

## The Interaction Stabilization Criterion.

### I. A Pair of Selected Economic Entities

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#### Abstract

The conditions leading to dynamic stabilization of interaction in the organizational networks and their mathematical formalizations are studied in this article. Also the criteria of the economic interaction stabilization and occurrence of the equilibrium state are formulated in the article. Equilibrium state means parity situations for both: the couple of selected enterprises and the economic entity arbitrary network.

**Keywords:** interaction stabilization, risk management, organizational network, Pareto efficiency.

#### 1 Introduction. Problem statement of interaction stabilization in the pair of economic entities

Let's consider a pair of enterprises  $P_i$  and  $P_j$ , located in the organizational network structure. There are network links between these enterprises. Due to the economic necessity, the processes of interaction and resources movement (material, financial and informational) appear between the enterprises  $P_i$  and  $P_j$ .

In practice, there are always some variants (programs) of interaction among the selected couple of enterprises. These variants can differ from each other by terms of cooperation, by sale prices for goods and services, by ways of interaction and interaction duration, by shares of investments in joint projects and various terms of participation in these projects, by schemes of product procurement in different quantities. It is clear that when implementing various variants of cooperation  $T_1, T_2, \dots, T_m$  the enterprises  $P_i$  and  $P_j$  will receive different benefits, i.e. different

amount of resources  $V_{ij}$  и  $V_{ji}$  coming toward them (Fig. 1).

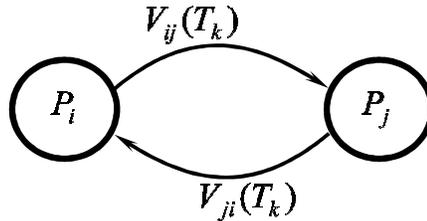


Fig.1. A couple of interacted enterprises of the organizational network

Figure 1 shows the volume of resources  $V_{ij}(T_k)$  и  $V_{ji}(T_k)$ , coming to the enterprises  $P_j$  and  $P_i$  respectively, in the result of implementation a variant  $T_k$  of the interaction process.

The analysis of the experience of interaction between enterprises shows that the total amount of resources, received by enterprises  $P_i$  and  $P_j$  in the result of interaction, is always bounded above by some maximum volume:

$$\forall T_k : V_{ij}(T_k) + V_{ji}(T_k) \leq V_{\max} = \text{Const}. \quad (1)$$

- the implementation of any variant of cooperation (implementation of any project) cannot bring arbitrarily large profits because of the overall economic resources limitation.

To the couple of interacted enterprises  $P_i \leftrightarrow P_j$  inequality (1) means that on approaching to the maximum possible (within described embodiment of interaction) meanings of incoming resources volumes  $V_{ij}$  и  $V_{ji}$  to the enterprises  $P_i$  и  $P_j$ , the increasing of profit from interaction at the one of enterprises can be achieved only by means of decreasing profit at the another enterprise.

In the case of one enterprise dissatisfaction by terms and results of interaction, the enterprise will strive to change the cooperation terms, will strive to choose the more suitable variant of interaction and will strive to look for the ways of conversion organizational links, i.e. the interaction of pair  $P_i \leftrightarrow P_j$  will be unstable.

In the extreme case, when the volumes of resources  $V_{ij}$  or  $V_{ji}$ , incoming to the enterprise as a result of interaction, are unreasonably low, the cooperation may become economically unreasonable and the ligament of the organizational network  $P_i \leftrightarrow P_j$  disintegrates.

Hence, there is a problem of stabilization the economic interaction of the economic network elements and formalization the criteria of the enterprises stable interaction.

## 2 The stabilization criterion of the interaction processes in the pair of selected economic entities

To solve the problem of formalization the criteria of stabilization the interaction in a pair of enterprises let's use an idea of evaluation the economic solvency of the economic entities [1-14].

An assessment  $k_{cond}^{(i)} = K_{cond}(P_i)$  of an enterprise economic solvency corresponds to the enterprise  $P_i$ . In fact, the assessment  $k_{cond}^{(i)} = K_{cond}(P_i)$  of the enterprise  $P_i$  economic solvency is a meaning of some assessed functional.

A form of assessed functional  $K_{cond}(P_i)$  of the enterprise  $P_i$  solvency depends on the character of the task and practical requirements to the evaluations. The functional  $K_{cond}(P_i)$  is implied monotonous. It means that the meaning of the economic solvency assessment  $k_{cond}^{(i)} = K_{cond}(P_i)$  of the enterprise  $P_i$  should be the higher, the bigger the enterprise recourse content and meanings of economic indices of the enterprise are.

It is obvious that the meaning of economic interaction is that each enterprise  $P_i$  is aimed to increase its economic solvency  $k_{cond}^{(i)} = K_{cond}(P_i)$ . During interaction each enterprise  $P_i$  strives to achieve the maximum meaning of the magnitude  $\Delta k_{cond}^{(i)}(T_s)$  - an increment from implementation any variant  $T_s$  of interaction. Here  $\Delta k_{cond}^{(i)}(T_s) = k_{cond}^{(i)}(T_s) - k_{cond}^{(i)}(0)$ , where  $k_{cond}^{(i)}(T_s)$  is a meaning of the enterprise  $P_i$  economic solvency after implementation a variant of interaction  $T_s$ , and  $k_{cond}^{(i)}(0)$  is the initial value of the enterprise  $P_i$  economic solvency.

By inequality (1), there are competing interests in the pair of cooperating enterprises  $P_i \leftrightarrow P_j$ . Increase economic solvency of one of the enterprises prevents increase of the value  $\Delta k_{cond}^{(j)}(T_s)$  of another enterprise. Presence of the enterprises  $P_i$  and  $P_j$  conflicting interests allows formulating the criterion of stabilization economic interaction in terms of game theory, because the choice of possible variant of interaction between the enterprises (contractual process) can be regarded as a game with conflicting interests [82].

For each variant of interaction  $T_s$  from the set of all possible variants  $T_1, T_2, \dots, T_m$  of interaction let's calculate increments  $\Delta k_{cond}^{(i)}(T_s)$  and  $\Delta k_{cond}^{(j)}(T_s)$  of the both enterprises  $P_i$  and  $P_j$  economic solvency assessments, received from implementation the variant of cooperation  $T_s$ . Results of the calculated forecasts are presented in the Table 1:

*Table 1*  
Increments of enterprises solvency in different variants of interaction

	$T_1$	$T_2$	...	$T_m$
$P_i$	$\Delta k_{cond}^{(i)}(T_1)$	$\Delta k_{cond}^{(i)}(T_2)$	...	$\Delta k_{cond}^{(i)}(T_m)$
$P_j$	$\Delta k_{cond}^{(j)}(T_1)$	$\Delta k_{cond}^{(j)}(T_2)$	...	$\Delta k_{cond}^{(j)}(T_m)$

Let's collate each variant of interaction  $T_s$  with point  $A_s$  on a coordinate plane with coordinates  $(\Delta k_{cond}^{(i)}(T_s); \Delta k_{cond}^{(j)}(T_s))$ , i.e.  $T_s \mapsto A_s(\Delta k_{cond}^{(i)}(T_s); \Delta k_{cond}^{(j)}(T_s))$ .

The calculation results (Table 1) of the solvency increments for the given couple of cooperating enterprises  $P_i \leftrightarrow P_j$  are presented on the coordinate plane (Fig. 2).

Figure 2 shows the multiplicity of points  $A_1, A_2, \dots, A_m$ , corresponding economic solvency increments of the enterprises  $P_i$  and  $P_j$  in the case of all possible variants of interaction  $T_1, T_2, \dots, T_m$  implementation.

The variant of interaction  $T_s$  between the enterprises (as well as the point  $A_s$  of the variant of interaction results  $(\Delta k_{cond}^{(i)}(T_s); \Delta k_{cond}^{(j)}(T_s))$ ) is called Pareto efficiency [6] if there is no more preferable for both players variant with better results of economic solvency increment simultaneously (a variant that improves result for one enterprise and does not decrease results for another enterprise). Optimality of the enterprises cooperation variant  $T_s$  means fulfillment of the conjunction conditions:

$$\forall T_r \left( \Delta k_{cond}^{(i)}(T_r) \leq \Delta k_{cond}^{(i)}(T_s) \right) \& \left( \Delta k_{cond}^{(j)}(T_r) \leq \Delta k_{cond}^{(j)}(T_s) \right) \quad (2)$$

Geometrically, the conditions (2) mean that there are no other points that can be more preferable variants of cooperation in the right angle on the right and up from the Pareto efficiency point  $A_s$  (in rectangular area with a vertex at the point  $A_s$ ) (Fig. 2).

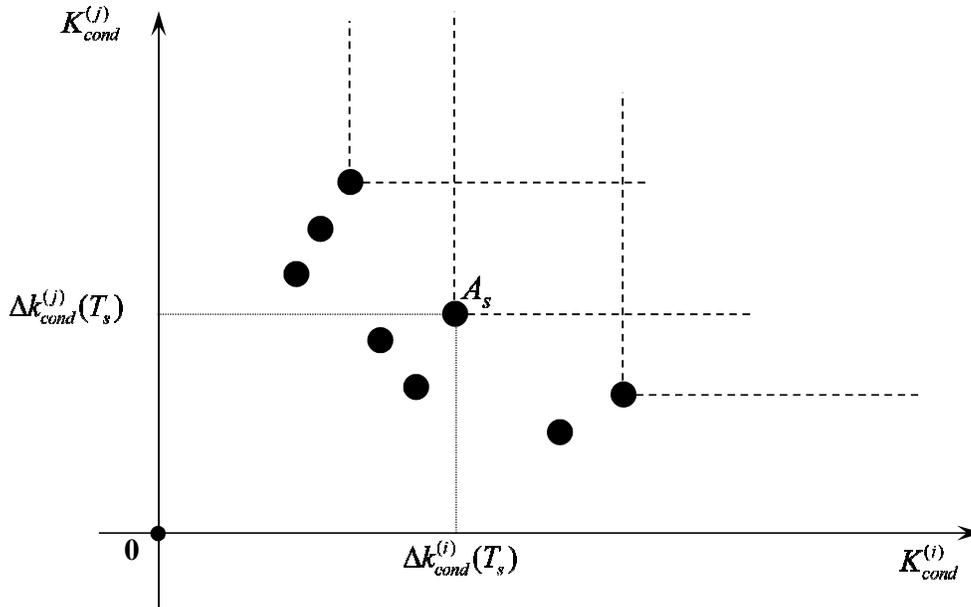


Fig. 2. Presentation the economic solvency increments of the enterprises  $P_i$  and  $P_j$  in the result

The conditions (2) for the variant  $T_s$  of interaction between a pair of the organizational network enterprises are the criterion of the economic interaction stabilization.

Indeed, when the Pareto efficiency variant  $T_s$  is implemented, none of the cooperating enterprises could improve anything by means of searching additional cooperation variants. Any improvement of interaction results for one enterprise can be implemented only by means of worsening results for another one, and none of the economic entities agrees to cooperate on the worse for itself conditions. In practice it means that after reaching an agreement on the implementation of Pareto efficiency variant of cooperation  $T_s$ , during some time enterprises  $P_i$  and  $P_j$  are not going to look for new variants of cooperation and relationships in the couple  $P_i \leftrightarrow P_j$  have stabilized, variant  $T_s$  is mutually acceptable.

As shown in the figure 2 there are several stable variants of cooperation among the pair of enterprises. Choice a particular variant of cooperation from several optimal variants is defined by means of taking into account additional factors of the considered interaction, negotiation to reach agreements, decisions of managers as well as various additional factors such as organizational and legal or directive impact, established traditions, accidental causes.

### 3 Conclusion

The stable state of the pair of enterprises  $P_i \leftrightarrow P_j$  can last for a long time until the existing practical problems of interaction (entailing the formation of the pair) will be performed.

Relationships in the environment that destabilize current relationships and change the meanings of their solvency assessment functionals  $K_{cond}(P_i)$  can break the stability of a couple of enterprises  $P_i \leftrightarrow P_j$  interaction.

Such changes break established relationships or propose new additional variants of interaction which transmogrify the old forms of interaction to Pareto suboptimal and dissatisfying the stabilization criterion.

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