SYSTEMIC APPROACH OF THE CONSUMER BEHAVIOR

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Abstract:
In an era of globalization, we witness the encounter of cultures and the exchanges between them. Often, the cultural influences affect the consumer's decision to purchase goods. Many cultures have their own specific product offer, which is a way of promoting them. In this regard, a good example is the media culture called "anime". As a result, the consumer is faced with many decisions and its choice is influenced by many internal and external factors. When studying the market fluctuations due to the social, cultural, or otherwise influences, which may create new categories of consumers, we consider it is important to analyse the consumer behavior in the systemic terms, which could lead us to a new overview of the effects of these various influences.
This paper proposes a mathematical model, starting from an original scheme, based on the Veblen theory. The study uses a simple matrix algorithm for the optimal solution of the dynamical systems with quadratic cost function.

Keywords: culture, influence, black box, system

1. Introduction

Once the phenomenon of globalization has been widespread, the meeting between different cultures is more frequent. Advances in technology have made the media to become a planetary phenomenon and access to information is becoming easier.

In this context, new forms of culture emerge. One of these new forms is the media culture. This, in its various forms, is also an important factor of influence on consumer behavior. An example of this is the culture of anime, which originating fron Japan, it took the West by surprise, influencing the decisions of many consumers of products similar to those introduced by it, producing noticeable effects culturally and economically, and creating its own reference groups and even of belonging , in a word, exercising upon the consumer's decision three or even four of the Veblen influences(Veblen, 2009).

Anime is a distinctive animation style that characterizes all animation produced in Japan. They are differentiated from animations produced in the rest the world by the artistic specific traits and thematic richness.(Steiff, 2010).

The anime fan acquires a cultural identity due to the acquisition of products in connection with the anime logo, trademark or other distinguishing feature. Through discussion about anime, online or verbally by attending events where those goods are acquired, and fans dress up and

interpret their favorite characters. This cultural identity was structured in mind anime hay due to the specific artistic language of animes and the complexity of their themes. (Denison, 2010) Since the 70s, anime began to gain popularity in America, influencing the Western consumer perception on animation. Once anime was dubbed and subtitled in English, they started to win a lot of fans in America, then in Europe.

According to JETRO, Japanese animation has occupied for two decades the first place in the world of animation, of all cartoons made in the world, 60% were Japanese, and in 2005, when these estimates were made, the export value of anime amounted to figure 4.5 trillion dollars. Also the anime fans organize themselves into groups of online discussion, debate various aspects of anime countries, meet and exchange specific products.

Also they dress up as their favorite characters, activity called "Cosplay", and organize competitions in this respect at European and global level. As such we observe the existence of reference and belonging groups.

The concept of the consumer behavior is a multidimensional concept. Because of this, it is hard to reconcile the wide variety of approaches, one being the overall systemic approach, in the center of which we find the human being. Under this approach, researchers(Kotler, 1969) transposed the issues of consumer behavior in the cyber language.

Simply, we can talk, at this approach, of elements such as: "*inputs*" (economic situation, price, quality, convenience, culture, socio-professional biography consumer), "*input channels*" (marketing sources or personal sources: advertising, consumer observation), "*outputs"*(product selection, unit sales, the necessary amount) The concept lies between inputs and outputs of the system, the so-called "*black box*" in which the input data are processing, process allowing the output to be obtained, practically *the consumer's decision*.

Regarding the system input, another researcher of the consumer behavior(Veblen, 2009), studying the outer motivation, proposes five types of influence as follows: culture, subculture, social class, reference groups, belonging groups.

Mathematical approach

Starting from the model proposed by Kotler, which highlights the importance of the external motivation, applying this model to the theory developed by Thorstein Veblen, we find the "*motivation*", divided into five entry levels. These are not exactly a pyramid, but they are listed in some particular order: culture, subculture, social class, reference groups, belonging groups. In the first approach, we consider these influences as having balanced inputs.

In order to fit into a dynamic open system, with the influences as entries, and the output as the final consumer decision to choose a product, we propose the scheme presented bellow.(figure no.1) The definitions of the main factors of influence, in Veblen theory are the following(Veblen, 2009):

✍ Culture is defined as the "*level at which are inserted the sustainable influences, due to the assimilation of traditions, customs and values*".

✍ Subculture is defined as a "*regional entity*" or segment of the advanced, modern culture, which has lost its homogeneity.

✍ Social classes are "*entities-expressions of the people's vertical differentiation*".

✍ The reference group is the "*social entity*", to which the individual, although not a member, identifies himself, by some common features, such as:

- Similarity of aspirations
- Social behavior, so on.

✍ The membership group is the "*social entity*" to which the individual belongs, such as:

- Family
- Friends
- Coworkers

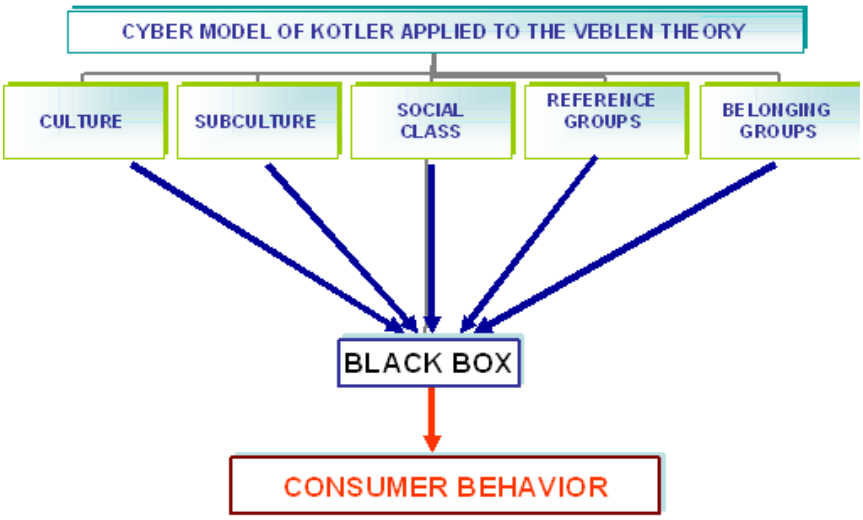

Figure 1. The scheme for the process of consumer behavior

Based on this ***scheme,*** we shall represent the contribution of the five influence categories in the next equation(Teodorescu,1998):

$$z^{(5)} - \alpha z^{(4)} - \beta z^{(3)} - \gamma \ddot{z} - \delta \dot{z} - \mu z = 0 \quad (1)$$

The coefficients represents the percent in which each of the five factors of influence is acting upon the individual, leading him to a determined consumer decision. That is why, all these parameters must be some real numbers, in particular, if they are considered as percent: $\alpha,\beta,\gamma,\delta,\mu \in [0,100]$(the sum is 100, $\alpha\%,\beta\%,\gamma\%,\delta\%,\mu\ \%$).

Our purpose is to study the properties of this new model. The equation (1) can be written in the matrix form, the assumptions are:

(we have noted: $z^{(3)} = \dddot{z} = z'''$, for simplicity of writing)

$$\begin{aligned} z &= x_1 \\ \dot{x}_1 &= -x_2 = \dot{z} \\ \dot{x}_2 &= x_3 = \ddot{z} \\ \dot{x}_3 &= -x_4 = z^{(3)} \\ \dot{x}_4 &= x_5 = z^{(4)} \\ \dot{x}_5 &= z^{(5)} = \alpha z^{(4)} + \beta z^{(3)} + \gamma \ddot{z} + \delta \dot{z} + \mu z \end{aligned} \quad (2)$$

The consumer behavior dynamical model

As any other differential equation, this one also can be analysed in the state form, with regard to the stability, the trajectory and the optimal command.

The system matrix form is presented in the equation(3):

$$(3)\quad \begin{pmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \\ \dot{x}_4 \\ \dot{x}_5 \end{pmatrix} = \begin{pmatrix} 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \\ \mu & \delta & \gamma & \beta & \alpha \end{pmatrix} \cdot \begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \end{pmatrix}$$

This matrix transforms the consumer behavior from the initial state to a new one, a process that occurs in the so-called "*black box*", or ***BB***.

Like Kotler, we consider the achievement of certain conduct, not from inside the box (as did Freud) but from the outside, thus permitting the inclusion of the "*black box*" in a cybernetic system, the result of which is the consumer behavior.

We keep only the linear terms of the system and we are interested about the existence of an optimal external disturbing factor, which is acting upon x_1(for example), that is the influence of the cultural factor. Let: $\omega=(\omega_1, \omega_2, \omega_3, \omega_4, \omega_5)$, the vector of the "*external disturbing factor*", and the vector $y=(y_1,y_2,y_3,y_4,y_5)$, which represents "*the system response*" to this external factor.

$$\begin{pmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \\ \dot{x}_4 \\ \dot{x}_5 \end{pmatrix} = \begin{pmatrix} 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \\ \mu & \delta & \gamma & \beta & \alpha \end{pmatrix} \cdot \begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \end{pmatrix} + \begin{pmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix} \cdot \begin{pmatrix} \omega_1 \\ \omega_2 \\ \omega_3 \\ \omega_4 \\ \omega_5 \end{pmatrix}$$

$$\begin{pmatrix} y_1 \\ y_2 \\ y_3 \\ y_4 \\ y_5 \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix} \cdot \begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \end{pmatrix} \qquad (4)$$

The dynamical system, we will call "Σ", and it will have the form in equation(4).

The external factor, $\omega=(\omega_1, \omega_2, \omega_3, \omega_4, \omega_5)$, is acting upon x_1. The response of the system will be interested by the result of the disturbing action upon x_1 value, that is the cultural factor. We are in the general conditions of the algorithm for the optimal solution of the dynamical systems with quadratic cost function(Drăgoescu, 2009a, 2009b).

The initial restrictions are listed in the equations (5).

$$A,B,C\in M_5(R), X=Y, t_0=0, t_1=1, (t_0,t_1)\subset R,$$
$$\rho(t)=0, \sigma^{-1}(t)=1, x_0=1, p(t)=p^*(t), C_0=e^A \qquad (5)$$

with: $A=\begin{pmatrix} 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \\ \mu & \delta & \gamma & \beta & \alpha \end{pmatrix}$

$$B=\begin{pmatrix}1&0&0&0&0\\0&0&0&0&0\\0&0&0&0&0\\0&0&0&0&0\\0&0&0&0&0\end{pmatrix}$$

$$C=\begin{pmatrix}1&0&0&0&0\\0&0&0&0&0\\0&0&0&0&0\\0&0&0&0&0\\0&0&0&0&0\end{pmatrix}$$

According to Kalman's theory and theorem(Kalman, 1969)), the optimal control problem leads us to solve a Riccati equation formed with the system Σ coefficients, in the particular case, a Bernoulli equation in *p(t)* variable:

$$\dot{p}(t)-R\cdot p(t)-S\cdot p^2(t)=0_5 \quad (6)$$

with: p(t), p:R→ L(R) selfadjoint continuous differentiable operator on $T(t_0,t_1)\subset[T_1,T_2]\subset R_+$. The R and S coefficients are:

$$\mathbf{R}=A+A^*=\begin{pmatrix}0&1&0&0&\mu\\1&0&1&0&\delta\\0&1&0&1&\gamma\\0&0&1&0&\beta+1\\\mu&\delta&\gamma&\beta+1&2\alpha\end{pmatrix}$$

S=$BB^*=B^2=B$, with: $\rho(t)=0$, $\sigma(t)=1$("*initial restrictions*") (Drăgoescu, 2009). As a result of this algorithm and the theorem 2.3(Drăgoescu, 2011, p.23), if $\det(A+A^*)\neq 0$, the optimal trajectory is the solution for the differential equation (7):

$$\dot{x}(t)=[A-B\cdot p(t)]\cdot x(t)=M(t)\cdot x(t)\Rightarrow$$
$$\Rightarrow x(t)=E\cdot e^{\int_t M(\nu)d\nu}$$

(7)

with the "*initial restriction*":

$$x(0)=E=x_0\Rightarrow x(t)=x_0\cdot e^{\int_t M(\nu(\nu)} \quad (8)$$

The parameters values must verify the condition (9):

$$\alpha+\mu-\gamma\neq\beta\gamma+\delta\mu-\beta\mu$$

equivalent with: $\det(A+A^*)\neq 0$ (there are a lot of accepted possibilities). We note, for example(%): α=20, β=50, γ=10, δ=10, μ=10, five arbitrary values for the parameters, corresponding to this particular case:

(20+10-10=20, 10·10+10·10-50·10=-300, which verifies the condition).

In the visualization of the optimal trajectory there are five branches, which evolutions are not the same, each of them being enlighted near the corresponding branch: (figure no.2)

The interval of time is: [0;1]. The result has five branches as we have the solution vector: $x=(x_1,x_2,x_3,x_4,x_5)$. The optimal command, has the analytic formula in the equations (10):

$$u^0(t,x)=-\sigma^{-1}(t)B^*p(t)x(t)=$$
$$=-B^*\cdot[e^{(A+A^*)t}C_1-B\cdot(A+A^*)^{-1}]^{-1}x_0e^{\int_t M(\nu)d\nu}$$
$$=-B^*\cdot p(t)e^{\int_t[A-B\cdot p(\upsilon)]d\nu} \quad (10)$$

C_1 is calculated from the condition: $v(0)=-[p(0)]^{-1}$.The response of the system, $y(t)=C\cdot x(t)$, for a longer time (10 u.t.), if we follow the result of disturbing by a positive action upon the cultural factor, has only one branch, the one which is most changed by the disturbing factor. (figure no. 3,a)

On the other hand, studying the trajectory of the consumer behavior, following the disturbing action pointed towards the reference groups or belonging, but enlighting the evolution of the influences due to the culture and subculture, the algorithm leads to some interesting results: the cultural influence is ascending, while the subcultural influence remains constant(Figure 3, b).

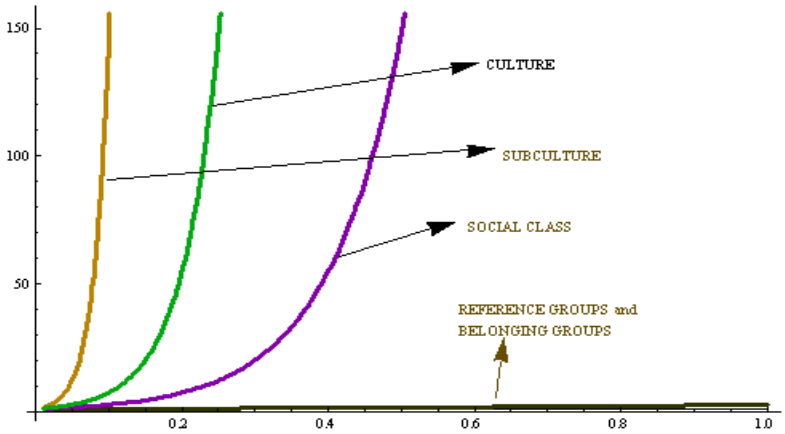

Figure 2. Evolution of the system trajectory when acting upon the cultural influence

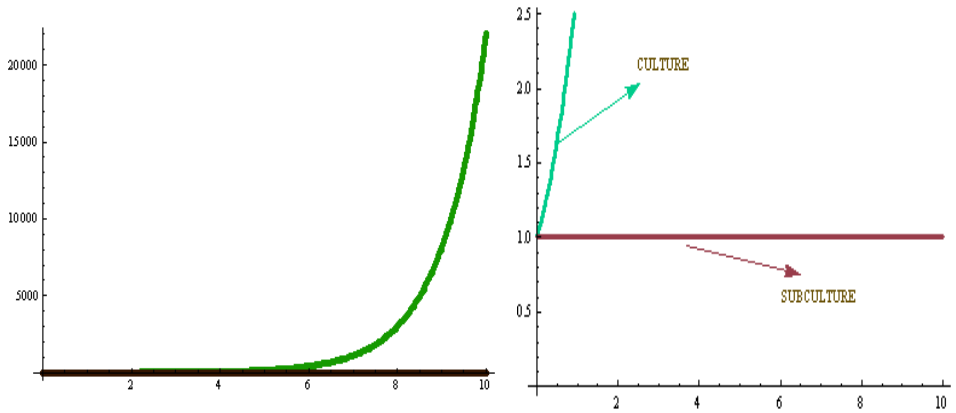

Figure 3. System response:
a) System response interested on the evolution of the cultural influence in a longer period(positive acting upon the same influence factor)
b) System response interested on the evolution of the cultural and subcultural influences, same period(positive acting upon the groups of reference and groups of belonging influence)

Refining the research, we will descend from the outside of the "*black box",* to the inside, and we will translate the model equation to the specific mechanisms of the ***BB***("internal" variables: ***a***=needs, ***b***=reasons, ***c***=intentions, ***d***=preferences, ***e***=behaviors), leaving the Veblen

influences("*external*" variables, noted: opened dynamical system, through which we better explain the consumer behavior, in a ***more complex model***, having the system result as the final decision of the consumer:

$$v^{(5)} - av^{(4)} - bv^{(3)} - c\ddot{v} - d\dot{v} - ev = 0 \quad (11)$$

with the new assumptions:

$$\begin{aligned} v &= x_1 \\ \dot{x}_1 &= -x_2 = \dot{v} \\ \dot{x}_2 &= x_3 = \ddot{v} \\ \dot{x}_3 &= -x_4 = v^{(3)} \\ \dot{x}_4 &= x_5 = v^{(4)} \\ \dot{x}_5 &= v^{(5)} = av^{(4)} + bv^{(3)} + c\ddot{v} + d\dot{v} + ev \end{aligned} \quad (12)$$

Consequently, the matrix form is the following:

$$\begin{pmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \\ \dot{x}_4 \\ \dot{x}_5 \end{pmatrix} = \begin{pmatrix} 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \\ e & d & c & b & a \end{pmatrix} \cdot \begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \end{pmatrix} \quad (13)$$

In the same mathematical context, the dynamical system "Σ" will have the state in equation (14), where: "x","y","C" have the same meanings as before, and "u" is the new disturbing vector: u=(u_1, u_2, u_3, u_4, u_5), (the system matrix A will be the"*black box*"-***BB***) with the B matrix different from the first case.

$$\begin{cases} \dfrac{dx}{dt} = \begin{pmatrix} 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \\ e & d & c & b & a \end{pmatrix} \cdot x + \begin{pmatrix} \alpha & 0 & 0 & 0 & 0 \\ 0 & \beta & 0 & 0 & 0 \\ 0 & 0 & \gamma & 0 & 0 \\ 0 & 0 & 0 & \delta & 0 \\ 0 & 0 & 0 & 0 & \mu \end{pmatrix} \cdot u \\ y = C \cdot x \end{cases} \quad (14)$$

$\alpha,\beta,\gamma,\delta,\mu$) as disturbing factors of the

Regarding the rest of it, the mathematical context and judgement is the same, including the initial conditions and restrictions(a+e-c≠bc+de-be). For a fixed set of initial values of the "*internal*" variables(belonging to a certain type of consumer), we wil be able to study the the varied effects of the Veblen influences(the "*external*" variables), following the evolution of the new "Σ" system for different values of the disturbing matrix parameters, study which we propose to achieve in the future. influences(the "*external*" variables), following the evolution of the new "Σ" system for different values of the disturbing matrix parameters, study which we propose to achieve in the future.

Conclusions

We conclude that, after a longer period of time, when positive acting upon the cultural factor, the "black box" system(i.e. the way we process the influences) will responde by an exponential evolution. The author contribution consists of applying the Veblen theory to the Kotler cyber model, using an existing matrix algorithm, in order to enlight the interactions between the internal and the external variables. Also, the paper points out a parallel between the theory and the practice, referring to the anime culture, studying the influences of the anime culture from the Veblen perspective, applied to the "*black box*" devices, and following the effects upon the consumer behavior. Using the algorithm "*Veblen influences.nb*", written in Mathematica 7.0, we can obtain many other graphical representations, for different values of the parameters and for different time

limits in which the external disturbing factors are acting.

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