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PROPERTIES OF CONSTRUCTING THE FINANCIAL ARCHITECTURE OF THE ECONOMY

Abstract. *The article examines a methodical approach to modeling of properties of constructing the financial architecture of the economy. It is proved that the study of the financial architecture of the economy implies the creation of a model that allows conducting an analysis and predicting its behavior in the range of appropriate conditions of functioning, as well as solving tasks of structural components at different levels of the hierarchy. One has found out that depending on the goals and objectives, modeling can be carried out at different levels of abstraction. It is revealed that the description should correspond to the concept of financial architecture development and meet particular requirements: it should be transparent and allow the possibility of expanding (narrowing) the range of functions and tasks, as well as provide the possibility of shifting from one level of the hierarchy to another. The article presents a formalization of certain properties of constructing the financial architecture of the national economy that includes emergence, homeostasis, holisticity, functionality, structurization, synergy and adaptation.*

Keywords: *financial architecture, emergence, homeostasis, holisticity, functionality, structurization, synergy, adaptation.*

Problem statement. The problem of functioning of the financial architecture of the economy in the current conditions of uncertainty is enhanced by insufficient development of theoretical foundations and complicated practice of its complex use. The study of behavioral financial development as a separate area allows constructing a model of the economic system, which is the basis for the establishment of the holistic financial architecture with internal structure and parameters. The development of the economic model based on the spiral of financial development contributes to the fullest description of characteristics of the evolutionary financial architecture. The formation of the basis of the evolutionary model of the holistic financial architecture gives grounds for the application of mathematical modeling principles.

Analysis of recent research and publications. The essence of the financial architecture in the contemporary economic theory, dynamics of changes, levels of its hierarchy and methodical approaches to modeling of its properties were investigated by numerous foreign scientists: M. Barkley, R. Brealey, S. Brigham, H. Demsetz, T. Dolgopiatova, R. Entov,

I. Ivashkivska, R. Kapeliushnikov, M. Kokorieva, B. Kolas, R. La Port, F. Lopez de Silanes, S. Myers, K. Smith, A. Stepanow, D. Finnerty, J. Van Horn, A. Shleifer, etc. Ukrainian scientists focusing on the problem include: N. Bychkova, M. Bilyk, I. Blank, A. Hrytsenko, I. Ziatkovskyi, I. Kalinska, O. Laktionova, V. Melnyk, A. Nakonechna, A. Poddieriohin, O. Sosnovska, O. Tereshchenko, V. Fedosov, L. Fedulova, S. Yurii, etc.

Formulation of the article's objectives. The article is aimed at examining the methodical approach to modeling of properties of constructing the financial architecture of the economy.

Presentation of the basic material. The exploration of the financial architecture of the economy includes the development of a model that allows conducting the analysis and predicts its behavior in the range of appropriate conditions of functioning, as well as solving tasks of structural components at different levels of the hierarchy [1-4]. Depending on the goals and objectives, modeling can be carried out at different levels of abstraction.

The description should correspond to the concept of financial architecture development and meet particular requirements [5, 6]:

- it should be transparent and allow the possibility of expanding (narrowing) the range of functions and tasks implemented as part of the financial architecture;
- it should provide the possibility of shifting from one level of the hierarchy to another, ensuring the construction of virtual models of the financial architecture.

Such a description of the financial architecture covers a wide range of its properties. Given below is the formalization of certain properties of constructing the financial architecture of the national economy.

Emergence. The regularity of integrity / emergence is manifested in the financial architecture in case of the appearance of new properties that are absent in its structural components.

To better understand the regularity of integrity of the financial architecture, one should initially take into account two aspects:

1. properties of the financial architecture (as whole) Q_s are not the simple sum of the properties of its components:

$$Q_s \neq \sum Q_i \tag{1}$$

2. properties of the financial architecture (as whole) depends on the properties of its components:

$$Q_s = f(q_i) \tag{2}$$

In addition to these two aspects, keep in mind that structural components combined in a particular configuration of the financial system generally lose some of their properties, namely the configuration of the architecture somehow depresses the number of properties of its components. However, on the other hand, components, getting into the construction of the financial architecture, can acquire new properties.

Let's turn to a regularity that is ambivalent to the regularity of integrity – additivity (independence, separateness). Additivity properties are manifested in the financial architecture in case of its distribution into independent structural components; then the following expression becomes fair: $Q_s \neq \sum Q_i$

Homeostasis. The hierarchy is created by level factorization of processes $\{F_i\}$ using generalized parameters $\{Q_i\}$, which are features $\{F_i\}$. It is assumed that the number of parameters is much smaller than the number of variables on which the processes of dynamic

changes in the state of the financial architecture over time depend. This way of the description allows us to define the relationship between properties of structural components interacting with the environment and the efficiency of the financial architecture itself.

Processes $\{F_i(1)\}$ can be defined as initial parameters in financial architecture functioning. These are processes of interaction with the environment. Let's consider them as the first-level processes defined:

- by parameters of the first-level system – $Q_1(1), Q_2(1), ..Q_j(1), ..Q_m(1)$;

- actively counteract environmental parameters that directly target the financial architecture to reduce its efficiency – $b_1, b_2, ..b_k ..., b_K$;

- by neutral (random environmental parameters) $c_1, c_2 ..., c_1, ...c_L$;

- by favorable environmental parameters $d_1, d_2 ..., d_p, ..d_P$.

The environment has a direct contact with lower-level subsystems, affecting subsystems of the higher level of the hierarchy, thus:

$$F_i = F_i * (\{b_k\}, \{c_1\}, \{d_p\}) \quad (3)$$

By constructing the hierarchy (β-level parameters – β-1-level processes – β-1-level parameters), we can relate environmental parameters to the efficiency of the financial architecture.

Parameters of the financial architecture $\{Q_i\}$ can change during the transformation of the external environment. They depend on processes in the design of the financial architecture and are written in the form of state features $Q_{j1}(t)$. The own functional space of the financial architecture W will be the space whose points are all possible states of the financial architecture, which is defined by the set of parameters up to the level b:

$$Q = \{Q(1), Q(2), ... Q(\beta)\} \quad (4)$$

An individual state of the financial architecture can remain constant at some interval of time T.

Processes $\{F_i(2)\}$ cannot be defined as initial parameters of the financial architecture. These are the second-level processes depending on $Q(2)$-level parameters of the financial architecture (second-level parameters) and so on.

It results in the following description hierarchy: efficiency (finite set of features) – first-level processes (functions) – first-level parameters (features) – second-level processes (functions) – second-level parameters (features), etc. At some level, our knowledge of functional properties of the financial architecture runs out, and the formalization process breaks down. The break can occur at different levels for different parameters (processes), and both on the process and on the parameter.

Holisticity. This term is often used as a synonym for integrity. However, some researchers distinguish this regularity as an independent one in order to stress the interest not in the external factors of integrity but in the deeper reasons for the emergence of this property, in factors keeping the integrity of financial architecture configuration.

System-forming and system-saving factors of the financial architecture are called holistic. An important role among them is played by heterogeneity and inconsistency of structural components, on the one hand, and their desire for integration, on the other hand. Formalization of regularities of the interaction between structural components and financial architecture configuration as a whole is presented in Table 1.

Table 1

Formalization of regularities of the interaction between structural components and financial architecture configuration as a whole

Regularities of the interaction between structural components and financial architecture configuration as a whole	Degree of integrity of the financial architecture λ	Structural component utilization factor ρ
Integrity / emergence	1	0
Progressive systematization	λ >ρ	
Progressive factorization	λ<ρ	
Additivity (summation)	0	1

Functionality. The functional description of the financial architecture should include such characteristics as parameters, processes and hierarchy.

Let's assume that the financial architecture S_{fa} performs N functions $\varphi_1, \varphi_2 ... \varphi_s ... \varphi_N$, which depend on n processes of influence on the efficiency of its functioning $F_1, F_2, .. F_i, ..., F_n$. The efficiency of performing the *s* function:

$$E_s = E_s(\psi_s) = E(F_1, F_2, ..., F_i ..., F_n) = E_s(\{F_i\}), i = 1..n,\ s = 1..N \quad (5)$$

The total efficiency of the financial architecture is a functional vector $E = \{E_s\}$. The efficiency of the financial architecture depends on the combination of internal and external factors of influence. It is extremely difficult to imagine this dependence in an obvious form, and the practical value of this concept is insignificant because of its multidimensionality and multi-connectedness. The rational way to form the functional description is to apply a multilevel hierarchy of descriptions where a higher-level description will depend on the generalized and factorized variables of a lower level.

Structurization. When describing the financial architecture, we will consider it as a structure into which any variable describing the functioning of a separate structural component can be introduced at certain moments of time, and from which such variable (or a set of them) can be derived at certain moments of time. Thus, the architecture itself will have a dynamic character with a set of relationships with the external environment.

In the most general form, the functional description of the financial architecture in any dynamic system is shown as follows:

$$S_{fa} = \{T, x, C, Q, y, \varphi, \eta\} \quad (6)$$

where T is a multitude of moments of time in the analyzed period;

x is a set of values of the input external influences on the state of the financial architecture;

$C = \{c : T \to x\}$ is the number of allowable input influences on the state of the financial architecture;

Q is a multitude of states of the financial architecture in time;

y is a multitude of values of output quantities;

$Y = \{u : T \to y\}$ is a multitude of output values;

$\varphi = \{T * c \to Q\}$ is a transient function of the state of the financial architecture in dynamics;

$\eta : T * Q \to y$ is the initial reflection of changes in the states of the financial architecture in time;

c is the time interval of the input external influence on the state of the financial architecture;

u is the time interval of the output value (variable) of the state of the financial architecture.

Synergy. As part of the research of the synergy property, the financial architecture has the following main characteristics: a multitude of heterogeneous components; activity (purposefulness) of components; a set of different relationships between components; semiotic (weakly formalized) nature of relationships; coordinated behavior of components; transparency; distribution; dynamics; ability to adapt; evolutionary potential; uncertainty of external environment parameters.

We suggest considering a new complex type of classification when all properties and features of system synergy and synergy from the transfer of competencies within the configuration of the financial architecture of the national economy are preserved:

- synergy from the integration of structural components according to the levels of the hierarchy;
- synergy from the centralization of functions of structural components in order to save costs for each structural component and obtain an additional effect by minimizing risks and transferring competencies.

The formula for calculating the synergy effect within the configuration of the financial architecture:

$$S_h = S_c + S_i \tag{7}$$

S_h is the synergy effect within the configuration of the financial architecture;

S_i is the synergy effect from the integration of structural components according to the levels of the hierarchy;

S_c is the synergy effect from the centralization of functions of structural components of the financial architecture.

The formula for the synergy effect from the centralization of functions of structural components of the financial architecture is presented as follows:

$$S_c = \sum((\Delta C_i + E_i) * K_i - C_c), i = 1,..n \tag{8}$$

K is a centralization coefficient;

ΔC are transaction cost savings;

E is an additional economic effect;

C_c are the current costs of implementing a particular function;

n is the number of centralized functions.

Adaptation. Such property of constructing the financial architecture of the national economy as its adaptability to changes in the external environment to achieve the goal can be represented formally via the concept of the financial architecture as a goal-oriented system.

$$S_{fa} : X \to Y \tag{9}$$

There are two ways of defining this system S_{fa} as the goal-oriented system.

1. Let α be the goal for S_{fa}. The system is considered goal-oriented if each parameter $x \in X$ satisfies the goals α.

2. S_{fa} is considered the goal-oriented system (with feedback) if this multitude M (the set of input parameters) is together with a pair of displays (D, P)

$$P : M * X \to Y$$
$$D : X * Y \to M \qquad (10)$$

3. such as:

a) $y = S_{fa}(x) \leftrightarrow (P(m, x) = y) \wedge (D(x, y) = m)$;

b) D makes a decision regarding the goal α to reflect P_M defined on $M * U$, in в Y, namely: $P_M : M * U \to Y$

Obviously, according to the second concept, the financial architecture S_{fa} is the goal-oriented system if this pair of displays (P, D), such as S_{fa} , is a composition (with feedback) P and D and, in addition, D makes a decision regarding the goal α defined for P_M.

Based on the concept of the goal-oriented system, we can define some other notions, such as adaptation, self-organization, etc. For example, adaptation can be defined as a process aimed at reducing the amount of uncertainties U and self-organization as a process of changing the structure of the goal-oriented process, namely functions that define the goal-oriented system (such as a function of performance, process model P_M, admissibility function, satisfaction states, etc.).

One should take into account not only external structural particularities of the financial architecture hierarchy but also functional interactions between its levels [7, 8].

Conclusions. Therefore, due to the regularity of communicativity manifested not only between the financial architecture and its external environment but also between the levels of the hierarchy of this architecture, each level of hierarchical arrangement has a complex relationship with the higher and lower levels. Each level of the hierarchy has the property of direction to a lower level, has the nature of the autonomous whole (system), on the one hand, on the other hand, is directed to the node (top) of the highest level, and shows properties of the dependent part (a structural component of the financial architecture). This specification of the hierarchical regularity explains the ambiguity of the use of concepts of system and subsystem, goal and means (the element of each level of the hierarchical structure of goals acts as a goal in relation to the lower and as a lower-level goal, and starting from some level, as the means in relation to the higher-level goal) in such complex organizational systems as the financial architecture of the national economy, which is frequently observed in real conditions. The most important specific feature of the hierarchical arrangement as the regularity is the fact that the regularity of integrity / emergence (namely qualitative changes in properties of the higher-level components are combined by the lower-level components) is manifested in it at each level of the hierarchy. At the same time, the combination of structural components within the configuration of the hierarchical structure of the financial architecture leads not only to the emergence of new properties of the configuration, which are combined by components of some of its own properties, but also to the fact that each structural component at different levels of the hierarchy acquires new properties that are absent in the isolated state.

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ВЛАСТИВОСТІ ПОБУДОВИ ФІНАНСОВОЇ АРХІТЕКТУРИ ЕКОНОМІКИ

Анотація. *У статті досліджено основні властивості побудови фінансової архітектури економіки. Доведено, що вивчення фінансової архітектури економіки передбачає створення моделі, що дозволяє здійснити аналіз і передбачити її поведінку в діапазоні відповідних умов функціонування, вирішувати задачі структурних компонентів на різних рівнях ієрархії. З'ясовано, що залежно від цілей і завдань, моделювання може проводитися на різних рівнях абстракції. Виявлено, що опис повинен відповідати концепції розвитку фінансової архітектури і задовольняти певним вимогам: має бути відкритим і допускати можливість розширення (звуження) спектра функцій й завдань та передбачати можливість переходу від одного рівня ієрархії до іншого. Представлено формалізацію окремих властивостей побудови фінансової архітектури національної економіки, яка включає емерджентність, гомеостаз, холастичність, функціональність, структурованість, синергію та адаптацію.*

Ключові слова: *фінансова архітектура, емерджентність, гомеостаз, холастичність, функціональність, структурованість, синергія, адаптація.*