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NONEQUILIBRIUM MODEL OF INVESTMENT PROCESS ON THE TRANS-PORT MARKET'S INNOVATIVE SEGMENT

1. Introduction

Innovation can be applied across the whole life cycle management of transport system and comes in many forms. It may be the use of innovative products, an innovative means of integrating various vehicles across a network, an innovative approach to project management or an innovative decisionsmaking to novelties investment.

J. Schumpeter (1939) [4] was one of the first scientists who has divided the innovative process' participants into three groups (see Table 1). In Schumpeter's approach have been entered concepts disbalancing forces from the external factors and balancing forces from the supply for an explanation of swiftflowing nonequilibrium economic processes.

At the same time, his approach does not take into account all of microeconomic factors, which are apparent on the lower sublevel of economic system, i.e. at transport firms, distribution companies, logistic enterprises etc. On this fact the first have paid attention Burus T. & Stalker S. (1961) [1]. The further development of Schumpeter's ideas

are made Weidlich W. & Haag G. (1983) [7] and Zhang W. (1991) [8].

The offered author's nonequilibrium model of investment process is based on the evident statement: "The distinctions in an innovative policy, determining technodynamics on the transport market is the objective factor".

Table 1.

Types and functions of entrepreneurship /As Schumpeter's approach /

Schumpeterian types	Function of entrepreneurship Knowledge creation and modifications Activities in R & D, education, production, and etc.			
Inventor - type				
Investor $S(A) & S(P)_{-}$ types	Financing of innovation projects Risk - management and uncertainty regulation rules			
Innovator - type	Creative response to changing information Enforcing economic change by innovations			

Source: Author's research on a basis: Henk J. van Zuylen: Technological Innovations in Transport. The European Perspective. 1999.

Such distinctions determine character of the NGA (Non-Government Actors), engaged in investment business. The NGA which can be partition into two groups:

Group of the active investors [in future

S(A) – type]. Includes expansionists and rationalists. This group of NGA decisions make under such index numbers as ROI (Return on Investment), SML (Security Market Line), etc.

Group of the passive investors [in future S(P) – type]. This group NGA distributes free assets on deposits in banks and in securities. Decisions make under such index numbers as EPS (Earning Per Share), SV (Shareholder Value) etc.

The suggested nonequilibrium model of investment process is based on the following fact: The transport market depend from influence of permanent fluctuations (i.e. price, consumer's preference, rate on return, etc.). Such fluctuations are caused by alternate shifts of investments' portfolio between passive and active projects. On importance of this approach pointed Freeman C. & Perez C. (1988).

During these shifts:

- The long-term purposes of investment projects are realized, weakening cyclical movement of passive financial flows.
- ➤ S shaped techno-dynamics of transport infrastructure's development is formed.
- Groups of the early adopters & majority are created of exclusive profits grasp leadership on the transport market. As a rule, early adopters & majority are SMEs (Small and Medium-sized Enterprises).

Their difference is initiation of innovative techno-dynamics' possible scenarios, and, as consequence, the high risk of investment for the free funds.

The ratio of the financial assets allocated SMEs on realization of its innovative policy can be traced by a time-domain indicator of the investment project's structure (SI). At the same time, projects must be estimated on compatibility with norms ERDF (European Regional Development Fund) [3].

2. The investment activity on the transport market's innovative segment

Let's consider possible investment strategy of NGA (see Table 2). Suppose S(t) is the total volume of NGA investments on an innovative segment of transport market. The

set of investor's strategy depends from the acceptance level of investment risk and contains three basic alternatives:

- expansion of transport services' volume for consumers (the so-called expanding projects);
- change of offered transport services' spectrum (the so-called innovative projects);
- placing of available assets into banks, securities etc. (the so-called saving projects).

Then S(t) can be used for formation of three financial flows:

 $S(t) = S_r(R,t) + S_e(E,t) + S_k(K,t)$ where

 $S_r(R,t)$, $S_e(E,t)$, $S_k(K,t)$ – net investments allocated into innovative, expanding and savings projects, accordingly.

R – parameter defining business expense of the innovative projects;

E – parameter defining business expense of the projects expanding transport services activity;

K – parameter defining the free funds placing in bank, in securities etc.;

Table 2.

Possible types of investment strategy

N	Types of investment strategy	Realizable projects			Compensation
		innovative	expanding	savings	factors [equa- tion (2)]
1	The innovative strategy	Full concent-	Absence of	Absence of	a = 1.0
	changing structure of given	ration of the	the allocated	the allocated	b = 0.0
	transport services	free funds	funds	funds	c = 0.0
2	The expanding strategy incre-	Absence of the	Full concent-	Absence of	a = 0.0
	asing volume of traditionally	allocated	ration of the	the allocated	b = 1.0
	offered transport services	funds	free funds	funds	c = 0.0
3	The savings strategy suppo-	Absence of the	Absence of	Full concent-	a = 0.0
	sing placing of free funds	allocated	the allocated	ration of the	b = 0.0
	into bank, securities & etc.	funds	funds	free funds	c = 1.0
4	The first type's mixed strat-	Proportional	Proportional	Proportional	0.0 < a < 1.0
	egy supposing a bidirec-	allocation	allocation	allocation	0.0 < b < 1.0
	tionalness of financial flows	funds	funds	funds	c = 1.0
5	The second type's mixed	Proportional	Absence of	Proportional	0.0 < a < 1.0
	strategy supposing a bidirec-	allocation	the alloca-ted	allocation	b = 0.0
	tionalness of financial flows	funds	funds	funds	0.0 < c < 1.0
6	The third type's mixed stra-	Absence of the	Proportional	Proportional	a = 1.0
	tegy supposing a bidirec-	allocated	allocation	allocation	0.0 < b < 1.0
	tionalness of financial flows	funds	funds	funds	0.0 < c < 1.0
7	The mixed strategy suppos-	Proportional	Proportional	Proportional	0.0 < a < 1.0
	ing a triadirectionalness of		allocation	allocation	0.0 < b < 1.0
	financial flows	funds	funds	funds	0.0 < c < 1.0

Source: Author's research on a basis: Zhang W.: Synergetic Economics, Springer, Heidelberg, 1991; Semenov I. N.: Strategy of economic policy on transport market. Proc. 2nd European Transport Congress, US, 2003.

Let $S_0(R,t)$, $S_0(E,t)$, $S_0(K,t)$ be the volumes of free funds which are averaged over a slow variable [5]. Therefore the separate financial flows can be represented in the forms:

$$S_{r}(R,t) = S_{0}(R,t) \pm a \cdot \Delta S_{u}(t)$$

$$S_{c}(E,t) = S_{0}(E,t) \pm b \cdot \Delta S_{b}(t)$$

$$S_{k}(K,t) = S_{0}(K,t) \pm c \cdot \Delta S_{c}(t)$$
where

a, b, c - compensation factors (see Table 2);

 $\Delta S(t)$ – oscillatory shift in financial flows' volumes.

It is necessary to take into account that the application of oscillatory shift with sign (+) increase in financial flows' volume, and with sign (-) - its reduction.

The structure's indicator of investment projects has three particular forms:

Fist form.

Indicator SI for investment into innovative projects will be determined as:

$$SI(t) = SI_0 \pm a \cdot w_a(t) = \frac{S_r(R,t) - S_v(E,t) - S_k(K,t)}{S(t)}$$
 (3)

$$SI_0 = \frac{S_0(R,t) - S_0(E,t) - S_0(K,t)}{S(t)}, \quad w_a(t) = \frac{\Delta S_a(t)}{S(t)}$$

moreover

$$SI(t) \in [-1.0 \div +1.0]$$

Second form.

Indicator SI for investment into ex- $SI(t) \in [-1.0 \div +1.0]$. panding projects will be determined as:

$$SE(t) = SE_0 \pm b \cdot w_b(t) = \frac{S_e(E, t) - S_r(R, t) - S_k(K, t)}{S(t)}$$
 (4)

where

$$SE_0 = \frac{S_0(E,t) - S_0(R,t) - S_0(K,t)}{S(t)}, \quad w_h(t) = \frac{\Delta S_h(t)}{S(t)}$$

moreover

$$SE(t) \in [-1.0 \div +1.0].$$

Third form.

Indicator SI for investment into savings projects will determined be

$$SB(t) = SB_0 \pm c \cdot w_c(t) = \frac{S_k(K,t) - S_c(E,t) - S_r(R,t)}{S(t)}$$

$$(5)$$

$$SB_0 = \frac{S_0(K,t) - S_0(R,t) - S_0(E,t)}{S(t)}, \quad w_c(t) = \frac{\Delta S_c(t)}{S(t)}$$

moreover

$$SB(t) \in [-1.0 \div +1.0]$$

3. The transport market investors

Let's consider construction of the investors configuration. We shall accept the following three assumptions for simplification of this concept's understanding.

First assumptions:

Suppose each NGA can take part only in one investment project on an innovative segment of the transport market.

Second assumption.

Let N be the general number of the projects. These projects are realized in the transport market and financed in identical volume.

Third assumption.

Let concept "typical investor" be NGA behaving according to the average long-term scenarios profitability on an innovative segment of the transport market. The volume of his individual investment project in total investment flow S(t) is equal $s(t) = \frac{S(t)}{N}$ and

will consist of active and passive investments $s_0(e,t)$ & $s_0(r,t)$, accordingly. Then the balance of the individual investment project has the form:

$$s(t) = s_0(e,t) + s_0(r,t) + s_0(kt)$$
 (6)
where

$$s_0(e,t) = \frac{S_0(E,t)}{N}, \quad s_0(r,t) = \frac{S_0(R,t)}{N}, \quad s_0(k,t) = \frac{S_0(K,t)}{N}.$$

However real investors behave not how conditionally "typical investor". It is connected to next influencing factors:

probable speed of innovation diffusion;

the developed market conjuncture;

inflationary fluctuations etc.

According to earlier accepted assumption, there are the investors preferring active ("green" & "yellow" scenarios) or passive ("black" scenarios) investments instead of adhering to the basic tendency. "Brand Image", "Image of the firm", "Customer satisfaction", "Market Leadership", "Know-how ownership" etc. can be criteria of such preferences. Then the investment project of the S(A)-type investors having the free funds can be written down as:

$$\{s(t) \in s_{e}[(e,t) + s_{e}(r,t) - s_{e}(k,t) \cup s_{r}(e,t) + s_{r}(r,t) - s_{r}(k,t)] \cap [s_{k}(e,t) + s_{k}(r,t) - s_{k}(k,t)] = \emptyset\}$$
 (7)

where

$$\begin{split} s_{e}(e,t) &= s_{0}(e \pm \Delta e,t); & s_{e}(r,t) = s_{0}(r \pm \Delta r,t); & s_{e}(k,t) = s_{0}(k \mp 2\Delta k,t) \mid \Delta e > 0. \\ s_{r}(e,t) &= s_{0}(e \pm \Delta e,t); & s_{r}(r,t) = s_{0}(r \pm \Delta r,t); & s_{r}(k,t) = s_{0}(k \mp 2\Delta k,t) \mid \Delta r > 0. \\ s_{k}(e,t) &= s_{0}(e \pm \Delta e,t); & s_{k}(r,t) = s_{0}(r \pm \Delta r,t); & s_{k}(k,t) = s_{0}(k \mp 2\Delta k,t) \mid \Delta k > 0. \end{split}$$

Suggested model (7) allows to form set of investment policy's strategy. Three of them have a leading role:

the averaged strategy used by "typical investors"; it is formed proceeding from the "yellow" scenarios of innovation's competitiveness.

the active strategy used by S(A)— type investors and supposing additional investments in expansion of traditional transport services' volume in size Δe , or in change of transport services' spectrum in size Δr ; it is formed proceeding from the "green" scenarios of innovation's competitiveness.

the strategy of transformation, supposing transition of S(A)— type investors in group of S(P)— type investors with corresponding reduction of proactive investments on size $2\Delta k$; it is formed proceeding from the "black" scenarios of innovation's competi-

tiveness (see Fig.1).

Let's accept simplifying assumption, that the dimension of PIMS (Profit Impact of Market Strategies) parameter traditionally used in models of an estimation of market strategy for active NGA, be the same size. It follows that the volume of additional financing Δ for S(A)- type investors is accepted constant.

We now analyze configurations of active investors. Assume, that passive investors don't possess free funds in the examined time interval $t \in [t_{a_1}; t_{a_2}]$.

Let n_{S_e} be a subset of expanding investors, and let n_{S_r} be a subset of innovative investors. Then the sum of these subsets will be defined by equality:

$$n_{S_{s}}(t) + n_{S_{s}}(t) = N$$
 on the time interval $t \in [t_{a_{1}}; t_{a_{2}}]$ (8)

policy making on the innovative segment of the transport's services market, will depend on set of decisions NGA- $\{n_{s_s}(t), n_{s_s}(t)\}$.

The investment projects' structure is defined by volume of free funds $[S_u(E,t), S_r(R,t)]$. Therefore the investment's

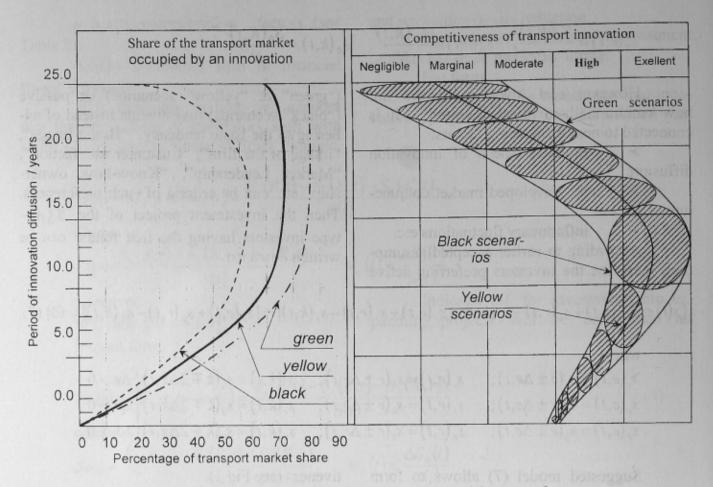


Fig. 1. Scenarios of innovations competitiveness change Source: Author's research

We'll call this set the investors' configuration and we'll determine its integrated index CI(t) as:

$$CI(t) = \frac{n_{S_r}(t) - n_{S_r}(t)}{n_{S_r}(t) + n_{S_r}(t)} = \frac{n(t)}{N}$$
 (9)

where
$$n(t) = n_{S_r}(t) - n_{S_r}(t)$$
,
moreover
 $CI(t) \rightarrow -1,0$ - by setting $n_{S_r} \rightarrow 0$; i.e.

all N investment projects are realized to expanding investors;

$$CI(t) \rightarrow +1,0$$
 - by setting $n_{N_p} \rightarrow 0$;

i.e. all N investment projects are realized to innovative investors.

Let the configuration of investors will change according to transition logic, during each moment of time:

$$\left\{n_{S_r}(t), n_{S_r}(t)\right\} \rightarrow \left[\left\{n_{S_e} \pm \delta_i n_{S_e}; \quad n_{S_r} \mp \delta_i n_{S_r}\right\} CI(t)\right] \quad \text{for } \forall t \in \left[t_{a_1}; t_{a_2}\right]$$

$$(10)$$

where $\delta_i = 1, 2, 3, ...; \& i = 0, 1, 2, ...$

Logic transition (10) supposes an opportunity of reorientation of innovative investors in expanding investors and on the contrary. Each such reorientation is an element of an innovative wave and is noted as multistage change of an index CI(t). From conditions of model's formation (7) follows, that the total volume of expanding investments can be represented as:

$$S_{e}(E,t) = n_{S_{e}}(t)s_{0}(e,t) \pm n_{S_{e}}(t)s_{0}(r,t) = S_{0}(E,t) \pm \Delta S_{e}(t) \times CI(t), \text{ for } \forall t \in [t_{a_{1}};t_{a_{2}}]$$
 (11)

The equation (11) takes place under the condition that passive investors haven't

free funds. Then total volume of innovative investments can be represented as:

$$S_{r}(R,t) = n_{S_{r}}(t) s_{0}(e,t) \mp n_{S_{r}}(t) s_{0}(r,t) = S_{0}(R,t) \mp \Delta S_{r}(t) \times CI(t), \text{ for } \forall t \in [t_{\sigma_{t}}; t_{\sigma_{t}}]$$
 (12)

where

$$\Delta S_{e}(t) = s_{o}(\Delta e, t) \cdot N$$

 $\Delta S_{r}(t) = s_{0}(\Delta r, t) \cdot N$

Using equations (12) and (11) in combination with (3) and (9) we get:

$$SI(t) = \frac{S_0(R,t) - S_0(E,t)}{S(t)} \mp a \cdot \frac{\left[s_0(\Delta e,t) - s_0(\Delta r,t)\right] N \times CI(t)}{S(t)}$$
(13)

therefore

$$SI(t) = \frac{\left[\left(1 \pm a\right) s_0\left(\Delta r, t\right) + \left(1 \mp a\right) s_0\left(\Delta e, t\right)\right]}{S(t)} \times N \times CI(t) = \mu \times CI(t)$$
(14)

where

$$\mu = \frac{\left[\left(1 \pm a\right) s_0\left(\Delta r, t\right) + \left(1 \mp a\right) s_0\left(\Delta e, t\right)\right)}{S(t)} \times N$$

Follows from (14), the indicator SI(t)is proportional to an investors configuration's index CI(t) during each moment of time. The possible influences of economic factors on profitability of investment projects call forth changes of the investor's configuration $\{n_{s}(t), n_{s}(t)\}$. Plural transitions NGA from S(R) - type in S(E) - type and back is underlie of these changes. The principal type of such transitions is determined by logic of the equation (10) and their full formalization is possible at use of a stochastic method for the description of investor's behaviour. The choice of this method is determined by need of the market uncertainty's account. The transport market uncertainty is basic riskfactor for successful realization of individual investor's innovative projects.

Let's consider one of possible formalization methods for transformations model of investor configuration. The suggested method is based on the following assumption. Dynamics of investment activity can be submitted by combinations set of two types' transitions:

Increasing number of expanding investors. The operator of transition will be the following form: $p \to (n_{s_e})$.

Increasing number of innovative investors. The operator of transition will be following form: $p \rightarrow (n_{s_s})$.

Then:

1. According to the equation (10) individual transition NGA from investment projects S(R)— type to investment projects S(E)— type can be written , as:

for
$$\forall \{n_{S_r}(t), n_{S_r}(t)\} \xrightarrow{1.0 \ge p \ge 0} \{n_{S_r}(t) + 1, n_{S_r}(t) - 1\}$$
 (15)
Generalizing logic of individual transitions we have:
for $\forall \{n_{S_r}(t), n_{S_r}(t)\} \xrightarrow{1.0 \ge p \ge 0} \{n_{S_r}(t) + i, n_{S_r}(t) - i\}$

where i = 1, 2, 3, ...

p = 0, corresponds to a situation at which transport market's conjuncture are ad-

verse for expanding investments;

p = 1.0, corresponds to a situation at which transport market's conjuncture are favourable for expanding investments.

2. According to the equation (10)

individual transition NGA from investment projects S(E)— type to investment projects S(R)— type can be written, as:

for
$$\forall \{n_{S_e}(t), n_{S_r}(t)\} \xrightarrow{1.0 \ge p \ge 0} \{n_{S_e}(t) - 1, n_{S_r}(t) + 1\}$$
 (16)

Generalizing logic of individual transitions we have:

for
$$\forall \{n_{S_s}(t), n_{S_s}(t)\} \xrightarrow{1.0 \ge p \ge 0} \{n_{S_s}(t) - i, n_{S_s}(t) + i\}$$

where

 $i = 1, 2, 3, \dots$

p = 0, corresponds to a situation at which market conjuncture are adverse for innovative investments;

p = 1.0, corresponds to a situation at which market conjuncture are favorable for innovative investments.

Let p(n,t) be probability of the following: the index CI(t) corresponds to pair $\{n_{S_s}(t), n_{S_s}(t)\}$ at any time-point.

From earlier accepted assumptions follows that one of investors configurations set is realized in each moment of time. Then the following boundary condition takes place:

$$\sum_{n} p(n;t) = 1 \tag{17}$$

Let's impose some simplifications:

- p(n;t) has the expressed peak of values connected to qualitative changes in the transport services market;

- p(n;t) are unimodal concerning the average sizes M_n , i.e.:

$$\mathsf{M}_{n} = \sum_{n} n \, p(n; t) \tag{18}$$

differentiating (18) with respect to time, we get the approximate relationship:

$$\frac{\partial M_{n_{t}}}{\partial t} = \left\{ n_{S_{r}}(t) - i; \ n_{S_{r}}(t) + i \right\} - \left\{ n_{S_{r}}(t) + i; \ n_{S_{r}}(t) - i \right\}$$
(19)

Using (9) and (19) we can estimate transformation speed of the active investors' configuration:

$$v\left(\mathsf{M}_{CI_{i}}\right) = \frac{\partial \mathsf{M}_{CI_{i}}}{\partial t} = \frac{1}{N} \cdot \frac{\partial \mathsf{M}_{n_{i}}}{\partial t} \tag{20}$$

In view of influence factors, the transformation speed can be presented as function:

$$\frac{\partial \mathsf{M}_{\,cl_{\epsilon}}}{\partial t} = f(\alpha_{cl}, P, R) \tag{21}$$

where

 $\alpha_{\rm CI}$ - alternator of the current configuration for active investors. It shows on increase / reduction of innovative investor's number;

R - the current of a risk-value for passive and active investment;

P, R - predicted level of investment project profitability.

4. Concluding Remarks

As shown above

-, The distinctions in an innovative policy, determining techno-dynamics on the transport market are the objective factor.

The possible influences of economic factors on profitability of investment projects call forth changes of the investors' configuration.

- The configuration of investors develops depending on their predisposition to investments. It is defined by an objective economy condition of the transport market and the subjective relation of investors to financial risks.

- It is necessary to construct system of logic transitions for the description of the current conditions economy for the transport market. Logic transitions predetermine periodic changes in the investors' configuration.
- Stability of investment project's structure is defined by reliability of marketing forecast in the transport services market.
- Formalization of changes in the investors' configuration is possible at use of a stochastic method.
- The choice of this method is determined by need of the transport market's uncertainty account, for its innovative segment, especially. Uncertainty is basic riskfactor for successful realization of investment projects.

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ІНВЕСТИЦІЙНИЙ КЛІМАТ: ПІДХОДИ ДО МОДЕЛЮВАННЯ

Аналіз наявних наукових джерел, присвячених дослідженню інвестиційного клімату, показав, що єдиного методологічного підходу до визначення цього поняття до сьогодні не розроблено. Частіше за все поняття "інвестиційний клімат" відображає:

- сукупність об'єктивних та суб'єктивних умов, які сприяють (гальмують) процесу інвестування народного господарства (на макрорівні) та окремих підприємств, компаній, галузей (на мікрорівні) [2, с. 636-637];
- сукупність політичних, економічних, юридичних та інших факторів і умов регулювання інвестиційної діяльності, які визначають ступінь ризику інвестицій і

можливість їх ефективного використання [3, с. 29];

- середовище, в якому проходять інвестиційні процеси [4, с. 83];
- багатофакторну систему цілеспрямованих вчинків і дій, яка свідомо формується на державному та регіональному рівнях в інтересах ширшого залучення на конкретну територію додаткових ресурсів як у грошовій, так і в матеріальних формах [5, с. 139].

Дослідження інвестиційного клімату в країні, який би сприяв залученню як вітчизняного, так і іноземного капталу, є метою написання даної статті.

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