ECONOMIC MODELING IN BUSINESS SIMULATION IN FLOW-ORIENTED AND ON-LINE GAME DESIGN

Marcin Wardaszko
Kozminski University
wardaszko@kozminski.edu.pl

Helmut Wittenzellner
Stuttgart Media University
wittenzellner@hdm-stuttgart.de

ABSTRACT

The paper describes and discusses a specific case-study of demand modeling for an on-line business simulation game called Hotel Stars. It presents a specific flow-oriented on-line design through econometric and mathematical modeling. The model of demand is covered from the perspective of utility and function deployment. Moreover, advertisement modeling has been described with regard to local optimization methodology. The last section features an analysis of additional elements influencing demand. Seasonality, competition strategies modeling, random events, and memory effect are all examples of additional effects that can be modeled and implanted in the major demand model and function.

INTRODUCTION

Demand and cost modeling is an essential part of every business simulation game. In the last few decades of scholarship, we have seen many excellent and overreaching contributions to demand and cost modeling (e.g. Cannon, Cannon, & Andrews, 2010; Teach, 1984, 1990, 2008; Pray & Gold, 1982, 1984; Gold, & Pray, 1990; Gold, Steven, Markulis & Strang, 2011; Murff, Teach & Schwartz, 2006; Goosen, 1986, 2010; Gold, 2005; Carvalho, 1992). Other group of contributions concentrated, in turn, on marketing decisions and impact modeling (e.g. Cannon & Schwaiger, 2005; Cannon & Cannon, 2008; Cannon, J. N., Cannon & Schwaiger, 2012). Both of these trends contribute significantly to the main body of knowledge about the methods and practices of econometric modeling in business simulation games. However, the range of scopes and means of implementing business simulation games changes and thus requires specific approaches to modeling. The following paper offers a case-study analysis of a specific game design from an econometric perspective.

GAME DESIGN WITH FLOW CONCEPT

Hotel Stars is a computer aided simulation game (Wardaszko, 2016) created as part of an innovative program of teaching called "Economics in practice", implemented by *Foundation of Development of Education Initiatives.* It is a program supported by a business simulation game addressed to secondary school students for the purpose of teaching them fundamental knowledge in economics, entrepreneurship, and business administration.

The described simulation game has been designed based on user-oriented and visual design methodologies (Pagulayan, Keeker, Wixon, Romero, & Fuller, 2002; Schell, 2008); in order to secure a user-oriented design process, a series of research studies has been conducted on the main stakeholder and user groups (Wardaszko & Jakubowski, 2013). Hotel Stars is a web browser-based game. It has been designed for PCs and tablet devices. The main interface with the decision input system, user feedback, and graphic design have been designed and optimized for touchscreen technology. The game has been designed to be played in small (2-3 persons) groups of students, which was a requirement from the ministerial syllabi for teamwork. The aim of the game is to create, run, and manage hotels in the virtual city of Pekunia (*Latin for 'money'*). Teams can choose three different locations for their establishments, and the decision will have long-term consequences. Information about features of each location is provided and tied to planning and budgeting activities. There is a total of 16 decision rounds during which the players will have to manage their business, which will gradually grow and, consequently, involve more and more complex decisions; the complexity model has been designed on the basis of the model of flow of optimal experience (Csikszentmihalyi, 1990) and previous research on complexity in business simulation games (e.g., Hall, 2007; Cannon et al., 2009; Cannon et al., 2010). Dynamic scenario of the game features seasonality, random events, and competition, which are designed to grant the players some additional challenge and fun. Students play against the computer and do not compete directly against each other. Ranking is introduced in the middle of the game (8^{th} period), and the teams can see the results of all other teams in their game.

The general game scenario is known to students, but seasonality and periodic events are not announced, so students play in a partially obfuscated environment. Partial obfuscation gives additional emotional arousal and a feeling of a more dynamic and thus realistic environment. Partial obfuscation builds uncertainty of the future, and uncertainty is one of the key components in games (Caillois, 1962; Avedom & Sutton-Smith, 1971; Epstein, 1995). Periodic events impact all areas of business demand, costs, administrative decisions, sustainable development, ecology and management. Random events can influence demand and costs, or can provide opportunities for sustainable and socially responsible management. In majority, they are built on the volunteer and call to action principles; some of them influence demand and costs directly, but their impact is manageable and they are announced at the beginning of a given period. Their appearance is also timed with the game and the complexity level of the game's current stage. Competition appears in the final stage of the game, and it is designed primarily as the "final boss" (Koster 2005; Shell 2008) of the game (see figure 1). The complexity of the game grows gradually; the game actually features a dual period system. The scenario and storyline of the game cover a period of over 4 years. However, the basic decision period is a quarter, so the game is divided into 4 years with 4 decision rounds for each year. Using the dual period system seems more natural from the business perspective, as the fiscal year of the company is one year and students plan and analyze their business performance in years. However, using a one-year decision round in the service and hospitality industry is very strange and would not allow for experiencing seasonality, which is crucial to the level of realism and the narrative of the game. Using a dual period system allows students to adapt to the new complexity level during the whole year and feel confident with it before the game provides them with new challenges. On the other hand, there are small changes introduced between quarters and seasonality; random events and periodic decisions give the players a sense of dynamic environment, and offer them a possibility to experience 'flow' (Csikszentmihalyi, 1990).

ELEMENTS OF DEMAND MODELLING IN HOTEL STARS SIMULATION GAME

Game delivery is a crucial element; the main challenge of the game design was to create a model that is challenging, realistic, manageable, and predictable all at the same time. The econometric model of Hotel Stars simulation game has been designed with the aim of giving students the best possible idea of consequences of the decisions made during the game (Teach, 1990; Selen & Zimmerman, 2004).

The basic element of the created model is a description of the trend of demand depending on the price set by a student (demand function), and then a description of changes in the demand triggered by the student's decisions and by the economic situation in each round of the game (Gold & Pray, 1990). The main requirements of the developed model were:

1. Simplicity – upper-secondary school students should be able to understand the demand curve graph, assuming that they possess basic mathematical knowledge of plotting and understand function graphs
2. Complexity – the model shall be complex enough to prevent smarter students from trivializing their decisions
3. Adequacy – the model should give an 'as-real-as-possible' idea of the mechanisms affecting the shape of demand with respect to the decisions made during the game and the simulated conditions
4. Flexibility – the model should be flexible enough to be adapted to variable conditions in each round; e.g., appearance of competition, changes of the level of operating costs, seasonality.

Taking all of the above requirements into consideration, it has been decided to use the basic model of demand function, with a constant price elasticity of demand:

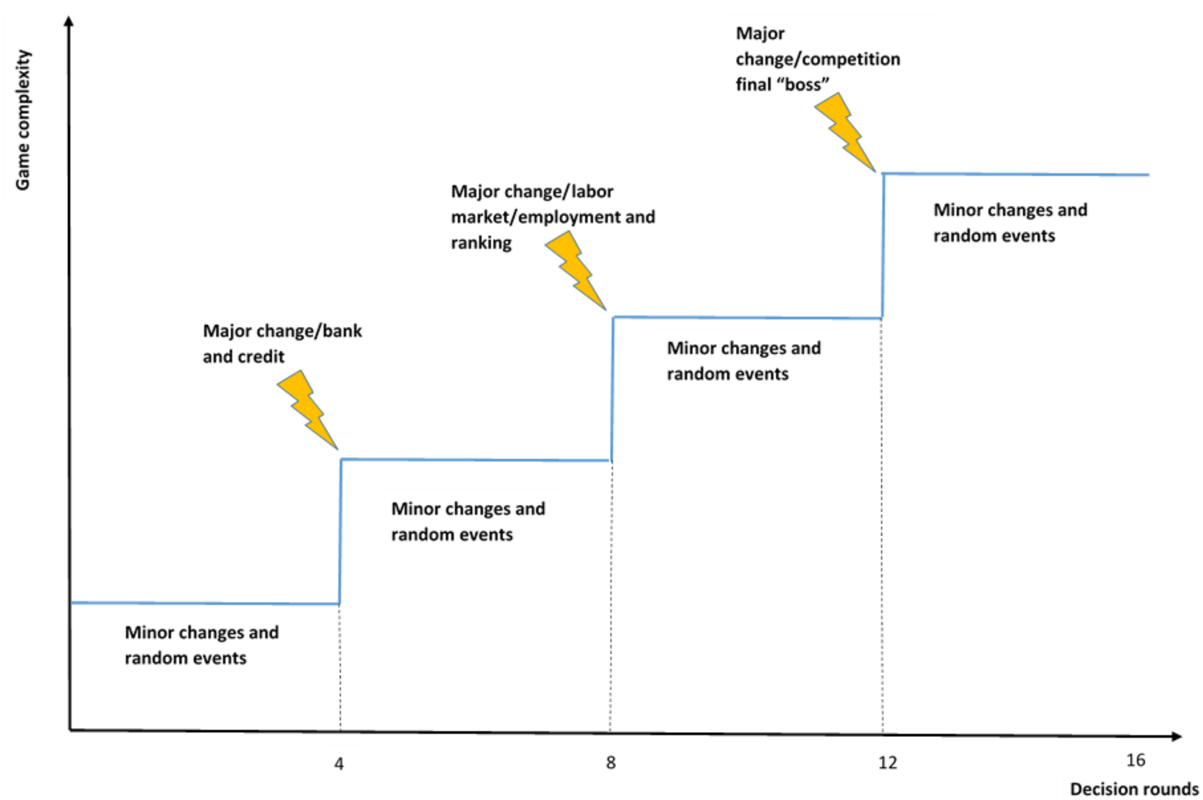
$$F(x) = a \cdot x^t \quad (1)$$

where x is the price for a room, and, a, t are the parameters.

The law of demand states that the function should be decreasing, i.e. $t < 0$. The values of the model parameters depend on the expected operating costs and the requirements included in the scenario, especially those concerning location.

The obtained function is a power function known from mathematics classes to majority of high schools students, but more complex than the linear model referred to quite often in

FIGURE 1
EVOLUTION OF THE GAME SCENARIO AND COMPLEXITY.



the literature on the subject (e.g. Milewski, 2005; Begg, Dornbush & Fischer, 2007; Czarny, 2011). On the other hand, the game is based on an open model, i.e. the so-called glass-box model (Metera, Pańków & Wach, 1983). Hence, it is important to make this demand function predictable on the one hand, and analytically challenging on the other. In order to make it so, students are given full information about the demand in different locations in the form of graphs and tables, as well as an exercise to calculate the volume of demand, revenues, and costs. This demand curve, however, offers a constant elasticity of price. Changing price elasticity has been excluded from the game because modifying the demand reaction could affect the game mechanics, which would be too difficult to read for the target audience. Instead, the game offers different demand curves in particular locations with different base price elasticities, which results in the same effect.

The scenario of the game offers three locations: strict city center, downtown area, and suburbs. The first location involves higher costs, but also makes it possible to gain the biggest profits by charging more for rooms. The second location offers medium costs of operation, but also lower revenues than those attainable in the strict city center. Hotels in the suburbs are the cheapest to maintain and manage, but the possibility of gaining bigger profits with higher prices is obviously smaller. Thus, it has been decided to use three different demand functions in the model, depending on the location. The obtained functions are to support the different game strategies with locations. Each location features an option to offer deluxe rooms, which are more expensive to build, maintain and manage, but also yield higher profits. Deluxe rooms are aimed at more demanding clients; that is why other demand functions will be applied to such rooms. Moreover, the location in the center will focus more on providing deluxe rooms, and the location in the suburbs will accordingly concentrate more on providing standard rooms.

To sum up, we should obtain six basic demand functions, two for each location. In order to arrive at the assumed targets, we have to modify the basic functions by adding additional parameters that enable moving basic functions horizontally (left and right) and vertically (up and down).

The general formula for the demand function is as follows:

$$F(x) = a(x + c)^{t} - b \qquad (2)$$

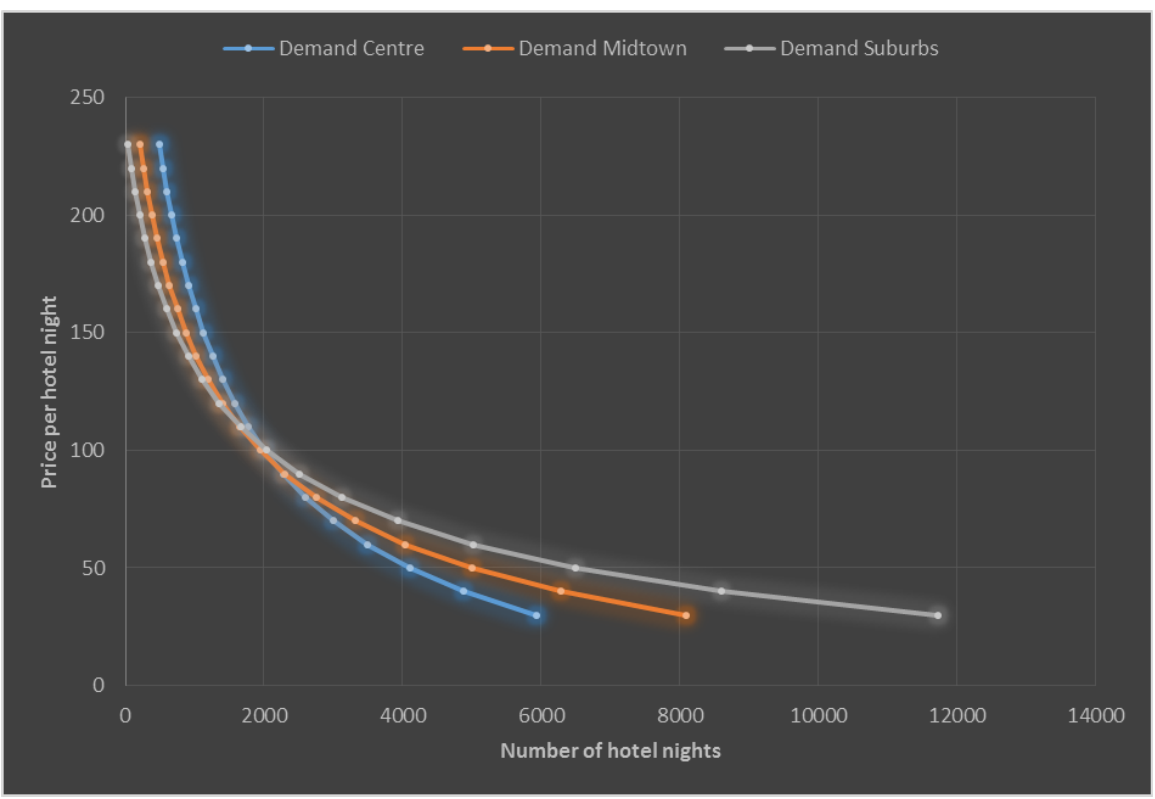
where $\boldsymbol{c}$ is the parameter of horizontal shift and b is the parameter of vertical shift.

Hence, a clear description of the demand function requires storage of the values of ***a, b, c, t*** parameters (parameters are described in section below and Equation 3). The parameters set for the final version of the game are based on empirical data analysis (CSO Statistical Yearbook, 2011), hotel data from websites, direct interviews with hotel owners, and scaled in the game for playability and realism.

The chart shows standard demand functions for hotels with 20 standard rooms in different locations.

Different stages of the game involve numerous decisions which affect the function of demand. They are modelled in the form of $\boldsymbol{w_i}$ factors, i.e. assuming certain values mainly from the range of 0 to 1, but sometimes including values which are negative (lower than zero) or bigger than 1 as well, which makes it possible to carry out a proper simulation of the effect of a given factor. In this model, each w_i factor features 4 assigned values, i.e. $\boldsymbol{A_i}$, $\boldsymbol{B_i}$, $\boldsymbol{C_i}$, $\boldsymbol{D_i}$ which define the effect on

FIGURE 2
A CHART OF SAMPLE DEMAND FUNCTIONS FOR STANDARD ROOMS.
SOURCE: OWN WORK.



the demand function:

A_i – affecting A factor of scaling (multiplying) the demand function
B_i – affecting B factor of vertical shift of the demand function
C_i – affecting C factor of horizontal shift of the demand function
D_i – D factor of direct multiplication of the demand function; appears sporadically

The values of A_i, B_i, C_i, D_i are set for a given location and a given type of room and do not change over the course of the game, whereas w_i factors are subject to change.

Let us assume that J is the amount of all identified factors, R is the round number, and $w^R{}_i$, $i = 1, \ldots, J$ is the value of all factors in round R. It should be noted that many of these values may equal zero, e.g. when a given factor is inactive or has not appeared in the game yet.

$$A^R = 1 + \frac{1,5 \cdot \sum_{i=1}^{J} A_i \cdot w_i^R}{\sum_{i=1}^{J} A_i} \tag{3}$$

$$B^R = \sum_{i=1}^{J} B_i \cdot w_i^R$$

$$C^R = \sum_{i=1}^{J} C_i \cdot w_i^R$$

$$D^R = \prod D_i^R$$

$$f_o^R(x^R) = D^R \cdot A^R \cdot \left(a\left(max((x^R + c - C^R); 1)\right)^t - b + B^R\right), \tag{4}$$

Next, a limit for the function should be set since demand cannot have a negative value, and the size of the demand and revenues cannot exceed the number of the rooms in the hotel.

$$f_1^R(x^R) = max(f_o^R\,(x^R), 0) \tag{5}$$

$$f^R\,(x^R) = min(k \cdot 90, f_1^R\,(x^R)) \tag{6}$$

where k is the number of rooms in the type and 90 is the number of nights available in the quarter.

Hence, the game is played against the computer system, and its basic goal is to steadily grow one's business and optimize the decisions concerning the demand and production function (number of rooms); lack of optimization leads to losses, and a better optimization – to higher revenues.

The sample of the econometric model of demand presented in the article aims to show how to implement knowledge of the subject into simulation games where the goal is to maximize the effectiveness of education. The purpose of such modelling is to create a model of demand function so that the student teams playing the game and making relevant decisions are not only able to control their activities and execute their strategies, but also experience the consequences of their decisions (and of the lack of optimization thereof) and wrong judgments made during the game. The demand function complexity grows along with the game complexity and is built into the game system. Every full year (i.e. 4 decision quarters), the demand function evolves and activates new areas and parameters that influence the size of demand. In my opinion, this evolutionary approach to demand modeling in business games is an interesting option worthy of further investigation.

ECONOMETRIC MODEL OF ADVERTISING

Hotel Stars simulation game offers its players many opportunities for decision-making in advertising strategies and business image management. There will be an option to buy market research, the analysis of which will provide substantial support to the players in making decisions related to marketing activities. Moreover, there will also be considerable sales support available, like different advertising media for different geographical reaches and impacts. The game designers had to consider how to show the variety and multitude of such decisions while simultaneously maintaining decision-making simplicity and educational value. It has been decided to set a limited number of advertising media: leaflets, posters, billboards, press advertisements, radio and TV commercials, with further division into local, regional, and national media. Also, the prices for each type of advertising media offer have been defined at a fixed level for the entire duration of the game. The purpose of such division is to maximize the educational value for the game's participants through making decisions concerning costs of advertisements, optimal number of repetitions/broadcasts, and effective communication.

Next, an appropriate model was constructed based on marketing theory (Garbarski, 2011) and market research in the area of advertising options and possibilities. Taking the above into account, we have decided to use a basic model of advertising in the form of the following function:

$$m(x) = \frac{ax^n + b}{ax^n + b + 100}, \tag{7}$$

where x is the number of repetitions in a round, and $a, b \in R$, $n \in N$ are the parameters.

The above function is of increasing type, and assumes values from zero to one.

The values of the parameters are based on the nature of each medium. They are chosen with consideration of the following:

- optimal number of repetitions – the value of function m will assume values close to 1,
- initial value – for one-time use of a given type of advert,
- function growth rate – based on the nature of a given medium.

The number of repetitions given above is considered optimal in that the value of function m becomes close to 1 (higher than 0.95). It will be possible to buy a larger number of repetitions, though it will increase costs and affect demand to a very small extent (see figure 3). The basic model of advertising is then implemented into the general model of demand by influencing the A parameter in the general demand function (see Equation 4), which is responsible for demand curve multiplication.

Students are to make their decisions on the frequency of use of a given advertising medium taking into consideration the issue of effectiveness with respect to costs of their decisions and decreasing marginal effectiveness of expenditures.

Such structure of decisions and functions enables the players of Hotel Stars to easily adjust their advertising strategy to a given situation from period to period. Still, the players have to take full responsibility for their decisions. This allows them to execute their own business strategies and make business decisions with a simultaneous result analysis support provided in the form of presentation of the consequences of their decisions in the relatively safe environment of their class (Bielecki, 1999).

OTHER ELEMENTS INFLUENCING DEMAND

Besides the major impact of marketing decisions, there are additional elements that can influence demand – and that have been featured in this model.

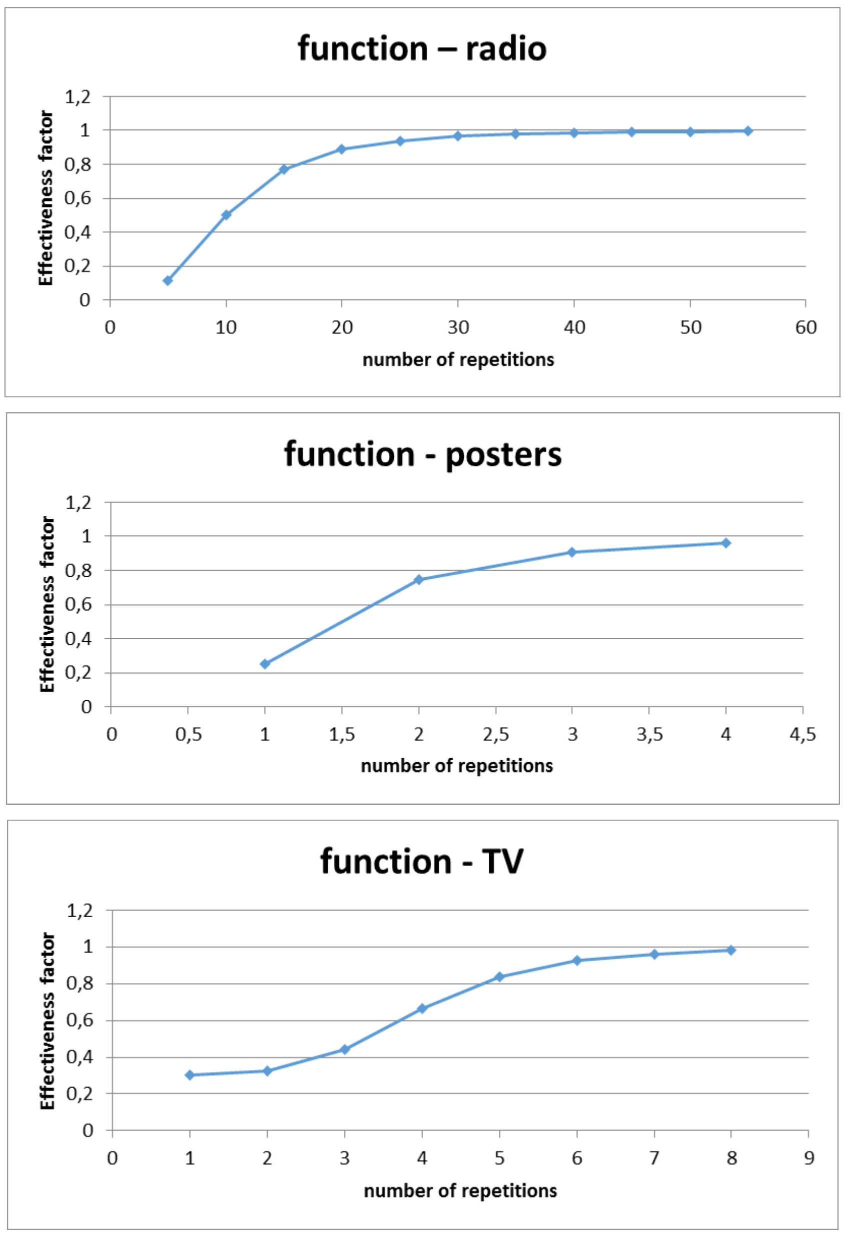
The first of them is seasonality, which has a big impact on the model of demand, and is strongly related to the type of business and narrative offered in the game (both in the epistemological and visual layer).

There were two reasons to model seasonality in this way. First of all, the model produces a recurring pattern of seasons and the demand changes behind them. Secondly, it also gives participants the ability to use or fend off negative demand changes resulting from seasonality.

The second element that we would like to present is competition modeling. The game does not feature direct competition, so it has to be self-sustaining. In order to offer such model, we have enriched the game with three virtual competitors with clear strategies: low cost – low price (Cheap Bed), High price – high quality (Busy Day) and value for money (Your Choice). Students have to be base their strategies using simple benchmarking technique to compare themselves to the competitor with the most similar strategy – and defend their position.

Our model features a competition indicator of ***comp* < *1***. It is always smaller than 1 because entering of a strong competitor to the market always decreases one's market share on a limited

FIGURE 3
EXAMPLE OF *M(X)* ADVERTISING FUNCTIONS BY THE TYPE OF MEDIUM.



market; the matter of localization and the type of room play a significant part as well. Additionally, we have introduced competitors' prices marked as fixed ***pcomp*** and players' price marked as *pstd***.** Then, the competition demand modifier will be calculated as follows:

$$\boldsymbol{rcomp = comp \cdot \frac{pcomp}{pstd}} \tag{8}$$

rcomp is directly implemented as a demand multiplier and influences ***D*** in the demand function.

This way, even without direct competition involving other players, we can create a situation that forces students to rethink their strategies and adjust their decisions to new market situations.

The third element influencing demand involves random events. There are three types of random events in the game. Events influencing demand, cost (supply) and sustainability related events, and social responsibility oriented events. One decision round can feature up to three random events. Of course, they are random from the player's perspective. The instructor can switch them on/off from the menu, or can use a predetermined scenario that places them in the scenario of a given gameplay in a predetermined order timed with game phases. Random events influencing costs and sustainability and social responsibility oriented events do not influence demand, but affect the costs and performance of a team directly or indirectly. Random events influencing demand have a direct impact on ***C*** indicator in the overall demand function.

The fourth – and last – element discussed is market memory effect. Market memory effect adds additional multiplier to the overall demand, influencing decisions based on previous decisions. It also has a decaying strength over time (up to three decision making rounds). The indicator is based on the customer service quality assessment indicator present in the game. This indicator is based on all decisions of the player that have an impact on demand, e.g. pricing, marketing decisions, room standard, hotel cleaning expenditures, number of employees, etc. Although market memory effect is quite interesting to see in action, we suggest offering it to more experienced players, or when students play the game for the second time. Without memory effect, students can switch easily between strategies and even if they make wrong decisions, they can correct their actions in the next quarter. Memory effect removes the opportunity to change one's strategy that easily or to improve one's decisions, but also helps those who have a consistent strategy but experience some temporarily slump in form. In essence, it forces students into a more rigid and strategic decision making process.

DISCUSSION AND CONCLUSIONS

The presented case raises a number of issues concerning specific design in modeling. This model has been designed for a specific task of a game that is constructed based on the flow methodology (Csikszentmihalyi, 1990). The model has to evolve together with the game and students' advancement. The demand function has been designed to this end with quite many indicators taken into consideration, but their effects are

TABLE 1
SAMPLE LIST OF COSTS OF A SINGLE USE OF A GIVEN ADVERTISING MEDIUM.

	unit cost
Local media	
leaflets (1,000 pcs.)	100
posters (100 pcs.)	300
billboards	1,000
press	200
radio	20
Regional media	
press	1,000
radio	100
TV	1,500
National media	
press	10,000
radio	1,000
TV	15,000

TABLE 2
SEASONALITY RULES AND PARAMETERS

Seasonality indicator	***Qj , j = 1, … , 4***	***Qj* influences *D* multiplier of the demand function**	
Lake and beach	***kplaza***	***rplaza***	Influences demand only in j=3
Ski-lift	***kwycnar***	***rwycnar***	Influences demand only in j=1
Golf course – only deluxe demand	***kgolf LUX***	***rgolf LUX***	Influences demand only in j= 3 and 4

introduced to the equation over time, i.e. the demand equation evolves with the game itself. On the other hand, we wanted this model to offer predictable and easy-to-read reactions, so the impact of particular demand influencing elements needed to be scaled to a reasonable reaction, and many sub-functions were introduced with both local and global optimum. Such model has been described in the advertisement part of the article and shows how a reasonable modeling can be introduced to the demand equation. We can also create many different action elements influencing demand actively and passively. Seasonality, competition strategies modeling, random events, and memory effect are all very good examples of that. Their major role is to make the game more vivid and thus more realistic (Selen & Zimmermann, 2004), but they have also a major impact on the game's complexity and can draw attention away from the core of the game itself.

This model has one major advantage, which is on-line scalability. We can run a virtually indefinite number of games at the same time; featuring a few hundred teams in the same game is not a problem either. The only limitation to this number is the computing power of the available servers. The price we have to pay for this scalability is the lack of direct competition, which can be a disadvantage to many instructors and teachers. In the light of the above, the whole econometric and mathematical model design has been concentrated on this perspective. Designing a model for independent player/team is easier on the level of modeling interactions with the system, but poses challenges in the context of the game's transparency. A correct mixture is hard to find because the market expectations, the types of users, and the delivery media change over time. Thus, further studies and case-study analyses are still in-demand and desired as a contribution to the main body of knowledge in simulation and gaming.

REFERENCES

Begg D., Dornbusch R., & Fischer S. (2007). Mikroekonomia *T1*. R. Rapacki et al. (eds.). Warszawa: Polskie Wydawnictwo Ekonomiczne.

Cannon H. M. (1995). Dealing With the Complexity Paradox in Business Simulation Games. *Developments in Business Simulation and Experiential Learning*, vol. 22. [Available from http://ABSEL.org].

Cannon, H. M., & Schwaiger, M. (2005). An algorithm for incorporating company reputation into business simulations: Variations on the Gold standard. Simulation & Gaming, 36,188-202.

Cannon, H. M., Cannon, J. N., & Andrews, C. (2010). Modeling cascading demand: Accounting for the effects of captive consumer relationships. Developments in Business Simulation and Experiential Learning, 37, 33-41. (Available athttp://www.absel.org)

Cannon, J. N., & Cannon, H. M. (2008). Modeling strategic opportunities in product-mix strategy: A customer versus product-orientation perspective. Developments in Business Simulation and Experiential Learning, 35, 183-190. (Available at http://www.absel.org)

Cannon, J. N., Cannon, H. M., & Schwaiger, M. (2012). Modeling the "Profitable Product Death Spiral": Accounting for strategic product-mix interactions in marketing simulation games. Simulation & Gaming, 43, 761-777.

Carvalho, Gerard F. (1992). A new market demand model for business simulations. Developments in business simulation and experiential learning, Vol. 19, 39-43. (Available at http://www.absel.org)

Chakravorty, S. S., & Verhoeven, P. R. (1996). Learning the theory of constraints with a simulation game. Simulation & Gaming, 27, 223-237.

Cyfert, S. (2003). *Strategiczne doskonalenie architektury procesów w zarządzaniu przedsiębiorstwem*. Poznań: Akademia Ekonomiczna w Poznaniu.

Czarny, B. (2011). *Podstawy ekonomii*. Warszawa: Polskie Wydawnictwo Ekonomiczne.

Draman, R. H., Lockamy, A. III, & Cox, J. F. III. (2002). Constraint-based accounting and its impact on organizational performance: A simulation of four common business strategies. Integrated Manufacturing Systems, 13, 190-200.

Epstein, R. A. (1995). The Theory of Gambling and Statistical Logic (revised edition), Academic Press.

Garbarski, L. (ed.), (2011). Marketing: koncepcje skutecznych działań. Praca zbiorowa. Warszawa: Polskie Wydawnictwo Ekonomiczne.

Gold, S. (2005). System-dynamics-based modeling of business simulation algorithms. Simulation & Gaming, 36, 203-218.

Gold, S. C. & Pray, T. F. (1990). Modeling demand in computerized business simulations. In James W. Gentry, (Ed.), Guide to business gaming and experiential learning. East Brunswick: Nichols/GP Publishing, 117-138.

Gold, S. C., & Pray, T. F. (1990). Modeling Demand in Computerized Business Simulation. W: F.W. Gentry, (ed.) *Guide to Business Gaming and Experiential Learning*. London: ABSEL, Nichols/GP Publishing, East Brunswick/ Kogan Page.

Gold, Steven C., Markulis, Peter M., & Strang, Daniel R. (2011). Demand equation redux: the design and functionality of the Gold/Pray model in computer business simulations. In Elizabeth Murf (Ed.), Developments in business simulation and experiential learning, Vol. 38, 28-35. (Available athttp://www.absel.org)

Goosen, Kenneth R. (1986). An interpolation approach to developing mathematical functions for business simulations. In Alvin C. Burns & Lane Kelley (Eds.), Developments in business simulation and experiential learning, Vol. 13, 248-255. (Available athttp:// www.absel.org)

Goosen, K. (2010). Is the Gold/Pray Simulation Model Valid and Is It Really Robust? Developments in Business Simulation and Experiential Exercises, 37, pp. 99 -106. (Available athttp://www.absel.org)

GUS. (2013). Statistical Yearbook *2013*, Warszawa.

Hilmola, O. (2001). Theory of constraints and outsourcing decisions. International Journal of Manufacturing Technology and Management, 3, 517-527.

Howe, N., & Strauss, W. (2007). Millennials Go to College (2nd ed.). Great Falls, VA: LifeCourse Associates.

Johnson, R. M. (1971). Market segmentation: A strategic management tool. Journal of Marketing Research, 8, 13-18.

Jordan, D. A. (2006). Supply-side modeling in a total enterprise simulation. Developments in Business Simulation and Experiential Learning, 33, 345-347. (Available at http:// www.absel.org)

Koster, R. (2005). A theory of fun for game design. Scottsdale, Arizona: Paraglyph Press, Inc.

Metera, A., Pańków, J., & Wach, T. (1983). Teoretyczne i metodyczne zagadnienia symulacyjnych gier kierowniczych. Warszawa: IOZiDK.

Milewski, R., & Kwiatkowski, E. (eds.) (2005). Podstawy ekonomii. Warszawa: Wydawnictwo Naukowe PWN.

Murff, E., Teach, R. & Schwartz, R. (2006). Three Attribute Interrelationships for Industry-Level Demand Equations. Developments in Business Simulation and Experiential Exercises, 33, pp. 213-218. (Available athttp://www.absel.org)

Pagulayan, R. J., Keeker, K., Wixon, D., Romero, R. L., & Fuller, T. (2002). User-centered design in games. In The human-computer interaction handbook, Julie A. Jacko and Andrew Sears (Eds.). L. Erlbaum Associates Inc., Hillsdale, NJ.

Pink, D. H. (2009). Drive: The surprising truth about what motivates us. Distribution, Canongate.

Pray, T. & Gold, S. (1982). Inside the Black Box-An Analysis of Underlying Demand Functions in Contemporary Business Simulations. Developments in Business Simulation and Experiential Exercises, 9, pp. 110- 115. (Available athttp://www.absel.org)

Pray, T. J. & Gold, S. C. (1984). Two algorithms for redistribution of stock outs in computerized business simulations. Developments in business simulation and experiential learning, Vol. 11, 247-252. (Available athttp://www.absel.org)

Schell, J. (2008). The Art of Game Design: A Book of Lenses. Elsevier, Burlington, MA.

Selen, K., & Zimmerman E. (2004). Rules of Play. Game Design Fundamentals. Cambridge, Massachusetts: The MIT Press.

Teach, R. D. (1984). Using spatial relationships to estimate demand in business simulations. Developments in Simulation and Experience Learning, 11, 244-246. (Available from http://absel.org)

Teach, R. D. (1990). Demand equations for business simulations with market segments. Simulation & Gaming, 21, 423-442.

Teach, R. D. (2008). Demand equations which include product attributes. Developments in Business Simulation and Experiential Learning, 35, 161-166. (Available at http://www.absel.org)

Wardaszko M. (2016), Building Simulation Game-Based Teaching Program for Secondary School Students, SIMULATION & GAMING. AN INTERDISCIPLINARY JOURNAL OF THEORY, PRACTICE AND RESEARCH, 47(3), s.287-303.

Wardaszko, M., & Jakubowski, M., (2013). Research of end user preferences in the design process of the simulation game for high school students teaching basics of economics and entrepreneurship. In S.A. Meijer & R. Smeds (eds.), Electronic proceedings of ISAGA 2013, KTH Transport Science publication series, Stockholm, 2013.