subordinate relationship. Whereas everyday-world superior-subordinate relationships are decided freely by the parties involved, role rotation is imposed. By itself, role rotation also does not allow the CEO to dismiss a team member, reorganize the team, or poach a member from a different team. The parties are compelled to work together, like prisoners in a work gang. In the everyday world setting, however, CEOs rely on incentives, not compulsion, to secure human efforts. Yet, incentive systems can be difficult for instructors to manage when they are not incorporated into the operation of a computerized game.

For this reason, we incorporated an incentive system for employment into GEO, a business simulation game built following an optimal-design (Thavikulwat, 2009) and constructivist (Thavikulwat & Pillutla, 2010) approach. Requiring participants to register individually, we dispense with imposed teams. We ensure that all participants of our game have at least one opportunity to be a CEO by rotating CEO appointments of identically financed investment companies over four rounds, leaving it up to each appointed CEO to put together a team of willing subordinates. A fifth consolation round is reserved for CEOs who are unable to earn in their first rounds a profit of at least a fourth of the profit earned by the investment company that earned the most profit of the round. We augment the game's intrinsic incentive system by allocating points towards grades for effective presentations to investors and for delivery of profits, so that participants might be especially attuned to these two critical aspects of the CEO's job.

FIGURE 1
Performance Flow Diagram



INCENTIVE SYSTEM

In the everyday world, the incentive system that binds superiors to subordinates is the compensation system. We replicate this in our game by enabling companies to compensate executive-participants with salaries and stock options. Salaries are disbursed periodically upon the elapse of an episode that the game calls a period, rather than a month, quarter, or a year. The strike price of stock options is set to the book value of shares when the options are issued. Participants apply income from various sources to repay loans incurred to buy shares and to purchase, ergo consume, products that extends their lifespans, as illustrated in Figure 1. Thus, profit is means, not ends. Simulating everyday life, extending lifespans is the goal of the game (Thavikulwat, 2012).

FIGURE 2
Supply Chain Relationships Among Industries

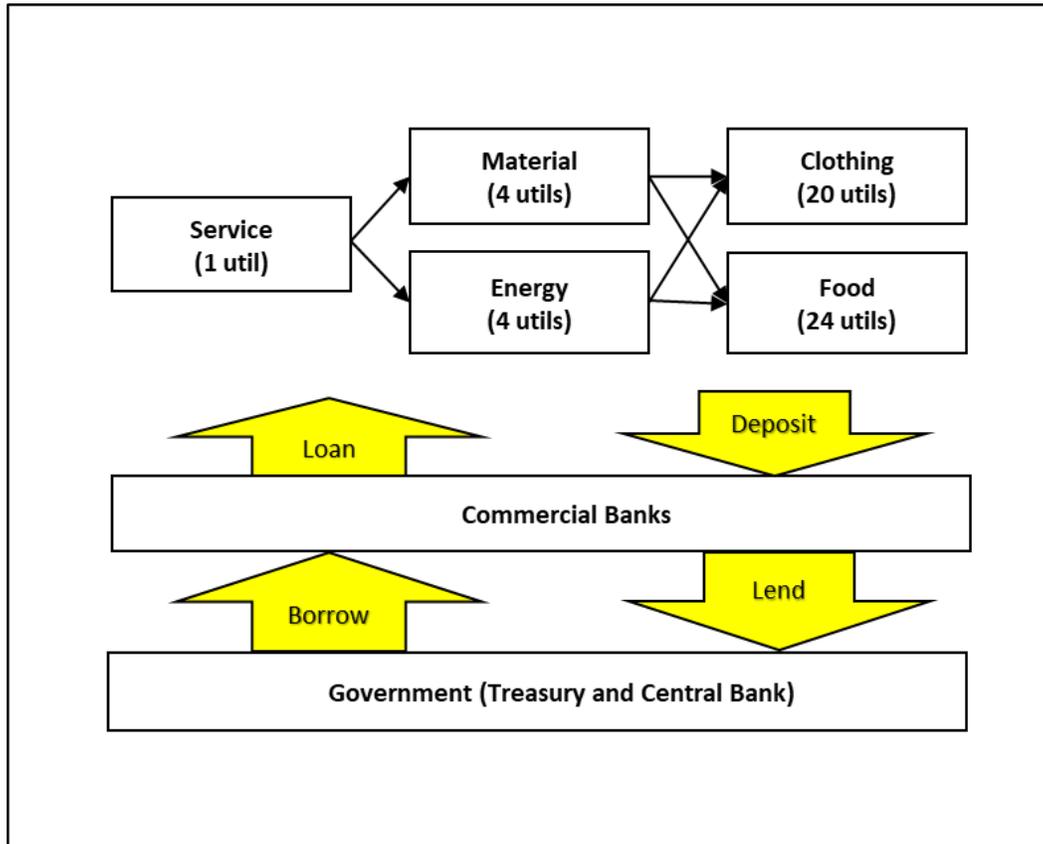


Figure 2 illustrates the supply chain relationships among industries. The value of products in extending participants' lifespans is denoted by its *util* value. As shown in Figure 2, food has the highest util value (24 utils); service has the lowest (1 util). Thus, one unit of food advances a participant's lifespan as much as 24 units of service. Companies that produce food purchase material and energy resources from companies in those industries. In turn, companies that produce material and energy purchase service resources from companies in the service industry. All production companies can turn to commercial banks, also owned and managed by the participants themselves, to earn interest on deposits and to take out loans. Commercial banks manage their reserves by borrowing from and lending to the government, itself operated by an equilibrium-seeking algorithm (Thavikulwat & Yu, 2019).

Employment of executives raises in steps the capacities of companies that produce products, as shown in Table 1 for companies without production experience in the game's five producing industries. Production itself raises capacities further, following the classical learning curve model (Wright, 1936; Reguero, 1957). Company executives are limited to a manager and two subordinates: a purchasing agent (buyer) and a sales agent (seller). A bank can employ only a manager, whose employment is required for the bank to extend loans. A company that produces either material, energy, clothing, or food can employ a manager, a buyer, and a seller. A company that produce service, which requires no resource inputs, has no need for a buyer. Each company can produce only one type of product, but all companies excepting banks can switch from the production of one product to the production of another at any time without incurring a direct switching cost.

TABLE 1
Production Capacities in Units per Period for Companies Without Production Experience

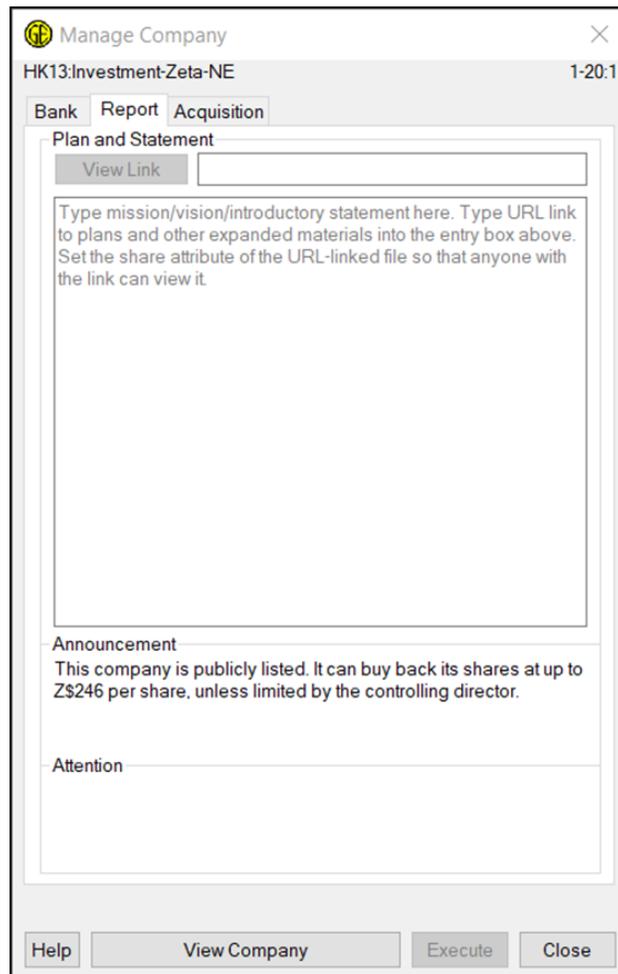
No. of Executives Employed	Service	Material	Energy	Clothing	Food
0	3	3	3	3	3
1	20	15	15	10	10
2	35	25	25	20	20
3	—	35	35	35	35

CEO PRIVILEGES AND DUTIES

To privilege the CEOs over other participants, we included for each round a ghost investor who founded and generously financed one investment company for each participant appointed to be the company’s CEO. To further empower the CEOs relative to other participants, we disallowed participants from founding companies with their own money . Thus, participants could buy and trade shares in the investment companies and their subsidiaries, but they could not found their own companies to compete with those of the appointed CEOs.

The game defines CEOs as managers with the authority to represent the company to investors and to invest company funds in other companies, which could be production companies, banks, or even other investment companies. A CEO asserts authority to represent the company by entering into a panel (Figure 3) a 1000-character-limit statement of strategy and a link to a presentation slide, and by presenting the company to the class at the instructor-scheduled time in the first week of the round.

FIGURE 3
CEO’s Report Tabbed Panel



At the end of each round, the instructor, assuming the identity of the ghost investor, dismisses the CEOs, liquidates the investments of the investment companies, and privatizes the investment companies, so that shares of the investment companies are no longer available for trading. Then the instructor begins the next round by registering a new ghost investor to found a new set of investment companies and appoint a new set of CEOs.

The next round is not a duplicate of the last round, because the operating companies founded as subsidiaries of the investment companies remain active. When the investment companies liquidate their holdings, the investment companies sell shares owned through the computerized stock exchange of the game, where a government-playing algorithm serves as market maker. Shares sold through liquidation by the investment companies are either bought by other parties at and above book value, or by the government at slightly below book value. The next round, therefore, is generally more demanding of CEO skill than the previous round, because of the generally increasing number of competing companies as the game progresses. Offsetting the increased skill requirement is the learning that the new CEO has gained from observing the events of the previous round.

GRADING

The question of performance measures in business games may have first been rigorously addressed by Hand and Sims (1975), who concluded from a study of 13 success measures of business games that the measures reduce to two: sales forecasting accuracy and profit. Since then, Teach (1990b, 1993) has promoted forecasting accuracy over profit, whereas Wolfe (1993a, 1993b) has taken the contrary position. Even so, the debate between Teach and Wolfe, and more recent related studies (de Souza, Bernard, & Cannot, 2010; Wellington, Hutchinson, & Faria, 2013), do not address how performance measures should be credited towards grades. Addressing the omission, we consider three ways of linking performance measures to grades that may be appropriate for games. We refer to the three as the basic method, the progressive method, and the log method.

BASIC METHOD

With the basic method, the participant's performance score (y) in an activity (i) is the product of the number of points towards grades allotted (a) to the activity and the ratio of the participant's performance outcome (x) relative to the upper limit of the performance outcome (x') in that activity. Thus,

$$y_i = a_i \left(\frac{x_i}{x'_i} \right). \tag{1}$$

The participant's letter grade for the course is based on the ratio (r) of the sum of performance scores across all n basic-method graded activities relative to the sum of allotted points (e.g., A for .90 and higher, B for .80 to .89, C for .70 to .79, etc.). Thus,

$$r = \frac{\sum_{i=1}^n y_i}{\sum_{i=1}^n a_i}. \tag{2}$$

A twist on the basic method is to designate one or more activities as extra credit, which means that their allotted points are omitted from the denominator of the grading ratio. Thus, if the last t activities ($t < n$) are designated as extra credit, Equation 3 applies.

$$r = \frac{\sum_{i=1}^n y_i}{\sum_{i=1}^{n-t} a_i}. \tag{3}$$

Without extra credit, the basic method is loss apparent, which we define as the extent to which a score will be perceived by the students as a potential loss rather than a potential gain. A well-established finding of prospect theory (Kahneman, 2011; Kahneman & Tversky, 1979; Tversky & Kahneman, 1974) is that losses loom larger than gains in human decision-making, notwithstanding that the difference between loss and gain is a perceptual difference in reference point rather than a substantive difference in state. Thus, students may perceive a score of 5 out of 10 as a 5-point gain on an activity labeled as extra-credit, because the 5 is viewed with reference to 0, while perceiving the same score on an equivalent unlabeled activity as a 5-point loss, because the 5 is viewed with reference to the upper-limit score of 10. With grades based on the sum of scores, the state on which grades are based is not changed by labels, for $5 + 5 = 10$ irrespective of whether the former or latter 5 is extra credit, but prospect theory suggests that labels change reference points, so student engagement should differ depending on how activities are labeled.

Even with extra credit, the basic method is not progressive, which we define as the extent to which a score will advance the grading ratio, r , of the otherwise lower-performing student more than that of the otherwise higher-performing student. With the basic method applied to all graded activities, the student receiving 10 points on one activity relative to the sum of 50 denominator points is credited with an r increment of $10 / 50 = .20$, irrespective of what the student might have received on other activities.

PROGRESSIVE METHOD

The progressive method builds upon the basic method by applying progressivity to targeted activities. Progressivity results when the scores of the targeted activities are added also to the denominator of r . Thus, if m is the number of targeted activities ($m < n$), z denotes their performance scores, and b represents scaling parameters, then

$$z_i = b_i x_i, \quad (4)$$

$$r = \frac{\sum_{i=1}^n y_i + \sum_{i=1}^m z_i}{\sum_{i=1}^{n-l} a_i + \sum_{i=1}^m z_i} \quad (5)$$

To see that Equation 5 is progressive for the z activities, consider the case of a student who receives the score of 10 points for one progressive-method activity and 40 points out of 50 allotted for any number of basic-method activities. This student would be credited with $40 + 10 = 50$ total points out of an adjusted denominator of $50 + 10 = 60$ points, for an r increment of $(40 + 10) / (50 + 10) - 40 / 50 = .033$ over what it would be if the student skipped the progressive-method activity. If the student had instead received only 30 points on the basic-method activities, the grading ratio increment would have been $(30 + 10) / (50 + 10) - 30 / 50 = .067$, which is, $.067 - .033 = .034$ more. Thus, the points received on the progressive-method activity are worth more in credit towards grades to the student who is less successful in basic-method activities.

Progressivity can be justified by two arguments. First, applying the progressive method to some activities tends to narrow the distribution of grades, which may have a positive effect on the learning environment. Second, Rogmans and Abaza (2019) has found that students who work less hard and like the class less appear also to be less engaged in an international business strategy simulation game that they administered. To the extent these less-game-engaged students also perform less well in basic-graded non-game activities that are part of the class, which might be expected, progressivity in grading game performance may boost collective game engagement, because progressivity allows game performance to contribute more credit towards grades to those who would otherwise be lower on the grade distribution of the class. The two arguments overlap. Whereas, the first argument applies generally to any course activity, the second applies specifically to games.

LOG METHOD

The log method corrects positive skewness, which is the extent to which a distribution of outcomes departs from normality because of a long tail on the high end of the distribution. If points towards grades of an exercise are proportional to positively skewed outcomes, then many students will receive much less in points towards grades for the exercise relative to the student with the highest performance outcome. The result may be perceived as inequitable, and therefore detract from the mutually supportive learning environment that is desired.

Positive skewness is characteristic of earthquakes, commonly measured by the well-known Richter (1935) scale, a logged scale. On a logged scale, each unit increase of the scale is associated with a q -fold change in the outcome measured, where q is the base of the applied logarithm ($q > 1$). Equation 6 presents a logged scale, with variables are as defined in Equation 1, constrained by a maximum ratio to assure that the resulting score cannot be less than zero.

$$y_i = a_i + \log_q \left[\max \left(\frac{x}{x'}, \frac{1}{q^{a_i}} \right) \right] \quad (6)$$

PERFORMANCE MEASURES

The three performance measures of our game are lifespan extension, shares sold, and profit. Whereas lifespan extension applies to every participant over the duration of the game, shares sold apply only to CEOs of investment companies in the first four rounds and profit apply only to CEOs of investment companies in the first five rounds. We agree with Teach (1990b, 1993) that forecast accuracy is an important measure, but we measure forecast accuracy prospectively, through shares sold, because investors buy initially offered shares of a company to the extent that they have confidence in the CEO's forecast of favorable performance at the CEO's presentation to investors within the game.

For grading, we apply the progressive method to lifespan extension, the basic method to shares sold, and the log method, using base 2, to profit. For both the basic method and the log method, we set x' equal to the performance outcome of the company with the highest outcome of its round.

EXPECTATIONS

We had three expectations of data. First, from previous experience with the game, we expected the lifespan extension scores of a few participants to be much higher than those of the rest. Exceptional performance in the game is possible but rare, because it requires collaboration among the few with high ability and motivation who must be fortunate enough to find each other in the loosely structured environment of the game. Second, we expected investment company profit to be positively skewed, because the game stops companies from trading when they become insolvent, thereby truncating the low end of the profit-score distribution. Third, we expected the students to be engaged with the game to the point that the three performance scores on which they were graded, namely lifespan extension, shares sold, and profit, would be positive correlated with each other, for students who are able and attentive to one graded class activity also are generally able and attentive to other graded activities, especially when the activities are components of the same engaging game.

From these three expectations, we select the last for our quantitative test of authenticity. If the game is authentic, participants should generally invest more in the investment companies of those who are more successful in the game, and higher investments (shares sold) together with superior competency (lifespan extension) should give rise to better corporate performance (profit). Thus, our null hypothesis is that lifespan extension, shares sold, and profit will be uncorrelated.

THE STUDY

We administered the game to a population of 32 undergraduate students enrolled in a one-semester strategic-management course at a U.S. regional public university. The game advanced through 160 periods over its five rounds, four regular rounds followed by a consolation round. At the game’s conclusion, the mean lifespan-extension score was 7.085 periods, $SD = 4.245$ periods. Means and sample standard deviation scores for shares sold and profits, the two measures of CEO performance, are shown in Table 2.

TABLE 2
CEO Performances in Shares Sold and Profit

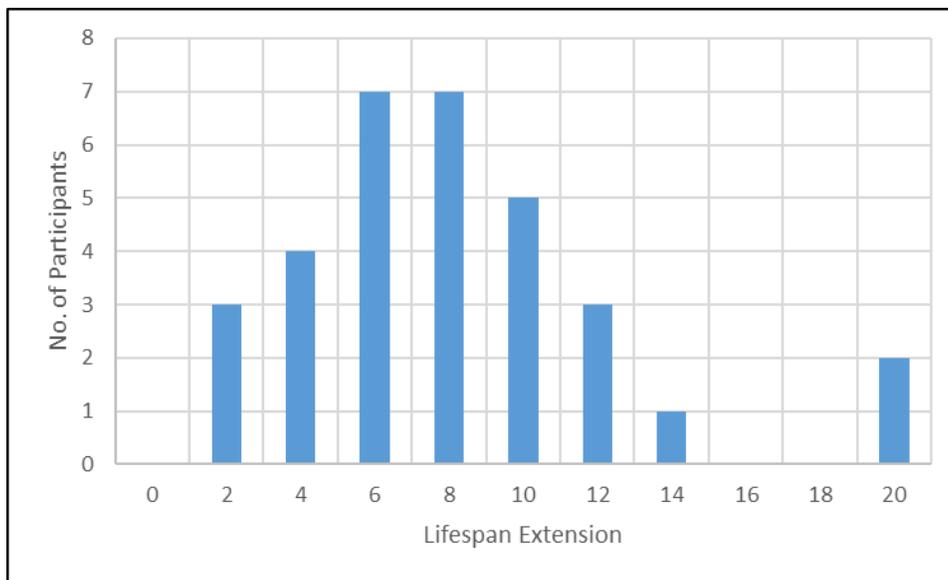
Round	No. of Periods	No. of CEOs	Shares Sold		Profit	
			Mean	SD	Mean	SD
1	14	6	269.67	66.74	1854.67	7611.31
2	20	7	263.57	46.16 ⁺	6324.43	8125.29
3	43	7	257.00	43.24	6590.14	14025.81
4	53	12	220.00	33.23 ⁺	7279.50	15547.35
5	30	22			4097.00	10507.34

⁺Difference in means significant at $p < .05$, $N = 32$. All other differences in means and standard deviations are not statistically significant.

RESULTS

The frequency distribution of lifespan extension over the duration of the game is shown in Figure 4. The distribution skews to the high end (Excel skew = 1.07) because of the two highest scores. Removing those two scores reduces the skew to 0.09.

FIGURE 4
Frequency Distributions of Lifespan Extension



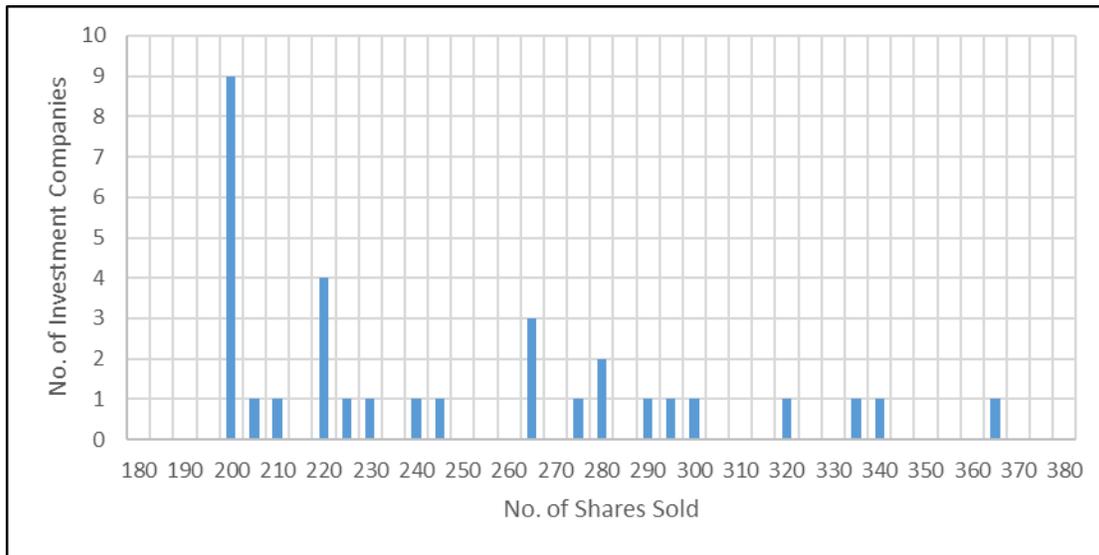
Frequency distributions of the absolute and relative number of shares sold over the four regular rounds are shown in Figure 5, the relative numbers obtained by dividing each investment company’s sales of shares by that of the investment company selling

the most shares in each round. Both distributions skew slightly to the high end, more for the distribution the of absolute numbers (Excel skew = 0.84) than for the distribution of relative numbers (Excel skew = 0.50).

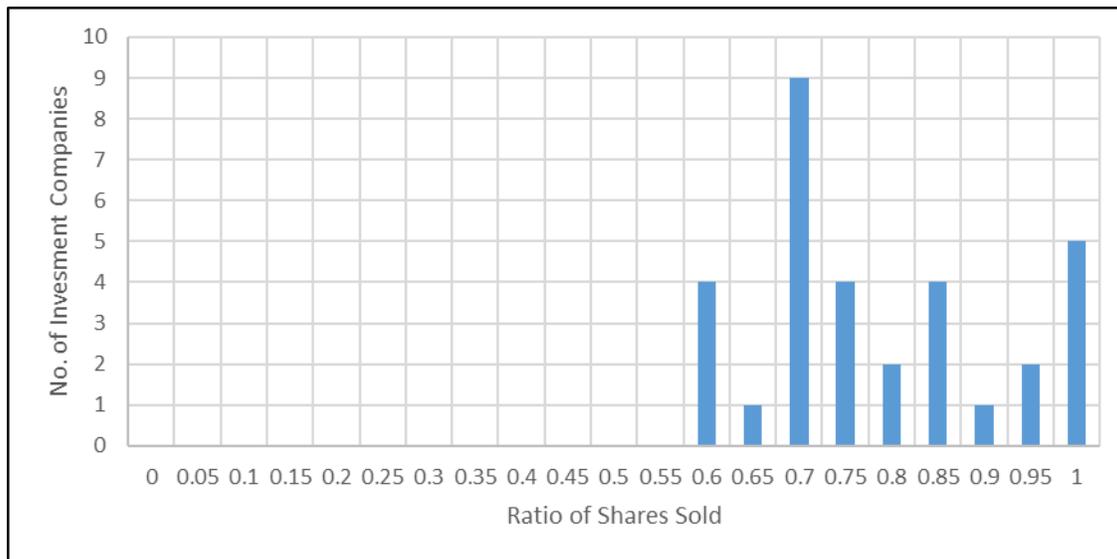
FIGURE 5

Frequency Distributions of (A) Absolute and (B) Relative Number of Shares Sold Over the Four Regular Rounds

A



B

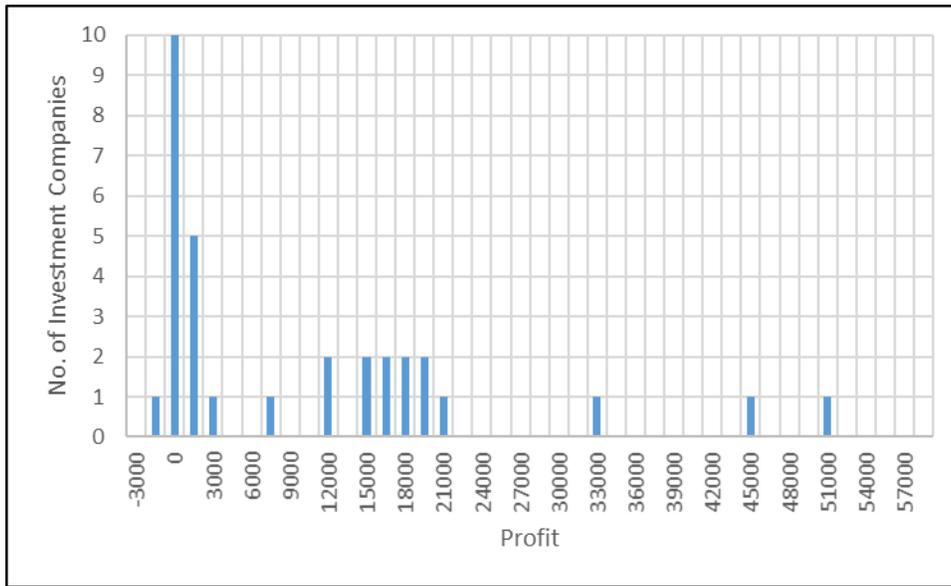


Frequency distributions of CEO investment company profit and logged relative profit over five rounds are shown in Figure 6. Logged relative profits are obtained by setting negative profits to zeros; by assigning participants who were CEOs in two rounds, a regular round and a consolation round, the higher absolute investment company profit of their two rounds; and by applying Equation 6, with $q = 2$ and x' equal to the profit of the investment company that had the highest profit of each round. This time, the skewness of the frequency distributions changes from the investment-company-profit frequency distribution being positively skewed (Excel skew = 1.61), higher than the skews of absolute and relative number of shares sold, to the logged-relative-profit frequency distribution being negatively skewed (Excel skew = -1.48). That the skew flips from positive to negative at $q = 2$ suggests that q should not be set greater than 2.

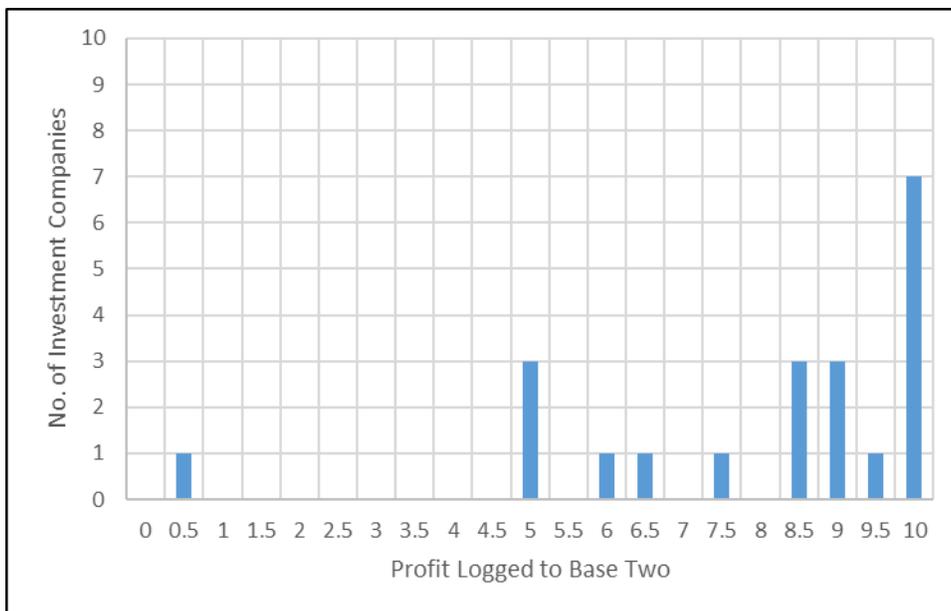
Table 3 shows Pearson correlations of game scores for life extension, relative shares sold, and logged relative profit. Ranging from .439 to .574, all correlations are statistically significant at $p < .05$ or better, so the null hypothesis is rejected.

FIGURE 6
Frequency Distributions of (A) Investment Company Profit and (B) Logged Relative Profit Over Five Rounds

A



B



CONCLUSION

The results are entirely as expected. Only 2 out of 32 participants had lifespan extension scores that were exceptional. The frequency distribution of investment company profit is positively skewed. Performance scores, namely lifespan extension, relative shares sold, and logged relative profit, are positively correlated. The results suggest that the game is authentic in replicating the functions of a corporate CEO.

Games allow a course in strategic management to move away from concept-intensive delivery towards a practice-intensive method that does not require the reading and grading of many papers necessary in a rigorous case-intensive course. Even so, games, like cases, are susceptible to concerns of authenticity. Much as a case can present a setting that is unauthentic, a game can put participants in an unauthentic setting that besides a collective presidency has often included identical firms in identical starting positions and market activity without transactions (Teach, 1990a).

Table 3**Pearson Correlation Matrix of Scores for Life Extension, Relative Shares Sold, and Logged Relative Profit Over Five Rounds**

	Life Extension	Relative Shares Sold
Relative Shares Sold	.439* (.012)	
Logged Relative Profit	.574** (.001)	.529** (.002)

Numbers on parentheses are two-tailed p values, $N = 32$.

* $p < .05$

** $p < .01$

We overcame these issues of authenticity by replacing collective presidencies with rotating offers for students to be singular CEOs of investment companies that could create subsidiaries spanning six interdependent industries operating in transaction-based product and stock markets. We also allowed the environment to evolve as the game progressed through its five rounds. We assured that CEO performance scores were comparable across rounds by scoring performance outcomes of each round relative to the highest outcome of the round.

To be sure, every method of instruction is problematic in some ways, so Rogmans and Abaza (2019) are surely correct in cautiously concluding from their study of a single strategy game in a single setting that “simulation games are not always necessarily effective in enhancing engagement among all students” (p. 393). For us, however, the issue of interest is authenticity, not engagement, for engagement in a game that is inauthentic cannot be educationally useful. Moreover, the problem of authenticity in games lend themselves to interesting solutions.

Generally, business games should be ideal settings for participants to practice essential business skills. To serve this purpose, the games must be authentic in replicating the functions that are involved. To replicate functions authentically, however, the game must allow participants to play roles that are central to those functions, such as the investor role and subordinate role central to the functions of a corporate CEO.

There remains many other key positions of business, education, government, and non-governmental organizations whose functions might be replicated in a game. A first step in the replication effort should be to define the roles that are central to the requisite functions and then to build support for participants to play those roles, with consideration of how performances might be scored for the optimal effect on participant engagement. The challenges may be formidable, but the most difficult challenges also may be the most rewarding ones.

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