Computer Simulations of Corporation's Reaction to an Environment on the Basis of Corporate Entrepreneurship Model in British Petroleum

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Basing on mean field theory and corporate entrepreneurship (CE) concept a mathematical model of complex organization has been derived. The model was applied to computer simulations of corporation's reaction to hostile environment in corporations similar to British Petroleum.

Introduction.Development of new business ideas and opportunities within large and established corporations is related to the concept of corporate entrepreneurship (CE). In two last decades there has been a growing interest in the use of CE as a means for corporations to enhance the innovative abilities of their employees and, at the same time, increase corporate success through the creation of new corporate ventures. However, the reality facing multinational corporations is that the traditional models of CE are fast becoming obsolete and forcing out by new reality. Emerging models obey new rules coming from inside the company and outside it as well. These new rules become necessary to navigate global economics. Let us present two examples of the new rules. Recently, creation of the new rule has taken place after the collapse of the Enron Corporation: Every company needs to embrace it, while understanding that, if taken too far, entrepreneurship has the ability to undetermine its own power. Another kind of the rule results from low efficiency of complicated models: While the Business World becomes complicated then the strategies must be be simple. For more examples and their derivation we refer to the paper by J. Birkinshaw.

Goal of this paper is to create mathematical model of CE and perform the computer simulations of corporation's reaction to the hostile environment. On the basis of derived results we will formulate indications concerning practical aspects of the model described here.

CE Model in British Petroleum. BP is now recognized as a leader in the restructuring of the global oil and gas industry and a highly innovative, forward-looking company that, in its pursuit of sustainable energy solutions, is effectively managing the difficult task of balancing growth, profitability, and social responsibility. According to Mr. R.F. Chase (former BP executive), the BP management model rests on four components that help guide and control entrepreneurial action. These are *direction, space, boundaries*, and *support*. Following the Birkinshaw paper we present definitions of these components[3]:

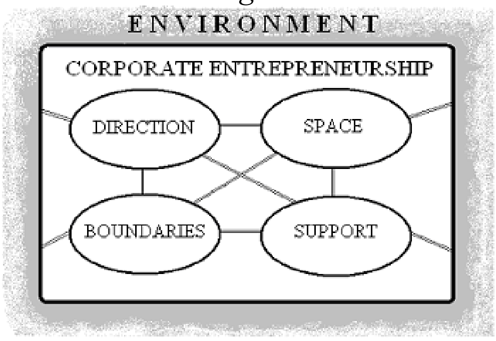
- *Direction* (DI)essentially is the company's strategy. It is a statement of the goals of the company, the markets in which it competes, and its overall positioning in those markets.
- *Space* (SP) identifies the degrees of freedom provided to business unit managers to deliver on their commitments.
- *Boundaries* (BO) are the legal, regulatory, and moral limits within which the company operates.
- *Support* (SU) denotes the systems and programs provided by the company to help business unit managers do their job.

J. Birkinshaw determines the following three states for each component: *constraint, balance, chaos*, and precisely describes definition each of them[3].

Mathematical model of CE in BP. Simplicity and completeness of the presented model enables to create its mathematical version. However, some additional details must be introduced. First at all we take into account external hostile environment depending on one parameter characterizing its strength. Next we introduced the following correlations:

component-component and CE-componet (Fig.1).

Fig.1



The correlations e*nvironment-component* and *environment-corporation* are considered in mean field approximation. In contrary to the Birkinshaw approach we assume a probabilistic model. In the case of deterministic model the point is that for positive, strategically predicated change to occur, the company needs all four components at balance. If any one is out of balance, the model breaks down for certain. However, in the proposed stochastic model such a situation may happen with a given probability. Therefore we introduce sample space of 3^5 events being projections of the four dimensional component's space into the one dimensional space of the CE states: [DI,SP,BO,SU]→[CE], where DI,SP,BO,SU and CE are random variables getting values in the set {*constraint (co), chaos (ch), balance (ba)}*. Some of them are very probable, for instance [co,co,co,co]→[co], on the contrary to [ba,ba,ba,ba]→[ch] of which probability is very low. The probability distribution for the sample set depends on the mentioned above relations *component-component, CE-component,* as well as on the state of environment. These relations determine structure of the considered model. The relations we talking about are correlations between the introduced random variables. Therefore we consider three types of the correlations: positive (+), negative (-) and negligible (0). We assume that these relations are constant with respect to the sign and the absolute values of the correlation coefficients. It is possible to consider an extended version of the model, where also the correlation coefficients are random. Total number of possible structures is 3^{10} , whereas we will simulate very view of them. For example one structure is presented below, where $J_{DI\text{-}SP}$ means the *dimension-space* correlation coefficient, etc.

Table 1

$\mathbf{J_{DI\text{-}SP}}$	$J_{DI\text{-}SU}$	$J_{DI\text{-}BO}$	$J_{SP\text{-}SU}$	$J_{SP\text{-}BO}$	$J_{BO\text{-}SU}$	$J_{CE\text{-}DI}$	$J_{CE\text{-}SP}$	$J_{CE\text{-}SU}$	$\mathbf{J_{CEBO}}$
-0.9	-0.5	+0.9	-0.5	+0.9	+0.5	+0.5	+0.4	+0.5	+0.4

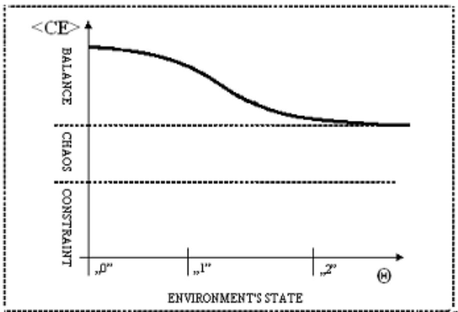
We simulate the following problem. Let the structure of the model is fixed (for example see Table 1.). Let the initial state of the company and its components is represented by an event of the sample set: *[DI,SP,BO,SU]→[CE]*. Let the environment is changing from the neutral to a hostile and further to the very hostile one. Goal of this simulation is how the corporal entrepreneurship changes while the strength of the hostile environment increases. In order to perform such simulations we need to define the probability distribution on the sample set. Let us assume the following form for this probability distribution

$p(DI,SP,BO,SU,CE)=p(DI,SP)\cdot p(DI,BO)$ $p(DI,SU)\cdot p(SP,BO)$ $p(SP,SU)\cdot p(BO,SU)$ $r(DI,CE)\cdot r(SP,CE)$ $r(BO,CE)\cdot r(SU,CE)/Z,$ where:

$p(X,Y)\sim exp[-J_{XY}(X+Y)/\Theta],$ $r(X,Y)\sim exp[-J_{XY}(X\cdot Y)/\Theta],$ X and Y are considered random variables, J_{XY} is correlation coefficient of the X,Y pair and Θ is the measure of the environment's strength. Z is the probability normalizer. All correlation coefficients J_{XY} are measurable. In order to determine value of J_{XY} one must select appropriate indexes in the correlated components and collect enough long statistical data for both of them. Computation of the Pearson correlation coefficient leads to the required magnitude of J_{XY}. The Θ parameter corresponds to temperature in physical system being in equilibrium with a thermal bath (environment). Therefore, values of Θ run the continuous set $[0,\infty)$. $\Theta=0$ corresponds to extremely ordered system, whereas, the increasing Θ pushes a system to chaos. There is not influence of random variables on Θ, therefore during the simulation process Θ is fixed. Information about the corporate entrepreneurship and its components resulting from the considered model can be read from the moments of the random variables. Here we limit ourselves to the first moments of the random variables (expectation values). The most important information about the CE state is its expectation value <CE> which we derive from the solution of self consistence condition (*SCC*): <CE>=<DI>+<SP>+<BO>+<SU>. Solution of this equation with respect to <CE> versus Θ is looked for function describing reaction of the corporate entrepreneurship to the assumed type of environment. For the computer simulation purposes we map the set of possible random values {co,ch,ba} onto {-1,0,1}.

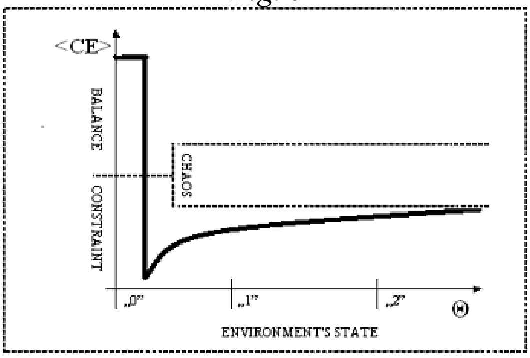
Simulations of the Structure 1. Considered Structure 1 is characterized by $J_{XY}>0$, for each pair *XY*. Simulations start from the following initial state of components [1,1,1,1] and very low strength of environment ($\Theta\approx10^{-6}$). Solving *SCC* we derived $<CE>\approx1$ which agrees with the Birkinshaw qualitative deduction. Next, step by step we increased Θ up to *100*. For each step we solved *SCC*. The solutions for $<CE>$ are depicted in Fig.2.The expaectation value $<CE>$ is continuous function of Θ and asymptotically approaches the *chaos*. There is not transition to the *constraint* if the model's structure is assumed to be rigid.

Fig. 2



Simulations of the Structure 2. *50%* of J_{XY} are negative, where $X\neq CE$ and $Y\neq CE$, whereas all correlation coefficients $J_{XY}>0$ if at least one random variables is *CE*. Example values of J_{XY} are displayed in Table1. Again simulations start from the initial state [1,1,1,1] for $\Theta\approx10^{-6}$ and go up to $\Theta=5$. Results are depicted in Fig. 3. For a weak environment the solution for <CE> corresponds to the *balance*. The <CE> changes very little when Θ runs from *0* to *1*. For $\Theta\approx1.02$ the <CE> jumps discontinuously to the *constraint*. This phenomena is very similar to a crash. Further increase of Θ approaches the <CE> to the *chaos*.

Fig. 3



We have performed simulations of the ten structures. On the basis of the obtained results we derive the following conclusions.

Types of transitions.The CE can change its state by the two ways: continuous and discontinuous ones. The discontinuous transition occurs only between the *balance* and the *constraint.* It results from the two presented examples that the type of the transition depends on the model's structure and a value of Θ. **Perspectives of applications**. The most desirable state of the CE is the *balance*, which means that <CE> should be equal 1, as close as possible. Unfortunately, the hostile environment pushes the CE out of the *balance* independently on the model's structure. However, there are structures which are resistant against environment. This means that corresponding <CE> decreases slowly and never jumps out of the *balance.* Such a property possesses the structure 1, which has all correlation coefficients positive. Therefore, we find that structure possessing more positive correlation coefficients is the better one. Since the correlation coefficients are measurable, it would be possible to recognize structure of the CE. Such an information could be helpful in prediction of crushes. Moreover, knowing which correlation coefficients are negative and analysing the statistical data it could be possible to recognize reasons of unprofitable structure. The full paper concerning researches presented here is in preparation.

References:

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[2] K.M. Eisenhardt and D.N. Sull, *Strategy as Simple Rules,* Harvard Business Review (2001), 1, pp 107-116.

[3] J. Birkinshaw, *The Paradox of Corporate Entrepreneurship,* Strategy+Business Magazine (Booz Allen Hamilton)