

Institutional Economics Modeling

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Abstract. The aim of this investigation is the elaboration of the economical institutions evolution model on the base of the mathematical formalization of diffusion processes and received author's empirical results². The solution of the model caused to the following non simple conclusions. Firstly, the time and functional distribution of transactional cost is describes by the wave (sine curve in mathematical language) dependence. Secondly, the value of transactional costs is decreasing in case of absence of internal influence. The both conclusions may be explained by the introduction of hypothesis about the presence of economical institution life time, and as consequence the opening of transactional costs sine curve.

Key words. Diffusion model, transactional cost, institutional evolution

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Introduction

The problems of evolutionary development are widely considered in the world economic literature. To the publications of last years it is necessary to refer articles of P. Francois and H. Lloyd-Ellis (2003), J. Hodgson (2004), D. Heller (2004), A. Ben-Shoham, R. Serrano and O. Volij (2004), Sh. Chakraborty (2004) and others.

However researches on evolutionary economy consider economical institutions just and forever generated decision rules for the economic agents. Such approach hampers simulation of translational development of economic activity of the firm. The process of the economical institutions growth may be observed more informative in comparison with other systems on the firm level – level of minieconomical systems (Popov, 2005).

From here, the aim of this investigation is the elaboration of the minieconomical institutions evolution model on the base of the mathematical formalization of diffusion processes and received author's empirical results.

Theory of Economical Institution Growth

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G. Hodgson (2002, p.123) wrote: “The emergence and stability of institutions may be enhanced by process through which institutional channels and constrains lead to the formation of concordant habits of thought and behavior. These arguments point to more open-ended approach to the evolution of the institutions, downplaying static comparisons in favor of more processual, algorithmic analysis.” Therefore, it is naturally to look for the economical institutional growth from the initial economical norm up to equilibrium institutional structure of the firm in the conditions of long-term interactions.

In this case, the business project which is the base of first investments may be determined as an initial economical institution of the firm. From the other side the institutions of firm management may be seemed as the long term equilibrium institutions.

Institutional structure of the firm activity may be possible divide on the four main management functions (planning, organizing, stimulating and controlling) which cover the four main resources (labor, financial, material and informational) on the three levels of activity (analytical, industrial and communicational). Such quantification of the firm activity allows dividing the about fifty minieconomical institutions with difference functional contents (Popov, 2004).

Therefore, the economical institutions I growth function during the formation of the separate firm is determined by the time-dependence t equation:

$$I = I(t) \quad (1)$$

However in the economical theory the term “institution” has only the qualitative character. Due to the R. Coase (1937) the quantitative determination of the institutional growth is possible from the estimation of transactional costs which are the value parameter of the institutional formation. So, the dynamic of the economical institutions growth may be represented as dependence of the whole transactional costs C from the time t and functional content x of economical institutions:

$$C = C(x, t) \quad (2)$$

It is known that the growth of the concentration of some substance (in our case it is the transactional costs of the economical institutions formation) in any environment is writing as the Fick’s diffusion law:

$$\partial C / \partial t = D (\partial^2 C / \partial x^2), \quad (3)$$

where D is the diffusion coefficient. In our case the diffusion coefficient is the coefficient of ratio between the whole transactional costs time dynamics and the distribution of these costs under the space of economical institutions functional contents.

The standard solution of the diffusion equation in zero boundary conditions is determining the following distribution of the whole transactional costs C from time t in the space x for economical institutions functional contents:

$$C(x,t) = \sum_{n=1}^{\infty} (2C_0/\pi n) \sin(\pi n x/d) \exp(-\pi^2 n^2 D t/d^2), \quad (4)$$

where C_0 is the initial value of the whole transactional costs (for example, it is the cost of the preparing the business project of the firm); d is the “wide” of the economical institutions functional contents (for example, it is the boundary conditions for used resources which are formed the analyzing institutional structure).

The last solution (4) caused to the following non simple conclusions. Firstly, the time and functional distribution of transactional cost is describes by the wave (sine curve in mathematical language) dependence. Secondly, the value of transactional costs is decreasing in case of absence of internal influence.

The both conclusions may be explained by the introduction of hypothesis about the presence of economical institution life time, and as consequence the opening of transactional costs sine curve.

Sine Dynamics of Transactional Cost

The author offers a hypothesis about existence of life cycle of economical institution permitting to consider the process of evolution of the firm as outcome of routine levels interaction, were on different stages of the development. Then in each moment the firm can be represented as some conditional institutional “briefcase”, including formative, taken roots and out-of-date economical institutions. The model of life cycle of economical institution allows to formulate concept of development of the firm, which we shall understand interaction economical institution life cycles, were at different stages. The conditional graph of life cycle of economical institution including three stages, represented in a fig. 1.

The initial stage including propagation guesses of economical institution determine creation (origin) new economical institution, improvement of its market perspectives, in which limits the response from changes of the settled complexes of activity of the firm should be incremented.

The second stage designated as rooting, represents a purely institution status those or others of inner firm institutes when their implementation in the internal environment of the firm is carried out. At this stage there are economical institutions which have confirmed the potential of sources of competitiveness, bringing to the firm a steady response.

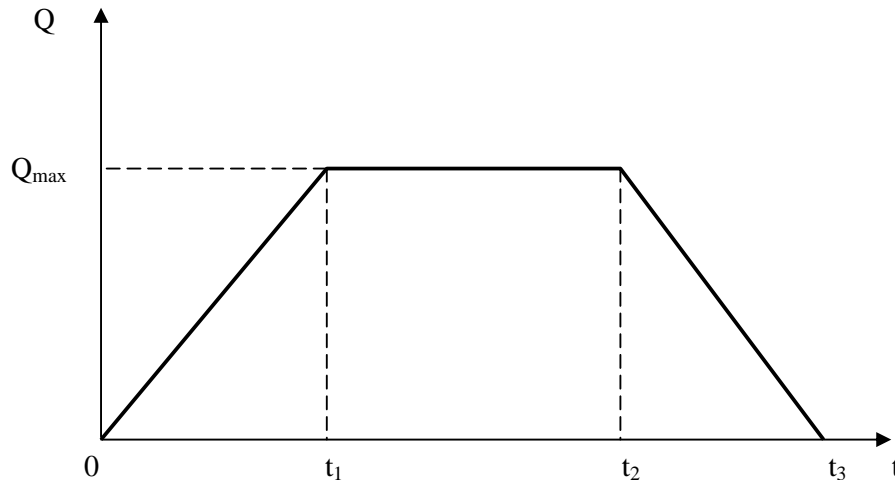


Figure 1. Life cycle of the economical institutions: Q - outcome of activity; Q_{\max} - maximal outcome of institution application; t - time; t_1 - completion of period of institution creation; t_2 - completion of period of institution rooting; t_3 - completion of period of institution corrupting.

At last, the third stage called as institution corrupting, concerns to becoming outdated institutional and behavioral states, the response from which is gradually reduced. There, using words D. Leonard-Barton (1995) are original “stones” or rigidities, which should undergo to corrupting. In the article “Key possibilities and key rigidities: the paradox of handle of development of the new product” D. Leonard-Barton determines “stones” as varieties of former norms, values, knowledge, skills and control systems, which difficultly give in to changes.

It is possible to select two groups of the factors appearing by catalytic agents of rooting or corrupting of economical institution, defining the value and speaker of a response from their usage:

- the internal factors - the value of transactional costs, which should incur the firm on creation new economical institution, maintaining of its steady operation and corrupting in a case of its growing old;

- the external factors - factors of the external environment defining adequacy of economical institutions from the point of view of its ability to provide to the firm competitive advantage.

If to speak about transactional costs, the author put forward a hypothesis about sine character of a curve of expenditures on creation, rooting and corrupting of organizational routines (fig. 2).

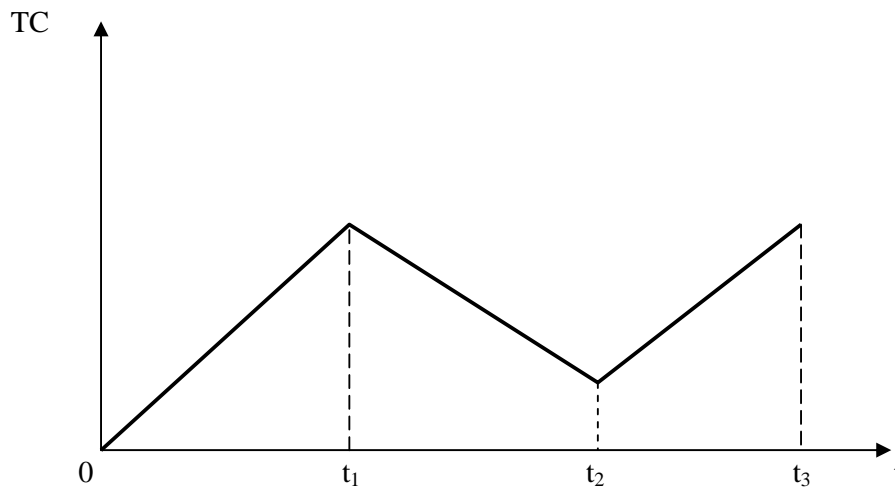


Figure 2. A curve of transactional costs TC in a time dependence of institution life cycle: t_1 - completion of period of institution creation; t_2 - completion of period of institution rooting; t_3 - completion of period of institution corrupting.

Sine character of a curve of transactional costs is explained to that during creation economical institution the necessary costs increase in connection with inducing effects of storage, motivation and control. Then after approach of a stage of rooting the transactional costs will be reduced inevitably owing to a response from an increasing scale of production. The lowering of transactional costs at complete design of economical institution was detected and by results of the empirical research carried out. Further, with a start of a stage of corrupting of economical institution, the costs should increase, as the padding gains on conversion training of the workers, change of motivation and monitoring system are required at change institution state.

The confirmation of the put forward model and hypothesis about sine character of change of transactional costs was obtained during the carried out empirical research in the Verch-Isetsyi metal works.

Here for last thirty years there was a replacement of application of the hot-rolled technology for the release of transformer steel on the cold-rolled technology of the release. As the similar technological reequipment has reduced in transformation of economical institutions of all levels of the firm, we could fix the integral characteristics of output and transactional costs. However, as the indicated two productions (hot-rolled and cold-rolled) are carried on separate shops, their visual matching and comparison (fig. 3,4) is possible. Let's mark, that the transactional costs were estimated through expenditures on hiring a labor for service of the indicated shops.

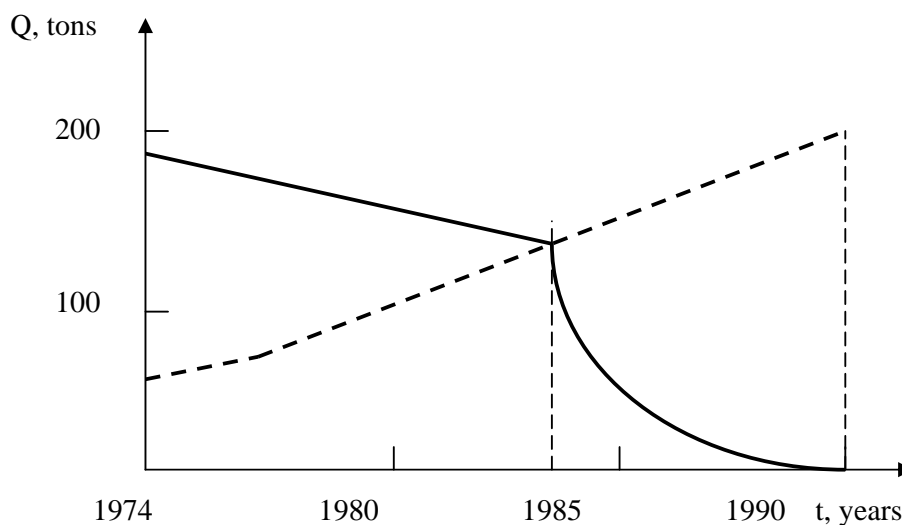


Figure 3. The production Q of transformer steel metal in the Verch-Isetsyi works: solid line - application of the hot-rolled technology; dashed line - cold-rolled technology

The data of a graphics for integral values of production and transactional costs represented for period 1974-1990 years. It is bound that in Russia from a beginning 1990 market conversions do not allow us legibly to select outcomes of operation of economical institutions in the separate firm, as the industrial firms during this period tested a great many of external signals (liberalization of the prices, privatizations of firms), hampering the correct economic analysis.

But even data, reduced on a fig. 3 and 4, demonstrate the convincing proof that the rooting and corrupting of hot-rolled production is characterized by relative lowering of costs during rooting the technology and sharp increase of costs during corrupting the given way of production. On the other hand, the creation of a cold-rolled way of production is provided with increase of transactional costs of this way of production. Thus, in one period of time it is possible

to observe propagation of a response from particular economical institution and lowering of a response from others institution.

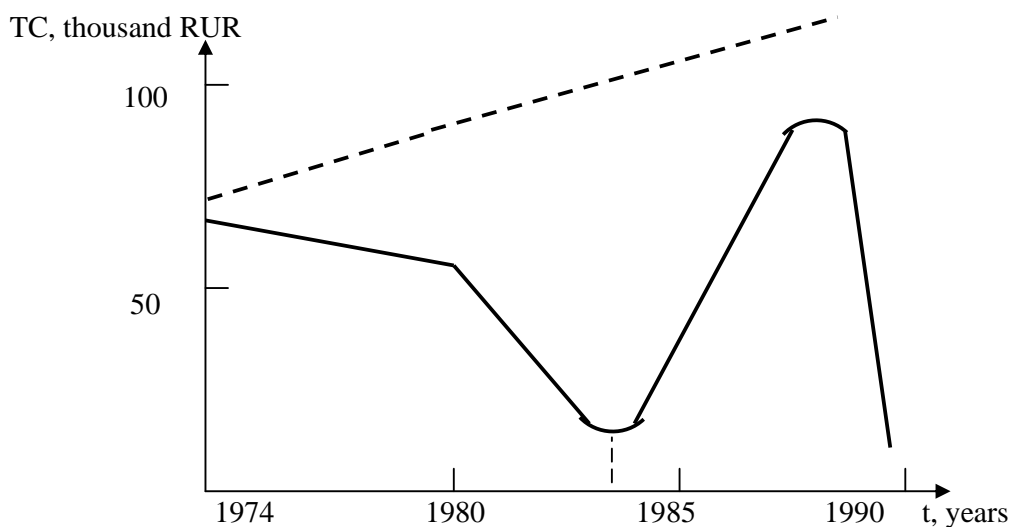


Figure 4. The transactional costs TC of activity in the Verch-Isetsyki works: solid line - application of the hot-rolled technology; dashed line - cold-rolled technology

Therefore, we may speak about the sine (wave) character of transactional cost dynamics for institutional activity on the minieconomical level.

At the same time the firm's economical institutions evolution is changing by various mechanisms – we may observe endogenous or exogenous institutions. So the problem of external effects of various institutions activity is arising.

External Effects and Institutional Application Risks

In the case of two mechanisms of economical institutions evolution (endogenous and exogenous for the firm) the Fick's diffusion equation divided on the system of two differential equations (5) which described the dynamic of transactional cost C_e for exogenous economical institutions activity and the dynamic of transactional cost C_i for endogenous economical institutions activity.

$$\left\{ \begin{array}{l} \partial C_e / \partial t = D_e (\partial^2 C_e / \partial x^2) - k_1 C_e + k_2 C_i \end{array} \right.$$

$$\partial C_i / \partial t = D_i (\partial^2 C_i / \partial x^2) - k_2 C_i + k_1 C_e, \quad (5)$$

Where D_e , D_i is the diffusion coefficients of transactional costs of exogenous economical institutions and endogenous economical institutions activity, accordingly; k_1 , k_2 - coefficients of transactional cost changes between various evolution flows.

Mathematical solution of the represented systems of equations (5) in the various border conditions demonstrates the significant influence of diffusion coefficients and exchange coefficients on the transactional costs dependences.

One may determine the conditional analogous of the diffusion coefficients with the coefficients of external effects realization due to the economical institutions activity and of the exchange coefficients with the risk shares due to the interactions between economical agents.

For the purpose of analysis of the economical institutions evolution the author's scientific group from the Institute of Economics (Ural Branch of the Russian Academy of Sciences) made the empirical investigation more than 150 firms in Russian Federation. The owners and top-managers of the firms were interviewed. The selection of the firms was stochastic and selected firms are illustrated the whole economical system of Russia.

The high volume of external effects was determined due to the empirical investigation of the institutions of the new knowledge generation. New knowledge in technological sphere increases the production process efficiency and also makes the external effects on other spheres of new knowledge application. The empirical results show that the technological base improvement by the new knowledge application causes to the improvement of environmental sphere, labor conditions and influences on the social sphere of knowledge using.

Therefore the activity of the institution of knowledge generation in one concrete sphere stimulates for the appearance of new knowledge in other institutional spheres. In Table 1 the estimation of external effects of new technological knowledge generation is represented. The observed data demonstrates the fact the generation of 100 % new technological knowledge causes to creation 17 % of new economical and ecological knowledge, 9 % of social knowledge and 4 % of new political and cultural knowledge, simultaneously.

External effects of institutions interactions may be explained in the diffusion model by information flows exchanges between various institutions with the accordingly changes of transactional costs on the formation of this economical institutions. The changes of transactional costs described by the coefficients k_1 and k_2 in the system of equations (5).

Table 1. External effects of new technological knowledge generation, empirical results

<i>Spheres of Knowledge</i>	<i>External Effects</i>
Economical	0.17
Ecological	0.17
Social	0.09
Cultural	0.04
Political	0.04

At the same time the exchange between flows of economical institutions evolution stipulates to the appearance of the risks of institutional application. By the risk of economical institution application we means the possible danger to have losses or to not achieves the planning aims of activity due to the using of concrete norm (institution) of interactions between economical agents. The empirical results of the estimation of the risks of new knowledge generation institutions application is shown in Table 2.

Table 2. Risks of knowledge application, empirical results

Type of risk	Spheres of knowledge application					
	Technological	Economical	Social	Ecological	Political	Cultural
Negative result	11.3	9.7	25.2	8.8	13.8	12.7
Absence of result	16.2	10.3	13.5	12.1	17.7	14.7
Analogs appearance	9.8	10.8	10.8	12.1	16.1	22.5
No application in practice	14.1	30.6	11.2	11.0	13.8	9.8
No competition ability	15.5	13.1	14.0	27.2	8.7	10.5
No corresponding to prognoses	18.1	11.7	12.4	15.8	14.3	14.9
Another	15.0	13.8	12.9	13.0	15.6	14.9
Total	100	100	100	100	100	100

Therefore the processes of evolution and application of economical institutions causes to the determined risk factors. The obtained empirical results demonstrate that the critical point of risk factors differs in various spheres of institutional application. So, no corresponding to prognoses is the main risk factor of new technological knowledge generation. Otherwise the generation of new economic knowledge causes to the no application in practice as the main risk factor. 25.2% of new social knowledge has negative result. 27.2 % of new ecological knowledge has no competition ability. The main risk factor in producing political knowledge is absence of result, and analogs appearance is the general risk of new cultural knowledge generation.

The empirical estimation of risk factors shows that the evolution of economical institutions accompanies with information exchange between various information flows. As the result of this one see the external effects appearance and the increasing of possibility to have losses in the institutional growth.

Conclusions

Therefore, the diffusion model of economical institutions evolution allows describe analytically the sine dynamics of transactional costs for economical institutions formation and the decreasing of this costs by time for economical institutions destruction.

In the presence of several mechanisms of economical institutions formation the diffusion model describe the appearance of external effects and risks of economical institutions evolution.

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