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# MODELLING ECONOMIC ENVIRONMENTS IN BUSINESS SIMULATIONS: SOME COMPARISONS AND RECOMMENDATIONS

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## ABSTRACT

The capability of business simulations to be run with different economic environments is linked to the teaching objectives of the instructor. Although some simulations allow for different economic environment, the instructor may want to set its own scenario. This capability is also linked to the number of times the simulation is run. As the simulation is run over several periods of play "new learning" takes place on the part of participants. This is because they become aware of what the economic environment is and what the best decisions are. This paper analyzes the economic environment models of five business simulations and proposes a model that has the advantage of generating different scenarios in a systematic way. By using this method, more variables can be involved in the economic environment and participants can have more elements to consider when making their forecasts.

## INTRODUCTION

Operations for firms in business simulations are conducted within an economic environment. Generally, the economic environment includes at least three parameters: (1) the stage of the business cycle in which the economy is in (expansion, contraction), (2) the level of inflation, and (3) the level of interest rates. Inextricably connected with these parameters are sales at the industry and firm levels, and costs. The simulation designer normally allows the simulation administrator (SA) to make changes in some of these parameters, although the degree to which changes may be made varies among different simulations. In determining the volume of sales, for instance, some simulations allow the SA to choose from different sets of values presented in tables, assign different levels of growth for the economy, or assign sales values. In more liberal simulations, the responsiveness of industry and company sales to decision variables affecting demand may also be modified by administrators, via assigning elasticities or weights. A default set of values is included in cases where the administrator does not want to make changes.

Assigning values to economic environment parameters is important, first, to determine the volume of sales that will be periodically assigned to the industry and to companies in the simulation; second, to provide a scenario in which the participant can experience periods of expansion and/or contraction along with high or low inflation rates; and third, in certain simulations, to furnish the participants with historical values that will help them make forecasts or spot trends in future economic conditions and of company sales. The ability to forecast company sales affects the performance of the companies in the simulation, through its effects on production orders, inventory levels, funds requirements and cost. Teach (1990) proposes the use of forecasting errors as a criterion for evaluating company performance in business simulations. Therefore, if forecasting is judged to be very important in measuring performance, then additional and more relevant information should be supplied to simulation participants. This includes providing sufficient historical data (so that regression analysis can be utilized), and more economic variables that participants can consider in their analysis.

The model proposed in this paper is intended to offer designers and users of business simulations a method of modeling economic environments, such that the generation of environmental parameters allows for more freedom to SA and be made in a more systematic way. Additionally, the proposed model will facilitate the inclusion of more variables in the economic environment, thus providing participants more elements to consider in making their forecasts. Before demonstrating the proposed model, instructor manuals of five-business simulation currently used in schools of business will be analyzed. Questions guiding our analysis include the following: What are the parameters defining the simulations' economic environment? Can the parameters be modified? Are there historical values for these parameters that can be used by participants in sales forecasting?

## ANALYZING THE SIMULATIONS

### The Business Policy Game

In this simulation, a GNP index is used as indicator of economic activity. A stock index is used as a leading indicator. Completing the economic environment, values for CPI, short and long term interest rates, and EPS are presented. The SA selects 28 sets of consecutive values reflecting different economic situations, from a table presenting 104 values for each of the variables aforementioned. These values can not be modified. The SA is also allowed to set price elasticities for demand at the industry and company levels, and adjust indexes and cost multipliers for labor and materials.

The levels of industry sales that will prevail during the simulation are indirectly determined by the SA through the chosen GNP indexes. Actual industry sales will depend on participants' price decisions and price elasticities set by the SA. Eight historical values for company sales are provided for eight quarters, which may be changed by the SA by adopting and running eight new sets of decisions before the participants start playing the simulation. Historical values for the economic variables can be made available to the participants.

### Micromatic

In this simulation, an index of economic activity and interest rates comprise the economic environment. The Business Week Index (BWI) is used as an indicator of economic activity. The BWI index is taken each week from the magazine and influences the level of

industry sales chosen by the SA. Long-term and short-term interest rates are decided by the SA in each quarter; the former may be negotiated with the participants. Outstanding bonds have an interest rate of 9%.

The SA is given nine sets of sales volumes to choose from, or unique forecasts may be generated by the SA by entering values. Sales volumes options, include periods of expansion, contraction, seasonal, random, or a combination. The BWI acts on these different scenarios, emphasizing or de-emphasizing their effects. The SA can change the effect of BWI changes on sales volumes at the industry level. He can also change the effect of sales promotion activity as well as set weights for the effects of national and local advertising, salespersons, product improvements, sales price changes at the company levels. Costs of purchasing, assembling, selling, and distributing may be changed.

Even though the SA has much flexibility in modifying the environment, changes have to be made in each quarter. Only fixed historical company sales figures for eight past quarters are available. These values may not be related to the values chosen by the SA for the following periods.

The Business Strategy Game

In this simulation, an indicator of economic activity, short and long term interest rates, and exchange rates, constitute the economic environment. The S&P 500 index is used as a measure of economic activity with an effect on sales at the industry level. The SA can change this index in any quarter. Changes in costs, interest rates on short-term loans, and interest rates for AA corporate bonds can also be made.

The SA can establish a demand schedule for the industry selecting one of six different tables with market growth rates at the beginning of the simulation, which can be reviewed at any time during the simulation. The S&P index emphasizes or de-emphasizes this growth. Finally, the SA can change the weights of the demand variables at the company level (i.e. price, quality rating, service rating, advertising, and dealers). Only fixed historical company sales are available for five periods (decisions are made on a yearly basis).

The Executive Game

Economic and seasonal indexes as well as inflation rates comprise the basic economic environment in this simulation. No changes are allowed in these variables but random error numbers change the indexes by 1Z or 2Z to generate new values for each variable, each time the simulation is run. The authors of this simulation suggest that instructors use exogenous data (e.g., historical data from U.S. experience) to modify the economic environment, which may be accomplished by accessing the source program; the code is presented in the manual.

Industry sales are influenced by economic and seasonal indexes, and industry price, promotional, and R&D expenditures. Company sales are determined by fixed elasticities. Investment tax credits and surtax charges can be set as desired. No historical sales or historical values of any other economic variable are made available to the participants.

Strategy! A Business Unit Simulation

In this final simulation, an index simulating economic expansion or contraction, and industry growth rates, constitute the economic environment. The SA is permitted to change industry and economic conditions at the beginning and at any time during the simulation. The economic index can be changed each quarter to and industry parameters can be changed to create new industry conditions. Industry parameters are: growth rate, the percentage rate of cost of goods, and industry overhead.

Regarding sales levels, the SA can make a selection between two sets of growth rate values for each industry, one emphasizing the business cycle and the other emphasizing long-range planning. These growth rates may be changed by the SA. There is no historical sales information available, as well as no historical values of any other economic variable.

Summary

In general, the economic environment is comprised by one index representing the level of economic activity (i.e. GNP, BWI, S&P 500 or a generic economic index) and interest rates, and in some cases, and inflation index or exchange rate. Only one of the simulations uses a variable as a leading indicator. Industry sales are determined by the SA from a set of fixed values, they can be generated by entering values or growth rates, or they may indirectly created or modified by entering values for the indexes of economic activity. In some cases industry sales are additionally affected by participants' decisions on price, promotional, and R&D expenditures. Impact of the variables affecting industry sales can not be always changed.

Although some parameters can be modified in these simulations, such modifications must be done in each period the simulation is run. However, care must be taken when making modifications to parameters, for isolated changes made without a particular structure in mind, may affect participants' ability to identify trends, unless the SA wishes unexpected shocks to the economic environment.

Historical data for variables comprising the economic environment is generally not provided. When it is, the number of observations is eight at the most. The same is true with sales data at the company level. Consequently, the few economic parameters included in these simulations, combined with the paucity of historical data, are not sufficient to identify trends in the behavior of the variables defining the economic environment at the beginning of the simulation. Sales forecasting using regression analysis, is not possible, at least at the beginning of the simulation, because of the lack of historical data (the maximum number of initial data points was found not to exceed eight). The number of variables affecting sales volumes also limit the use of econometric models.

## A PROPOSED MODEL

Clearly, additional variables would enhance the effectiveness of business simulations. Indicators such as the GNP, disposable income, composite leading indicator index, CPI, unemployment rate, industrial production rate, capacity utilization, housing starts, etc., would provide more information to participants, thereby affording them a richer learning experience.

Ideally, business simulations should have a number of historical values for variables influencing market and firm sales, as well as a number of independent

variables which can be analyzed on their effect on demand. A sufficient number of data points would help participants make more precise forecasts by facilitating the use of statistical techniques (e.g., regression analysis).

It would also be ideal if economic parameters were generated in a systematic way, according to SA preferences and teaching objectives. The SA should be able to set all the parameters at the beginning of the game; and in an efficient way, be able to determine short and long run trends as well as variability.

The equation models provided below represent an attempt on our part to demonstrate how simulation designers can overcome the shortcomings found in many simulations currently on the market. Though relatively simple, they provide a method of increasing the flexibility as well as the effectiveness of a simulation by facilitating the incorporation of additional economic parameters and generation of more historical data for forecasting purposes. Any number of variables and any number of values for each variable can be generated. For example, in generating periodical values for GNP, we propose the following:

$$GNP(i) = GNP(i-1) * (1 + g + (gg * i) + v * (RAND - 1)) \quad (1)$$

where:
- GNP (i) = GNP index for quarter i
- GNP (i-1) = GNP index for the previous quarter
- g = index growth rate
- gg = index acceleration rate (growth rate of the growth rate)
- i = quarter number
- v = variability rate (a fraction of g)
- RAND = random number between 0 and 1
- (gg * i): calculates the cumulative accelerator that has to be added to the original growth rate.
- v*(RAND-1): takes care of the variability.

If we make gg = 0 (constant growth rate) and v = 0 (no variability), then the formula becomes:

$$GNP(i) = GNP(i-1) * (1 + g) \quad (2)$$

where the behavior of the index is subject to a simple growth rate from one period to the next.

The SA sets the index base value for period 0 and then uses the formula to generate the values for the following periods. The SA also decides the growth rates, the acceleration rate and the variability. Random numbers are generated by the computer. In order to include the possibility of turning points (e.g., periods of expansion followed by periods of contraction, or vice-versa), an "if" "then" condition can be built into the formula. The SA decides the shift quarter (e.g., the beginning or ending of a period of expansion or contraction) and the growth rate, the accelerator, and the variability rate that will prevail after the shift quarter. The formula then will check for the number of quarters being generated to identify the set of parameters to be used in generating the index values. The formula will look like this:

$$GNP(i) = GNP(i-1) * (1 + \text{if } i<si, \text{ then } g_1 + (gg_1 * i) + v_1 * (RAND - 1)), \text{ otherwise } g_2 + (gg_2 * (i-si)) + v_2 * (RAND - 1)) \quad (3)$$

where: si = shift quarter
$g_1$, $gg_1$, and $v_1$ = growth rate, accelerator and variability rate before the shift quarter.
$g_2$, $gg_2$, and $v_2$ = growth rate, accelerator and variability rate during and after the shift quarter.
(i-si) reduces the number of quarters by which the accelerator has to be multiplied.

The above formula can be used in generating any number of indexes. Besides GNP, indexes can be generated for income, prices, inflation, population, industrial production, and a composite leading indicator. Values can be generated for any number of periods. For example, if a simulation is used for 12 periods, 32 periods would be generated. Twenty periods will be used as historical values and the remaining 12 dill be used as values during the game.

Product prices can also be derived from the CPI index using, an inflation multiplier and applying some variability to avoid a perfect correlation. Production and other costs will also be dependent on the CPI index in the same way (a multiplier and a variability rate). Finally, interest rates can also be derived from the inflation index, using a simple equation and allowing for certain variability. Such an equation is suggested by Gold and Pray (1990).

Given a series of periodical values for economic variables (i.e. income, price, population, and maybe promotional expenditures) they can also be used in conjunction with elasticities to generate sales at the industry level. Provided that economic indicators exist for 20 periods as historical values, industry sales can also be derived for 20 periods, as historical values. The remaining 12 will be potential sales against which actual sales, depending on company decisions (i.e. prices and and promotional effort), will be estimated.

## CONCLUDING REMARKS

By using the method proposed in this paper, parameter values can be generated at the beginning of the game, and may be changed at any time while the game is being played. This model can be included in new simulations or it can be used as part of existing ones. In the latter case, the SA enters values of variables already considered in the simulation and provides the participants with the complete set of values. Spreadsheets can be used to model the economic environment in this way. Spreadsheets have the advantage of allowing for easy modeling (King 1988). Results of parameters set by the SA can be immediately reflected in graphs, allowing for a better and more efficient modeling.

Variables can be modeled independently or they can be interdependent, forming part of a system of multiple equations. However, we suggest modeling each variable independently because it gives the administrator greater freedom in defining the economic environment. For instance, if inflation is supposed to be high during the expansion segment of the business cycle, a model where inflation is combined with recession could be represented. The SA would have to take care in modeling such an environment, because certain variables are inextricably linked, namely interest rates and inflation.

In conclusion, the model described in this paper will hopefully be considered by those interested in developing business simulations and by SA. by providing the participants with more variables to consider in

their forecasts as well as a sufficient number of values for each variable, the application of this model should enhance the effectiveness of simulations, as well as enrich the experience of those participating in them.

REFERENCES

Cotter, R.V., Fritzsche D.J. (1991), The Business Policy Game, Third Edition, Englewoods Cliffs, NJ, Prentice Hall.

Gold, S.C., Pray T.F. (1990), Modelling Demand in Computerized Business Simulations in Guide to Business Gaming and Experiential Learning, 117-138, Gentry, J.W., Editor, Association for Business Simulation and Experiential Learning.

Henshaw, R.C., Jackson J.R. (1990), The Executive Fifth Edition, Homewood, IL, Richard D. Irwin.

King,B, King A, Crookall D. (1988) Using Spreadsheets for Games Calculations and Model Development. Simulation/Games for Learning 18(l): 95-l0l

Priesmeyer, RH. (1987), Strategy! A Business Unit Simulation Unit, Cincinnati, OH, SouthWestern Publishing Co.

Scott, T.W., Strickland A.J. (1985), Micromatic: A Management Simulation, Boston MA, Houghton Mifflin Company.

Teach, R.D. (1990), Profits: The False Prophet in Business Gaming, Simulation & Gaming, 21(1), 12-26.

Thompson, A.A., Stapenbeck G.J., (1990), The Business Strategy Game, Homewod, IL, Richard D. Irwin.