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## **DEVELOPMENT OF MARKET RELATIONS IN RUSSIA: THE IMPACT OF THE STRUCTURE OF A FIRM**

The formation of market relations in Russia has been accompanied with considerable changes in the size and organizational structure of firms. It makes very actual the search of the optimal structure of a firm responding to the changes of external conditions.

The authors have made a quantitative analysis of the process of adapting a firm to the new conditions with the usage of the models, describing different types of organization ( one - leveled, network, hierarchical and cluster). There has been analyzed the impact of the final time of reaction in separate chains of a firm on the process of adaptation. The time necessary for full adaptation of a firm's activity to the changed external conditions with different types of organizational structures has been accounted. There has also been investigated a connection between the time for adaptation and the sizes of a firm.

The paper contains the suggestions on the optimization of the structure of a firm in the conditions of transitional economy.

## **Introduction**

For increase of a production efficiency and growth of productivity in not prime conditions of a Russian real, it is necessary to firms to decide a complex problem of search of the new forms and methods of management adapted to indeterminacy of managing.

The Russian firms tending to an adequate response on a modification of an external medium and a gain of competitive items in the market successfully master foreign experience of study of features of various organizational structures of firm.

As shows the analysis of a situation in the Saratov region, the majority of firms of a food industry is mastered with administrative innovations, react to faster modifications of an external medium. At that time there are firms, which are content with old methods and forms even then, when has ripened need for modifications and it is known about existence innovations. The firms relating the first group, are susceptiblis to innovations, have large innovational potential. The parameters of such firms (performance of staff and organizational structure), distinguishing them from the second group, and condition of their operation are object of our analysis. In each region of Russia it is possible to find enough of such firms. For example, in the Saratov region there are 16 enterprises of the food industry which have taken part in the second national exhibition “ Russian food-staffs - 98 ” and the received various awards.

The crisis of August, 1998, has forced many firms of a food industry of regions of Russia by a radical image to change style of management, to increase a susceptibility of firms to innovations. In the beginning of a 1999 more than 80 % of the goods in the Saratov food market were made by the local enterprises. Only for one 1998 in Saratov region four wholesale food markets are created and is planned to open two. Volume of production of a food industry was increased for a 1998 at 12 percents on a comparison with 1997.

As a rule, the susceptibility to innovations is measured by time of introduction of a concrete innovation or their general number accepted to assimilation in the given organization for a certain instant. Than earlier solution about introduction or will be reached than will be more run in of innovations to the given instant, the above susceptibility of firm.

It is possible to present a general model used by us for an evaluation of a susceptibility of firms to administrative innovations, as follows:

$$A=f(P, S, E),$$

Where A - susceptibility to innovations, P - psychological performances of staff, S - performance of an organizational structure (structural variables) and E - performance of an external environment and interorganizational connections (contextual variables).

In spite of the fact that psychological quality of the chief of firm and its subordinate render determined, and sometimes defining, influence to solutions, accepted by them, it is not unique and not a primary factor, as the behavior of the employee of firm is determined by the industrial relations, dominating in company, and also norms and procedures implying from a usual organizational structure.

The analysis of a situation in concrete firms testifies that the structural variables are more important in determination of a susceptibility of organization to innovations. Our conclusion is confirmed by work [1], in which the comparative analysis of influence various variable on two types of innovations - scientific and technical and administrative is given. In the paper [1] is shown, that, though the acceptance of scientific and technical and administrative innovations is influenced by various types of variables, but most important for both types of innovations appear structural variables.

The structural variables characterize three main organizational indications of firm such as size, magnitude of reserve resources and type of its organization. The innovations are accepted more often by the firm having certain reserves. And business not only that last allow to make the costs of purchase and assimilation of an innovation. They are necessary for indemnification of losses from acceptance of unsuccessful innovations. It is supposed, that than more largely firm, the more reserves it has. But quite often is missed from a kind, that the resources component reserves for innovations, not are always interchangeable. For example, it is impossible only by financial assets fast to increase qualification of staff of the company up to a level required by an innovation. Therefore more correct statement of a question about methods of a measurement of influence on a susceptibility of firm to innovations separate component of a reserve - such, as annual freely allocated funds; Subdividings created for development and introduction of an innovation; experience of application of administrative innovations in the past and other.

The question of how the organizational structure of a company affects its sensitivity to innovations is quite difficult. It was initially considered that organic structures with the least strict order of operation, decentralized decision making and developed internal and external communication networks were in any case more sensitive to innovations. Mechanistic structures

with strict order of operation and decision making were, on the contrary, not inclined to give up the long established practice in the favor of experiment and were orthodox in terms of methods of management. Therefore, it was believed that the companies of the latter kind were less sensitive to innovations. The similar point of view represented in work [2], while the empirical studies of other authors [3] reveal a positive relationship between formalization and centralization and acceptance of innovations, that means that any resistance of mechanistic structures to innovations is denied.

Such contradictory evaluation of influence of performances of an organizational structure on a susceptibility to innovations results in a conclusion about necessity of situational explanation of this communication. The analysis of activity of firms in a food industry of regions of Russia testifies that does not exist is universal of the best structures of management. To innovations the organization both with organic can be susceptible, and with mechanistic structure depending on what external environment it acts in, on what stage there is an innovation and what performances component it of staff. From here follows, that, if the firm functions in unstable and unpredictable conditions, slacking of centralization and formalization, that is transition to an organic structure, can facilitate process of acceptance of an innovation. So, in the last months of a 1998, when the financial crisis has reduced in a destabilizing of the food market of Russia, in majority it of regions the essential transformations in a control system of firms their susceptibility, directed on increase, to "signals" of the market, to search of the new investments and new suppliers of products of a feed were marked. These modifications were largely characterized by decrease of a degree of a regulation of a structure of firm, decentralizing in management and other similar indications. Effect on activity of firm of the factors of the external order simultaneously has amplified. In conditions of stability the influence of similitudes will carry a return character and more effective will appear mechanistic or hierarchies.

The different types of structures are efficient at different stages of the innovation process. Organic structures are good for searching for and creation of innovations as they facilitate the exchange of ideas owing to low rates of formalization and centralization. At the stage of introduction, when it is important to centralize the responsibility and avoid conflicts resulting from the introduction of new methods of management, mechanistic structures are more efficient (see Table 3.3.2.). That means that a company can only be regarded as sensitive to innovations if it can change its structure depending on the stage of the innovation process it is at. In other

words, if it has a dual structure. Switching of the structure is necessary in the following cases: 1. the need for innovations is very urgent, 2. the consequences the innovations might bring along are very vague, and 3. the innovations are extremely radical. The transition to the market has required of firms of essential transformations in a structure. So, meat-refinery enterprises of the Saratov region constantly master new kinds of production. Only in a 1998 is run in and 10 new names are started in production. In firms there are new subdivisions, stables there are communications with the suppliers of agricultural raw material.

However, the impossibility to constantly change the structure of a company in reality is evident. Its complexity (the total number of the lines of activity), order of operation and centralized decision making develop in time and depend on many factors. In view of this it seems more realistic that it is the behavior of the personnel that is to change. Good personal relations within the company acquire additional importance in this case, since they enable to avoid or resolve conflicts that may occur as the stages of the innovation process change. In general the idea of dual organizational structure is too abstract and very difficult to implement. Notwithstanding this it contains certain rational points: it shows that the innovation process should be viewed in dynamics and that the acceptance and introduction of innovations are different processes to be conducted by different innovation structures. This provides a conceptual grounding for the importance of labor division in innovation processes.

Among contextual variables describing activity of firm, the greatest attention to the factor of indeterminacy of an external environment is necessary to pay, which high degree generally stimulates acceptance of innovations. Among other contextual variables the degree of a competitiveness, interorganizational cooperation, sizes of region attended by organization is possible to name population shift, its structure etc. Empirical data on these variables are contradictory, the different contributors receive a various evaluation of a degree of a directness of their influence. In transitional economy the factors of an external environment can be defining for activity of firm. The firms producing the foodstuffs, as the outcomes of our analysis testify, are under effect of an incompleteness of process of privatization, test negative influence of unreliability of a banking system, inconsistencies and incompleteness of legal basis, regulation of the property rights, investments, process of pricing.

In our opinion, it is possible to consider all interfirm activity, as well as interaction of firm with an environment as process of transfer and information processing. Now process of

information processing received from the markets as prices of goods, orders and other data, and the information interchange for want of interaction with the buyers and suppliers, makes the vital medium of traditional activity of firms on production and realization of the goods.

For our analysis the submission about a structure of firm as populations of the separate agents is important. The individuals component organization, may have the various purposes: from a strictly rational behavior homo economic to the much greater gang of behavioral features. Between the agents component firm, the information exchange happens, which model can be circumscribed by a network of connected points (graph). To various organizational structures of firm there will correspond the various columns. The organization is probable, in which each agent is connected to all remaining individuals (i.e. complete interconnectedness). The structure is probable, in which there is a hub (nucleus) and "spokes" (that is all agents are accountable to the central manager - limiting variant of a mechanistic model). The hierarchical tree-like structure or any other model of a structure of organization is probable. Any restrictions on a structure of firm do not exist.

Let's consider influence of an organizational structure of firm to performances of adaptation process following the analysis offered in [4,5]. The important element of an information model of firm is a performance of capabilities of the agents on transformation of an information dependent and from their own intrinsic abilities, and from a possibility of the communication channels between them. In a model indicated below, this ability will be considered only in terms of the agents' characteristics, but should be kept in mind that the communication channels also can influence process of transfer of an information. More full model should be able to take into account separately abilities of the agents to transfer of an information and ability (and costs) network communication channels. We assume, that in a model the exchange only by discrete information contents transmitted through communication channels happens.

### **A Model of Innovation by Firm**

Is informational - processing organization we consider as a very simple structure. Each agent of organization can be in two stage designated 0 and 1. So condition of each agent is described only in one bit of an information. This bit of an information can describe or adaptation

of the agent to a favorable innovation, either purchase or loss any of a kind of activity positively influencing to operation of firm. The correlation between the agents also has a simple form: each agent sees, in what stage - (0 or 1) - there are agents, connected with him. The connection between two agents can be represented as a direct line, and the organizational diagram is a digraph.

The contents of a model is connected to the analysis of interaction of ability of the agents to transfer of an information and structure of their connections. Ability of the agent to be switched from a stage 0 in a condition 1 is function of the relation: the amounts of the agents switched in a condition 1, which are seen by the given agent, to a total number of the agents, connected with given agent. The kind of this function will describe a capacity of our network, that is force of external perturbation, which is swallowed by firm without a modification in it a condition. The time is considered as discrete magnitude, and during each interval each agent can adopt to innovation (that is go from state 0 to state 1), depending on an information about the neighbours, which to him is accessible, and from it abilities to treat this information. Formally, for a simplicity considering one instant, probability of transition from a condition 0 in a condition 1:

$$P_i(1|0) = f\left(\frac{\sum_j Y_{ij}}{T_i}\right) \quad (1)$$

Here  $Y_{ij}=1$ , if the agent  $j$  is connected to the agent  $i$  (in the sense that  $i$  sees a  $j$ ' state) and the agent  $j$  is in state 1; and  $Y_{ij}=0$ , if the agent  $j$  is connected to the agent  $i$  and the agent  $j$  is in a condition 0. Thus,  $\sum_j Y_{ij}$  is a number of the agents connected to the agent  $i$ , which is in state 1.  $T_i$  is a total number of the agents connected to the agent  $i$ .

The function  $f$  reflects capability of the agents to transfer of an information as follows. If the capability of the agents to transfer of an information is great, all agents will be switched at once, as soon as will see, that other agent was switched in a condition 1. In this case innovation will be distributed faster on all firm, if each agent is connected to each, because the information thanking only to one agent will be immediately transferred to all members of firm, which then everyone can adpot to innovation. If innovation is entered somewhere in firm in a temporary cycle 1, it can completely be distributed till all by the members of firm in a temporary cycle 2.

Now we shall consider more general form of function  $f$ . Let ability to transfer of an information will be represented by function of a logistics type, such, that probability of the agent

to be switched in a condition 1 is very small, if the agent does not observe significant group those who was already switched in a condition 1. That is for the agent i

$$f(x_i) = 1 / (1 + \exp(-(x_i - (a / c)) / (b / c))) - 1 / (1 + \exp(a / b)) \quad (2)$$

where  $x_i = (\sum_j Y_{ij}) / T_i$  as in the equation (1) is higher. This modified logistics function

requires some explanation. The second term in a right member of the equation (2) is deducted

present ability to transfer by the most simple method - as line with one-direction transmitting. For large c the function f is located close to a vertical axes and the agents have high ability to transition from state 0 in state 1, even if small group of the agents, to which they are connected, transmit to state 1. For small significance c the function f is shifted to the right. It means, that for transition of one agent in a state 1 rather large group of the agents in a field should pass it of visibility in state 1. The functions with various significance with never are intersected also everyone leave from zero. Thus, the ability to transfer monotonically depends from c. For small c (low transmitting ability) the situation of full correlation can really slow process of innovation, because the nonlinearity of function f will hinder with distribution of a innovation recognized by one agent. The signal about adaptation will sink somebody from firm in a noise of a signal of the not adapted members. Various f of function are shown graphically in a fig. 1.



information very weak, by the ideal form of organization will be connection of one agent only with one agent. In this case number of temporary periods necessary for adaptation of all agents should be equal to number of the agents in organization. The time of adaptation of all agents will be less, than in case, when any agents completely are interconnected, because the nonlinearity of function  $f$  owes messages to delay in adaptation, when in field of view there are not switched agents.

Thus, for very high ability to transfer of an information full connections of the agents is the best organizational structure of firm, while for very weak ability to transfer there will be more effectively completely hierarchical organization. For an average level of ability to transfer of an information there will be some optimal structures and degrees of correlation, which will minimize

expected interval of time necessary for distribution for an information on organization.

That fact, that optimum organization chart exists, at all does not mean, that it is easy and simply probably to define, with what it should be, as the number of the graphs grows very fast with growth of the agents in organization.

In our model with nonlinear function of ability of transfer it seems unlikely, that for firm even of average size the point algebraic expression for an optimum structure can be introduced, or even, that the algorithm permitting to reveal an optimum structure in a reasonable amount of time can be found.

In spite of the fact that there is no point algorithm of unequivocal definition of an optimum structure, our model gives more deep understanding of correlation between an organizational structure, ability to transfer and time of adaptation to an information due to numerical simulation of various organizational structures. We shall and to test influence of the various organizational forms.

We researched three organizational structures. The first structure - complete associated organization, in which each agent sees each agent (is circumscribed above). The second type is a simple outline shown in a fig. 2, in which some managers supervise over separate groups including small number of the agents. The agents of separate group completely are interconnected, and each from them is connected to the manager of group. The managers are interconnected among themselves, and each from them inspects some separate groups. In this case there is a double-side connection, so that each member of a connected pair sees other. For this structure we assume, that innovation arises accidentally at one from the agents occupied somewhere on a lower layer (in group); in other structures innovation can arise anywhere in organization.

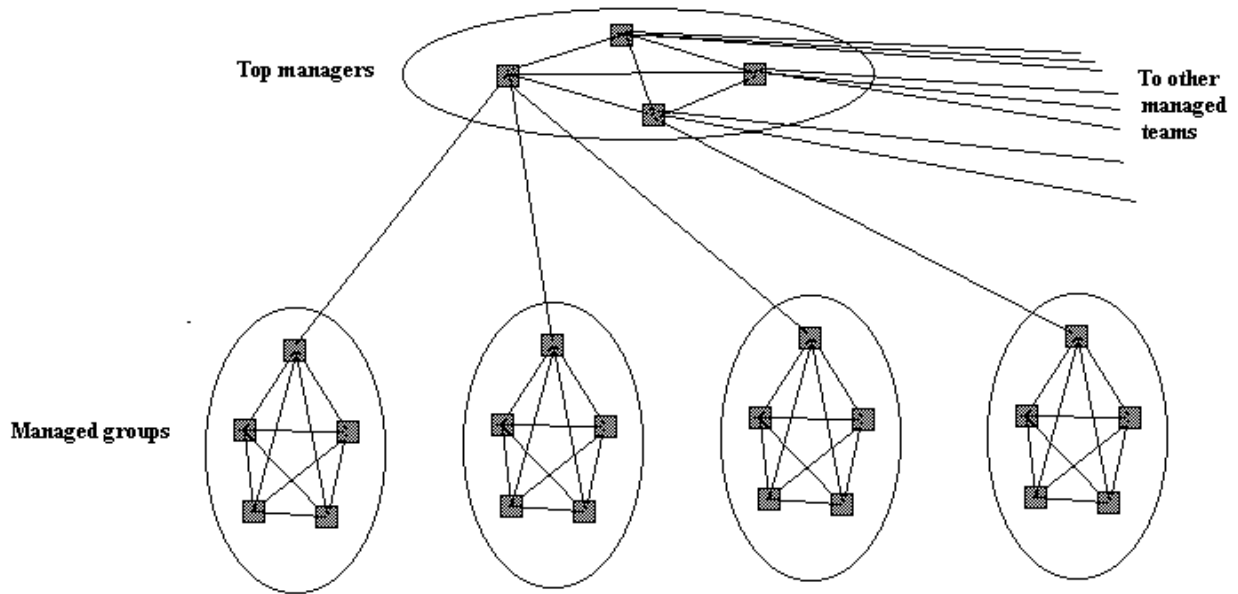


Fig. 2. Hierarchical organization

The third organizational form, which we researched, is a casual structure, in which the agent sees other five, accidentally of selected agents. We previously test each web to be sure, that all agents are connected, and there are no groups, isolated completely, as if they were, an innovation could not penetrate in isolated completely structure in any way.

To compare efficiency of various organizational structures, we simulated transfer of an innovation through each structure 500 times, and calculated average value and standard deviations of time measured among a cycle, necessary completely to adapt to different structures with different significance  $c$ . The experimental statistics for average time of adaptation, defined on more, than 500 attempts, represented in tab. 1.

Besides, in a fig. 3 and 4 represented in the graphic form the dependence of time of adaptation from significance of a parameter  $c$  for circumscribed above types of firm with the limited number of connections (fig. 3) and for a hierarchical structure (fig. 4).

Table 1.

Amount of a cycle necessary for full adaptation for want of for a various organizational structure and various abilities to transfer of an information

Significance c		3.0	2.0	1.0	0.9	0.8	0.7	0.6
Connection each with each	min	6	11	19	42	44	67	86
	max	116	198	400	615	588	671	1152
	mean	26.26	51.41	140.14	163.24	201.16	241.27	297.07
Hierarchy and subordination	min	6	6	17	29	48	97	150
	max	8	21	349	506	825	1401	2115
	mean	6.10	8.15	92.23	148.57	234.15	377.95	636.75
Restriction of number of connections	min	5	5	6	6	7	8	11
	max	8	8	12	18	22	65	115
	mean	5.48	5.46	7.13	8.63	11.40	16.264	27.164

### Conclusions.

It is possible to make of the conducted analysis a number of conclusions.

1. For firm of any given size consisting of the agents with the given ability to transfer of an information, the efficiency of activity of firm varies with a modification of its structure. Also efficiency of any structure is changed depending on ability of the agents to transfer of an information. Let's mark, that the given dependence is very force, since is described by function close to a hyperbola. The magnification of a parameter of transfer of an information in 2 times results in a diminution of time of adaptation at 8-10 of time.

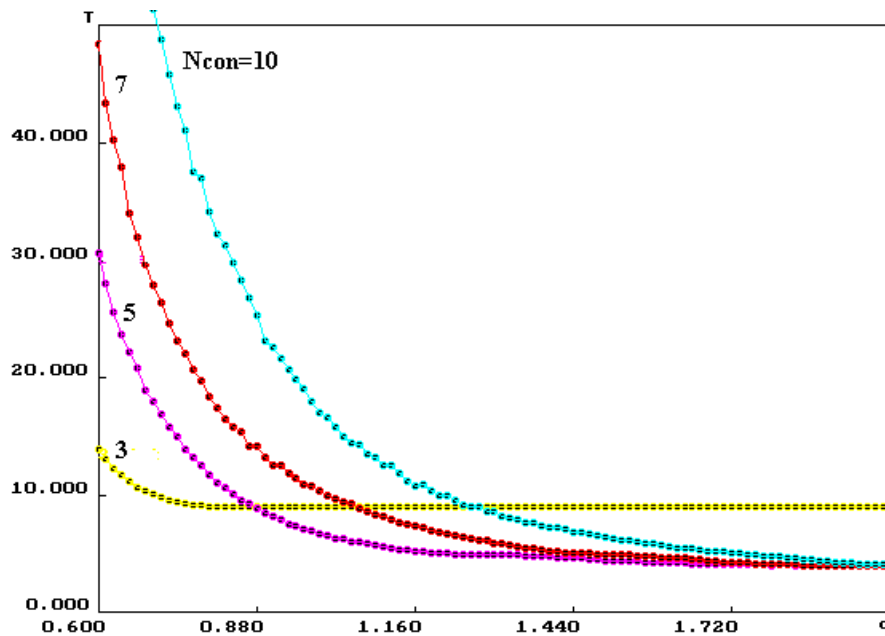


Fig. 3. Dependence of time of adaptation on a parameter of an individual susceptibility  $c$  and performance of an organizational structure  $N_{con}$  for case of the limited number of connections

2. For some range of significance of abilities of the agents on transfer of an information introduction of a hierarchy, the partition of organization on commands or other restrictions of streams of an information can give effective advantage. Most brightly it is exhibited in a fig. 3, where the dependence of time of adaptation on significance of a parameter  $c$  represented in case of firm with the limited number of connections between the agents. The various curves correspond to different number of connections  $N$  between the agents. It is possible to see, that for want of small  $c$ , agents, appropriate to weak ability, to mastering an information, the restriction of number of connections results in large advantage. For case  $c=0.6$  for full adaptation for want of number of connections 3 13 temporary cycle is necessary, and for want of number of connections 5 adaptation pass in 30 pitches. On the other hand, for want of significant abilities of the agents to transfer of an information (significance  $c$ ) the diminution of time of adaptation linearly depends on an amount of contacts between the agents: For want of  $c=2$  on full adaptation 9 pitches, and structure with 10 connections - 4 pitches are necessary for a structure

with 3 connections.

3. The organizational structure can bring to nothing magnification of efficiency connected to magnification is informational - transmitting of abilities of the members of organization. As it is possible to see in a fig. 3, for want of same significance of a parameter  $c$  the time of adaptation hardly depends on a structure of firm. The especially given note is fair for case small  $c$ , that corresponds to a small susceptibility to innovation on the part of the agents.

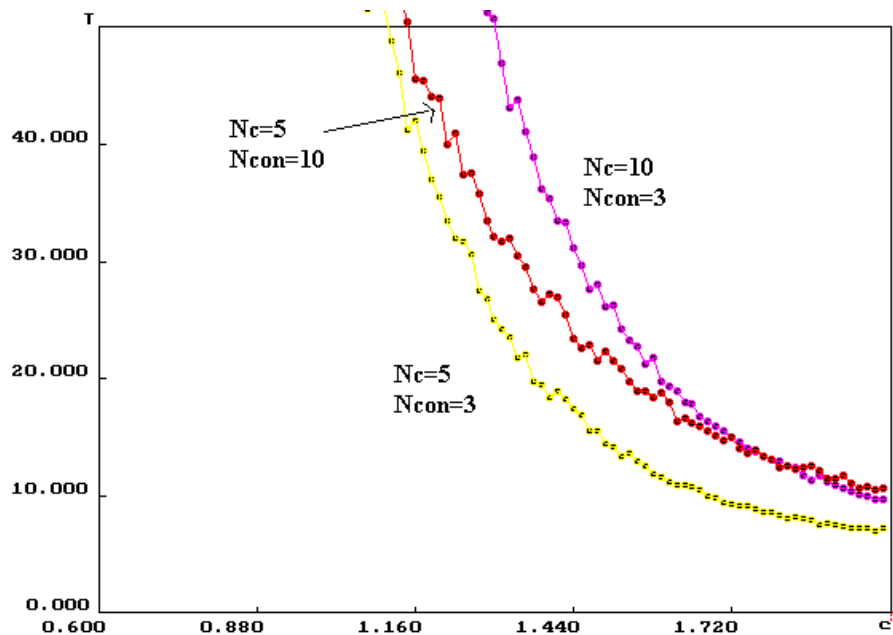


Fig. 4. Dependence of time of adaptation on a parameter of an individual susceptibility  $c$  and performance of an organizational structure  $N_{con}$  for case of a hierarchical structure

4. The hierarchical structure can have advantage before hierarchical.

Let's compare a fig. 3 and fig. 4, on which the dependence of a speed of adaptation on significance of a parameter  $c$  for an outline represented. It is possible to see, that in an outline the speed of switching is much lower, especially for want of small  $c$ . The proximity of significance of a velocity of adaptation for want of large  $c$  for hierarchical and nonhierarchical structures is connected to absence in this case influences of all agents, to which the given agent is connected. The switching suffices for switching this agent of one from which the given agent is connected to. The indicated fact results to decreasing of influence of a structure of firm for case of a high susceptibility of staff.

Obviously, that simple the model circumscribed here is informational - transmitting is

sufficient to supply the analysis of a behavior of firm from the point of view of its dynamic properties. Outcomes of numerical simulation allow to predict an optimum behavior of firm in the actual world. For example, the given model shows, that "alignment" of organization (the elimination occupied in management) should improve its ability to adaptation. Precisely also, the model allows to make a conclusion, that the size of organization can constrain growth of a velocity of adaptation to innovation. The alignment and decrease of a size, that is a distinctive feature of dynamics of an organizational structure of firms per the last years, can be a corollary of computer revolution, as the computers have increased abilities occupied in firms to information transfer.

The general recommendation consists of the following: for successful adaptation the restriction of streams of an information circulating in firm is necessary by restriction of number of interdependence for each agent. For want of it is necessary of a small susceptibility to adaptation to limit number of connections three for any agent. In accordance with magnification of ability to adaptation of the separate members the number of connections can be increased without a diminution of a velocity of adaptation of firm as a whole.

The universal presence of a structure and hierarchy in company can be a corollary of the most fundamental informational - analytical abilities of human organization. Not necessarily, however, only shaping of a single-level structure, for nonstructured organizations, which collide with transshipment by an information, can be the hierarchical structures are more preferable. The limited ability of individuals to transfer of an information means, that organizations, which can reasonably structure the internal links and limit channels, through which their members receive an information, will have competitive advantage. It contradicts the statement "the more, the better", dominating in a conventional economic theory. Though it seems clear, that large the ability better is informational - transmitting, than smaller, also it is clear, that cruder information can be an obstacle to growth of productivity, when the ability to its transfer and processing is limited. The problem on, whether implies necessity of a structure necessity of a hierarchy, remains open. There are very many graphs, in which the number of connections is limited, but which not hierarchical under the form. It requires to use methods of simulation to determine probable organizational structures with optimum abilities of adaptation and innovation.

At last, the consideration of firm as is informational - transmitting webs is enough perspective model permitting to conduct further researches. The potency of computer facilities

was considerably increased, so that it is possible to receive numerical solutions in models, which are conceptually simple and are rather easy in fulfillment, but for which the analytical solution is inaccessible.

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## **References**

1. Kimberly J., Ivanisko M. Organizational innovation: The influence of individual, organizational and contextual factors on hospital adoption of technological and administrative innovations. Acad.manag. J. - 1981. - vol. 24. - N 4. - p. 709
2. Evan W., Black J. Innovation in business organizations: some factors associated with success or failure of staff proposals. - J. Business, 1967. - Vol. 40
3. Burns T., Stulker S. The management of innovation. London, 1961
4. DeCanio Stephen J., Dibble C., Amir-Atefi K. The importance of organizational structure for the adoption of innovations. Working paper
5. DeCanio Stephen J., Watkins William E. Information processing and organizational structure. Working paper