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FORECASTING ACCURACY AND LEARNING: A KEY TO MEASURING BUSINESS GAME PERFORMANCE

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ABSTRACT

This paper looks at forecasting errors made by student participants of the CAPSTONE simulation. CAPSTONE is a total enterprise simulation in which participants make individual product decisions as well as firm-wide management decisions. Over the eight rounds of the simulations, the student learned how to more accurately forecast outcomes. Each participant was essentially a "brand manager" for a single product and each student was held responsible for the contribution margin of their product. After the decisions for each round were made, each student was required to forecast the following four items: 1) the unit gross margin of their product; 2) the unit sale of their product; 3) their product's market share; and 4) their product's ending inventory levels in terms of the number of units on hand and the number of days of sales the inventory represented at the end of the round. The accuracy of these forecasts was then related to the student product's contribution to overhead and profit.

After the product level forecasts were made, the team acting as a committee of the whole forecast three firm-wide outcomes: 1) the cash–on-hand at the end of the period; 2) the return on sales (ROS) for the period and 3) the earnings per share (EPS) for the period.

The study found a strong positive relationship between the product-level forecast accuracy and the product's contribution margin and the firm-wide forecast accuracies and the firm's profitability.

A rather strange anomaly was found. If a firm went into a chapter 11 Condition (it needed an emergency loan), it became more profitable. Implications of these findings are discussed.

THE CONCEPT

The ability to adequately forecast the impact of changing key decision making variables must be learned before one can become a good practicing manager. Demand forecasts are a prerequisite for conducting productive sales and operations planning (Lapide 2005). Management by objectives would be impossible without a method of periodically assessing progress and using these assessments to forecast the ability to reach the final objectives. Managers constantly forecast on premises and assumptions they make about the future. Firm expansion decisions are based upon forecasts of increasing demand at profitable prices. The purchase of raw materials and component parts are based upon forecasts of production rates which, in turn, are based upon forecasts of future sales. The stockmarket constantly forecasts future expectations of firm sales and profits and, if a firm does not meet theses forecasts, the stock price almost always falls; it almost always increases, if the firm exceeds these forecasts or expectations. The choice of majors by university students are often impacted by forecasts of employment opportunities. To show this latter case, check enrollments in computer science after the dot-bomb situation in 2001. The steep price collapse of technology-based firms' stock prices forecasted a drop in opportunity for students studying computer science. As a result, students changed majors and new students did not select computer science in the numbers that did in the 1990s. Note, the above discussion indicates that the ability to forecast events is a necessary but not a sufficient skill for managers. There is a long list of necessary managerial skills, and forecasting is but one of these many skills.

The economic implications of learning by doing were outlined by Arrow (1962). Arrow was explaining forecasting manufacturing cost reductions through the utilization of learning curves as a forecasting process. This technique has learning as it central theme. It was learning itself that forecast cost reductions.

The concept that forecasting is a key to a firm's performance is not new. Gregory Pickett and Roxanne Stell (1987) pointed out:

> "*Forecasting is an accepted and necessary function performed to some degree by all businesses. Forecasts are used to help identify expected labor demand or wage rates, anticipated cash flow, future product sales, plant utilization, raw material usage, purchase requirements and general economic trends for use in strategic planning. Given the breadth of business activity affected by forecasted information, one might assume that a forecasting class would be a basic offering at most business colleges.*" (Quote page. 165)

What is forecasting? Forecasting simply means "to calculate or predict (some future event or condition) usually the result of rational study and analysis of available pertinent data."[1] Forecasting itself is not technique dependent. It may involve very sophisticated statistical routines or econometric modeling or seat-of-the-pants

estimation. Rotenberg (1994), when discussing the forecasting of corporate financial performance, explained that there is a trend toward a greater reliance on more qualitative forecasting techniques. The results of a 1987 survey of Financial Executives reported that qualitative forecasts are creditable and informative to investors (Hoskin, Hughes and Ricks (1986). Skinner (1994) found an even greater proportion of non-quantitative forecasts.

This author has seen many types of highly successful forecasting techniques used in corporate environments. Newell Chiesl (1987) noted that forecasting methods vary in the degree of rigor and formality. And in Render and Stair's (1982) text on forecasting, they have written, "*In numerous firms the entire process is subjective, involving seat-of-the-pants methods, intuition and years of experience*," (quote from page 18). Forecasting can help minimize inventory and obsolescence costs as well as reduce potential loss resulting from their stock-outs (Jain 2005/2006).

Blue Cross and Blue Shield undertook a new strategy in 1992, one that was dedicated to learning. In that decree they cited, "*Modeling and forecasting are becoming one of the most valuable tools for learning*" (Ferguson 1992 p 27).

The link between a reduction in forecasting errors and learning was made by Mansfield (1996) when he claimed that learning had taken place because forecasting errors had decreased.

Since the late 1990s, there have been new measures of firm performance, namely, Economic Value Added (EVA) and it is claimed that this measure may be a better measure of firm performance than Earnings per share (EPS) (Ittner and Lacker 1998). However, EPS is still the preferred measure of firm performance. As a result, the new measure of EVA was investigated as a forecasting agent for EPS (Machuga, Pfeiffer and Veran 2002). These researchers found that Economic Value Added information could increase one's ability to predict Earnings per Share and they also found that forecasting errors were related to EPS (The smaller the error the better the forecast.) Thus, increasing the ability to forecast would increase a firm's financial performance.

George Day (2002) wrote that organizations learn about their markets by market sensing and sense making. He added that "*firms that have mastered these two processes gain an advantage by anticipating marketing opportunities ahead of their rivals and more accurately forecasting how the market will respond to their moves*." (p240) Thus forecasting is an important and a learning skill needed by successful firms. Not only is forecasting important, but it is becoming more important over time simply because of increased litigation concerns when firms publish their future expectations (Ciccone 2005).

FORECASTING AND BUSINESS SIMULATIONS

From a theoretical prospective, it would be extremely difficult to create a scenario in which forecasting was not an important component in the decision making process of a business simulation. Most total enterprise simulations require both strategic planning processes and decision making processes. Neither of these processes could proceed effectively unless the players forecast some form of competitive response from the strategic standpoint and the market-place response from the decision making perspective. For it to be otherwise, the participants would just be guessing or grasping at straws in the wind for direction. Capon and Palij (1994) reported that strategic forecasts were more accurate when greater levels of competition existed; and that superior forecasting performance was positively associated with superior firm performance.

In most simulations, the periodic nature of receiving data feedback is such that only a few data points are available for forecasting purposes. In general the degrees of freedom are such that the number of independent variables used for forecasting purposes in very limited. As a result most forecasting in business games is the result of using simplistic and not complex methodologies. But, a study reported by Homes, et al. (2005) suggests simple models may be more useful in the learning process. Their research found that the complex forecasting strategies, as compared to simpler techniques slowed down the learning process.

Numerous authors have written on the use of forecasting in business games. One of the more controversial articles was written by Richard Teach (1993) in which he suggested that business game performance could/should be measured by using forecasting accuracy and not enterprise profits. He concluded that if one could abandon using profits as the measure of success, the very nature of business simulations could change for the better. Business games could be designed that would make more realistic learning simulations that currently exist. Currently almost all business simulations start with identical assets and equality among the firms and the marginal rates of return for each of the decision variables are equal across firms.

Jim Gentry and Edward Reutzel (1977) reported on an inventory control game written by Ronald Frazer. Thy reported that the purpose of Frazer's game was to provide students with an understanding of the complexity of the inventory control process. One of the key learning aspects of this game was for the students to "*…devise a forecasting routine and incorporate it into the determination of the Economic Order Quantity (EOQ) and the reorder point (Quote from page 224).* Here again, accurate forecasting leads to grater firm performance and learning to forecast is a major attribute of playing a simulation..

In a paper relating forecasting abilities to business simulation performance, LaFollette and Belohlav (1981, p. 186) wrote:

> *"The forecasting accuracy of each group* (team) *reflected the quality of the decisions that then determined the company's performance. To put in*

another way, the accuracy of the forecasting of each group reflected that group's effectiveness"

Varanelli and Fazio's paper (1981, p186) claimed that *"…to forecast future results is crucial to being a successful game participant."*

In an early study of indicators of success, Gosenpud, Miessing and Milton (1984) conducted a stepwise regression using return on investment (ROI) as the dependent variable with four independent variables. These variables were: *forecast accuracy*, *strategic stability*, *price strategy* and formal planning. The data for this study were supplied by 106 students who had played THE EXECUTIVE GAME. The result showed the independent variable with the greatest Beta value was forecast accuracy which also had the lowest "p" value of less the 0.0005.

The need for good forecasting when playing business games was also recognized by Newell Chiesl (1987 when he wrote:

"The value of the forecasting and planning technique is to provide a versimilitudinal (sic) experience for the students participating in a Business Simulation. The ultimate goal is to have students learn a planning technique. In order for the students to be successful in the computer game, they must be good record keepers, planners and forecasters," (quote from page 30).

A study conducted at Columbia University on MBA students playing a business game (*Glazer, Steckel, and Winer.1989);* found that the degree of firm rationality in the forecasting process and the level of forecasting accuracy were directly related to performance.

Jerry Gosen and John Wasbush's (2001) study of what is learned by students when they use a business simulation confirmed the strong link between forecasting accuracy and simulation performance ($r = 0.87$ & $p < 0.0005$). Their finding that learning and forecasting accuracy were negatively related is not surprising, at least in this author's opinion, as it indicated those who cannot forecast have a lot more to learn than students who already know how to forecast.

In a 2002 paper, Washbush and Gosen had mixed results when comparing forecasting accuracy to simulation performance. In a Spring semester section of game players where the simulation went on for 13 periods, they found the relationship to have a coefficient of determination of 0.4142 with a "p" value of 0.0001, but in two sections taught in the Fall semester that ran for eight and nine periods, they reported lower coefficients of determination but unfortunately only reported the slope significance as N.S. instead of showing the actual "p" value. Thus, the level of significance is unknown to the reader.

John Washbush (2003, p 251) also reported findings that confirmed forecasting as highly related to simulation performance. He found, "*Three correlations* [between forecasting accuracy and performance] *were statistically significant beyond the 0.01 level*."

THE RELATIONSHIP BETWEEN FORECASTING ACCURACY AND FIRM PERFORMANCE IN BUSINESS GAMES HAS NOT BEEN ALWAYS FOUND

Philip Anderson and Leigh Lawton (1992, p334) when studying the relationship between financial performance in business games and learning, found a 0.0 coefficient of determination between forecasting accuracy and financial performance when their students forecasted unit sales. Note that it is extremely difficult to find a zero R^2 between any two sets of observations. However, they did find a relationship between forecasting accuracy and the team's mean grade on a written analysis of the game performance. Could this be an indication that forecasting accuracy was a measure of learning?

As a result of the above background research, a study was designed in an attempt to measure forecasting errors as learning phenomena by individuals and the impact of forecasting accuracy upon performance from an individual as well as a team basis.

LEARNING BY FORECASTING

In an article on agent based manufacturing systems, Shen, Maturana and Norrie (2000) divided the learning process into "learning from history," the learning from cases and reasoning and "learning from the future," which was learning from system forecasting simulations.

While accuracy in forecasting outcomes is very important in itself; there are other somewhat stealth learning outcomes that result from having participants produce forecasts of specific results. Below are seven specific forecasts and an analysis of what learning may take place as the accuracy of the forecasts improves. These are broken down into types: four forecasts about specific product measures and three forecasts about firm level outcomes.

FORECASTING UNIT SALES FOR EACH PRODUCT FOR EACH PERIOD

As the forecasts improve, it indicates that the participant is understanding and learning what drives or causes unit sales, not only the decisions made within his/her firm, but also the competitive responses of all the firms in the marketplace and their affect on the participant firm's unit sales.

Accurate unit sales forecasts are necessary if rational manufacturing schedules are to be established and if adequate funding will be available, since sales are the cash generator for most established firms. If the forecasts are inaccurate, excessive inventory or product "stock-outs" will occur, which adversely affects the firms' performance and cash positions.

FORECASTING THE UNIT CONTRIBUTION MARGIN OF EACH PRODUCT THE FIRM SELLS FOR EACH PERIOD

Contribution margin is the dollar and cents that each unit of product sold contributes to the firm's overhead costs and profits for the simulated period. The per-period unit contribution margin is very similar, though not identical, to the period's dollar sales less the average marginal cost times the unit sales. While the exact marginal cost is rarely known in a simulation, (or in practice) the concept in the economics-of-the-firm (Micro) is overwhelmingly important.

As the forecast of unit contribution margin improves, the participants learn the factors that drive unit variable costs. Forecasting of unit contribution margin drives home the importance of cost control and being aware of unit variable costs.

The combination of unit sales forecast and unit contribution margin, when multiplied produces an estimate of the product's total contribution margin for the period. If the firm manufactures more than one product, then the sum of these product contributions results in the firm's overall contribution margin for the period.

If participants plot the gross margins by product by time period, it provides a methodology for anticipating the firms manufacturing costs and allows the players to check their assumptions about causes and affects of its cash flows. The plots should also provide insight on the participant firm's total profits and losses for each period.

FORECASTING EACH PRODUCT'S UNIT MARKET SHARE FOR EACH PERIOD

Fortunately, simulation designers provide unambiguous information available to business simulation participants about industry level future demand. Accuracy of market share forecasts indicates that game participants are learning how to anticipate competitive responses, and the importance of competitive behavior in the market place. Initially, most business game respondents (at least this has been the experience of this author) rely only on their own decisions when estimating their expected results and they often ignore the behavior of their competitors. This exercise of forecasting expected market shares by product by period focuses participants' attention on all the players in the market place.

FORECASTING THE UNITS OF ENDING INVENTORY FOR EACH PRODUCT EACH PERIOD

Forecasting ending inventory requires an understanding of expected unit sales, expected manufacturing levels and the prior period's ending inventory. This should be an easy exercise because a unit sales forecast has already been generated, and the units of ending inventory are known. Thus, the simple equation of:

$$\text{Manufacturing level}_t = \text{expected unit sales}_t - \text{ending inventory}_{t-1} + \text{desired safety stock}_t$$

(Where the subscript t represents the particular simulation round or time period)

is in almost every operations and management strategy textbook. But, students constantly make substantial errors in this estimate. As the accuracy of the ending inventory forecast improves, the game participants may learn to apply what has been taught to students in numerous business school courses. This learn by doing creates a substantial reduction in the teams' cash management problems.

The amount of safety stock needed is a function of forecasting accuracy and the risk of running out of inventory (having stock-outs) balanced by the cost of carrying inventory.

FORECASTING THE RETURN ON SALES FOR THE FIRM FOR EACH PERIOD

The forecast of unit contribution margin is an estimate of the dollars and cents return on a single unit of sales for a specific product. The estimated firm-wide ROS is a broad measure of the firm's effectiveness. It measures the amount of profit that is generated by each dollar of sales (averaged across all products).

If a team can accurately estimate or forecast the ROS for their firm, it should indicate that they understand what drives this value. If they can accurately forecast ROS, they must be able to forecast the firm's earnings. If they understand the cause and affect aspects of earnings and the drivers of sales, they should know how to increase the performance of the firm. The more accurate the forecast, the more they have learned about how the firm accrues profits.

FORECASTING THE EARNINGS PER SHARE FOR THE FIRM FOR EACH PERIOD

The earnings per share estimate is determined by taking the earnings estimate used in determining the forecast of ROS and dividing it by the number of shares of stock outstanding. Thus, ROS and EPS forecasts should be highly correlated. If one is much more accurate than the other, it would indicate that the participants have a misunderstanding that needs be corrected.

FORECASTING THE ENDING CASH BALANCE FOR THE FIRM AT THE END OF EACH PERIOD

Understanding cash flow is a critical skill in managing a firm. As such, being able to forecast the available cash at the end of each period of play in a business game indicates that the participant has learned the skill of cash management. The more accurate the forecast, the more the participant has learned.

Many business simulations have an attribute that prevents bankruptcy. This feature exists in order that firms do not disappear from the competition. The logic of this characteristic is to prevent bankruptcy and keep all participants in the game for a limited number of rounds or periods. This design feature is necessary when the game is

used in a situation where participant performance is evaluated by a function of the firm's profits. This may have unintentional negative consequences. One of these negative consequences is that simulations often reduce the emphasis on cash management. This is a serious shortcoming because each time a firm needs an "emergency loan" to survive, the firm has actually gone into a Chapter 11 bankruptcy, but this condition and its serious consequences is often unrecognized. This point is rarely pointed out by the simulation designers. A firm's purpose is to maximize the shareholders value. Thus, when a firm is granted the "emergency loan" it has failed its stockholders and its creditors and the costs to its employees are almost never pointed out.

What is bankruptcy? It is the inability for a firm to pay its bills in a timely manner. Participants in business games, especially undergraduate students, often think that bankruptcy is function of profitability, but it is not. It is a matter of cash management. Profitable firms can and do go through Chapter 11 reorganizations and sometimes Chapter 7 proceedings if they have a poor chance of reaching a positive cash flow.

Thus, the accuracy of participant's forecasts is an effective measure of the learning that takes place during a simulation experience. This may well be the highest greatest use of business simulations.

THIS STUDY

In most previous studies, there has been difficulty in measuring forecasting accuracy and simulation performance because forecasting is an individual's skill and simulation performance is the result of team efforts. This paper reports on a study where each team participant was assigned a product to manage and each participant was competitively evaluated on her/his product's contribution to overhead and profit as well as their team's performance.

THE GAME

The data set used in this paper is from students in a B2B marketing course that played the game CAPSTONE (2004), which is a total enterprise simulation. The teams played two practice rounds and then eight rounds in competitive play. The game portion of each student's final grade in the course was 40%.

In CAPSTONE, each simulated company produces up to five products and each team had five participants. Each participant was assigned one product or brand that was his/her personal responsibility. Thus, each student would act as a Brand Manager for his/her assigned product and make all the decisions necessary to create the product, manufacture and market it to the specific target market. The students were told that their game grade would be based upon: 1) their product's relative amount of total contribution margin compared to their compatriots managing the identical brand in each of the other teams and 2) the relative market share of their product when compared to their competitors. Each student's performance was posted on the professor's door after each round of play.

THE FORECASTING TASK

Before each round was run, the teams handed in an "annual report" of their analysis of the results of the prior round. At the end of this analysis was a set of forecasting forms in which each participant recorded the actual sales in units, the dollar unit gross margin of their product/brand, the ending inventory of product/brand and their market share of their product/brand in their product's target market segment. Then, they forecast what they expected these values to be at the end of the next round of play. In addition, the each team

EXHIBIT 1
The product level forecasting form

Firm number _____ Firm Name _____ for simulation year _____

The name of the person responsible for product Able. _____

Unit Sales **in the current** year of product able _____ Units

The **expected** unit sales next year for the product Able _____ Units

The **current** unit gross margin of product Able $ _____.____

The **expected** unit gross margin **next year** for the product Able $ _____.____

The **current** units of ending inventory of product Able _____ Units _____ Days

The **expected** units of ending inventory of product Able (**next year**) _____ Units _____ Days

The **current** market share of product Able _____% (use at least one decimal place.)

The expected market share of product Able for next year _____% (use at least one decimal place.)

Signature: _____

EXHIBIT 2
The firm level forecasting form

Firm results and projections

What was the firm's ROS (Return on sales) **last year**? _____%

What **do you expect** your firm's ROS will be **next year**? _____%

What **was** your firm's EPS (Earnings per Share) **last year**? $_____.____

What **do you expect** your firm's EPS to be next year? $ _____.____

What i**s** the **current** cask position of your firm? $ _____

What do you **project** your firm's total cash to be **at the end of next year**? $ _____

Did your firm require an Emergency loan last year? [ ] Yes [ ] No

Reviewed by the team Captain _____
Please print your name

Signed by the team captain _____
Please sign you name

TABLE 1
Arithmetic mean of absolute values of the forecasting errors for 18 teams Product ABLE

Simulation Year	2006	2007	2008	2009	2010	2011	2012	2013
Average Errors in Unit Sales forecasts	204	291	259	230	250	210	184	148
Average Errors in Unit Contribution	$0.61	$0.62	$0.75	$0.75	$0.63	$0.37	$0.89[1]	$0.59[2]
Average Errors in Market Share Forecasts	4.50%	4.81%	2.04%	1.65%	1.85%	1.54%	2.87%[3]	2.79%[4]
Average Error in Ending Inventory Forecasts[7]	142	430	250	204	184	175	397[5]	227[6]
Superscript 1	Firm 17 had a $5.71 error in its forecast of unit gross margin. The average error excluding firm 17 was $0.566, still above 2011 error, but below 2010's error.							
Superscript 2	Firm 17 had a $3.57 forecast error of unit contribution margin. The average error excluding firm 17 was $0.396.							
Superscript 3	Firms 17 had an over-forecast of Market Share by 8.1 percentage points and Firm 3 had an over-forecast of Market Share by 6.3% percentage points.							
Superscript 4	Firms 17 had under forecast its Market Share by 4.7% and Firm 3 had overestimated its Market Share by 5.9%.							
Superscript 5	Firms 17 had underestimated its Ending Inventory by 2,140 units, Firm 12 by 1,287 and Firm 3 by 643 units. These were the 3 greatest errors							
Superscript 6	Firms 17 had underestimated its Ending Inventory by 1145 units							
Superscript 7	When calculating ending inventory forecasts errors, all firms that had stock-outs were excluded.							

recorded the rate of return on their companies' sales (ROS), the firms' earnings per share (EPS) and their cash balances. Each team was then required to forecast these same three values for the end of the following round of play.

In industry, forecasts are updated many times in a year, (Landry et al 2005). Many simulations have either a one quarter or one year accounting and decision cycle. Thus, in a game using one year decision cycles, does not allow for any updates to be made to annual forecasts; a situation that never occurs in an actual practicing firm.

Exhibit 1 shows the form for the product Able (all products had the same required forecasts.

Exhibit 2 shows the form for the three firm level variables.

THE RESULTS

Only the results of the product Able will be displayed. The results of all five products were very similar and the inclusion of the additional data would be redundant.

Table 1 displays the average of the absolute vales of the error in forecasting of the four product-oriented forecasts by period. The absolute values of theses errors were computed to prevent any over-estimated forecasting errors from canceling out under-estimated forecasting errors.

The errors in forecasting at the individual product level were calculated and averaged for each of the eight periods of play of the game CAPSTONE. Table 1 displays the averaged forecasting errors for each of the four forecasts required for the product identified as Able.

The first thing to notice is that in all four categories, the error terms went up in period 2. I believe this was a phenomenon of the two practice rounds that the teams completed before starting the eight competitive rounds. CAPSTON restarts the game with the same parameter and starting positions that exits in the practice rounds. As a rule, the students I have observed, when faced with a small set of practice rounds do not make drastic changes in their decisions when they begin their competitive game. Thus, they have experienced a similar outcome and their forecasts reflect this past experience.

The average of the absolute values of the error terms peaked in the second period for three of the four forecasts. The average unit sales error term peaked in period three then dipped, increased and then fell for the last three periods.

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The mean error term for forecasting unit contribution also peaked in the third period than then fell in each ensuing period with the exception of periods seven and eight. These last two increases in the average unit contribution forecasting error was the result of gigantic errors by only two of the 18 simulated firms.

The errors in the market share forecasts fluctuated a little more than the other three error terms. In periods seven and eight, much of this increased error in estimating market share was due to two firms.

Forecasting ending inventories also improved until period seven. Three firms had very large forecasting errors in this area, but in period eight, only one firm was off by a large proportion (see the footnotes in Table 1.). It was clear in the class that one firm no longer cared about the simulation and all members of this team were no longer willing to put in the time required to make effective decisions and more accurate forecasts. Their learning from the game came to a screeching halt.

FORECASTING ERRORS AND PERFORMANCE

The relationship between forecasting errors and product performance when product performance was measured by the total contribution to profit and overhead by product was

TABLE 2
Stepwise regression results using the contribution to overhead and profit as the dependent variable and the absolute values of the error terns in the three forecasts as independent variables

Model	Unstandardized β Coefficients	Standardized Beta	"p" value
Constant	4,426		< 0.0005
Absolute value of the error in forecasted unit gross margin	- 2,910	- 0.676	< 0.0005
Absolute. value of the error in forecasted unit sales	- 10.4	- 0.309	< 0.0005
Absolute. value of the error in forecasted market share	- 402	- 0.269	0.024
Model Summary			
Model	**R**	**R^2**	**Adjusted R^2**
3 independent variables	0.657	0.432	0.402
ANOVA			
Model	**Sums of Squares**	**df**	**"p" value**
Regression	2.09E+09	3	< 0.0005
Residual	1.79E+09	113	
Total	3.87E+09	143	

TABLE 3
Stepwise regression result using the period profits as the dependent variable and the absolute values of the errors in the three forecasts and the existence of a cash shortfall as independent variables

Model	Unstandardized β Coefficients	Standardized Beta	"p" value
	β		
Constant	7,107		< 0.0005
Abs value of the error in the ROS forecast	- 203,888	- 0.287	0.002
Abs. value of the error in cash forecast	- 0.224	- 0.308	0.001
Chapter 11 condition	5,884	0.238	0.002
Abs. value of the error in forecasting EPS	- 1,634	- 0.263	0.007
Model Summary			
Model	**R**	**R_2**	**Adjusted R_2**
4 independent variables	0.689	0.475	0.455
ANOVA			
	Sums of Squares	**Df**	**"p" value**
Regression	3.94E+09	4	<0.0005
Residual	3.60E+09	105	
Total	7.03E+09	109	

the next issue. The proposition was that lower forecasting errors were directly related to the amount of contribution the product generated, period by period.

To test this premise, a multiple regression was performed, using the product's contribution as the dependent variable and using the absolute values terms of the four forecast errors as independent variables. These results are shown in Table 2. For brevity, only the information of the last step of the regression analysis is shown. Readers should note that the errors in the ending inventory forecasts were excluded from this analysis because, when there was a "stock-out" condition, there were no readily available measures of the size of the forecasting error.

The absolute values of the three forecasting errors accounted for 40% of the variance of the contribution to overhead and profit. Growth in the market place accounted for slightly over 40% of the variance in the contribution to overhead and profit. Everything else, including the stock-outs and the decision and strategy errors made by the firms, accounted for less than 20% of the variation of the contribution to overhead and profit.

The above data analyzed each individual student's accuracy in forecasting and related it to the performance of a single product, as measured by the product's contribution to overhead and profit. The next section analyzes the corporate-wide forecasts of "ROS," "EPS" and the "Cash on-hand at the end of each round" and relates these errors of these forecasts to the profitability of the firms.

LOOKING AT CORPORATE-WIDE FORECASTING ERRORS AND ITS IMPACT ON PROFITABILITY

Firm profitability was then made the dependent variable of the second regression, which used the absolute values of the three forecasting errors, cash on hand at the end of each period of play, the ROS for each period of play, the EPS for each period of play and a dummy variable representing whether or not the firm went through a Chapter 11 bankrupts (ran out of cash) as independent variables.. These results are displayed in Table 3.

The three forecasting error terms all had very significant, negative coefficients, therefore the larger the errors in forecasting, the lower the firms profits were.

One would think that if a firm went through a "Chapter 11" bankruptcy its overall profitability should be negatively affected. But that was not the case in this CAPSTONE experience. It clearly indicated that when the firms in this one class of 18 firms simulated for eight rounds had cash shortfalls, they were (on average) more profitable.

RESULTS OF THE ANALYSIS

The analysis shows that participants in CAPSTONE, which took part in this experience (I leave it up to the reader to generalize), performed much better when they learned how to forecast the outcomes of their decision processes.

Also, as the game went on, they learned about the process of managing a simulated firm. Is this learning transferable to the practitioner world? That is beyond the capabilities of this data set, but this author can't help but believe that it is.

IMPLICATIONS

This analysis has implications regarding what simulation participants learn and the links between learning and their firms' performance. It also has implications for game design. If one measures game performance by forecasting abilities rather than profits, then games can be designed in more realistic way. We tend to fool ourselves into believing that our simulations are realistic because they produce income statements and balance sheets. However, what actual industry has every firm start with equal assets and exactly equal opportunities at the margin for each decision variable? Students should learn to leverage whatever their firm's inherent advantages may be. Some firms have better R&D facilities than others. Some firms have access to lower costs of capital. Some firms are better marketers than others. Some can manufacture products with lower variable costs and /or lower overhead than others, while still others have superior design capabilities. One thing is certain; an industry where all firms have equal opportunities never exists. If one measures simulation performance by the ability to forecast outcomes, the nature of business games becomes much more like the real world. Also – "end-play," where teams try to "beat" the game during the last period would disappear. There would be no reason to make drastic strategy or decision changes while making a last ditch attempt at winning. In fact, it would be best not to make drastic changes because the results of the drastic changes would be more difficult to forecast.

The author encourages other teachers, researchers and users of business simulations to experiment with using a variety of measures other than the firm's financial outcomes to evaluate student performance in a business game. Although short run financial performance is used on Wall Street, it is not necessary to use the same indicators to measure student learning.

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