

Duality and Dualism of Economic Systems

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By analogy with biological and physical systems the duality of economic systems passed through hereditary memory is studied. In particular, the parallels between the economic and biological systems concerning the information duality – the ability to carry stationarity (dynamic stability of the state) on the individual-level (species, economic agents) and ensure the variability in systems development on the population level (population, industries). By analogy with physical systems dualism of economic systems is analysed. It is an economic entity that simultaneously has properties of: a) discrete units – corpuscles, the coordinates of which can be uniquely identified within the space and time as a certain point; and b) a field entity, which is significantly extended in space and spread over time.

Keywords: development, duality, stationarity, systems, time.

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Introduction. The topic raised for discussion actually affects a wide range of issues and is very deep in content. Duality is a certain universal property, which generally belongs to all phenomena in the universe (Demin, 2011; Philosophskiy, 2003; Philosophskiy, 2002). Duality (dualism) requires two elements in the formation of the existing natural principles of understanding the world. The following pairs of dual concepts are the examples: information – energy, substance – field, movement – immobility, space – time, whole – opposite, good – evil, similarity – difference, separation – connection; analysis – synthesis, variability – stability; absolute – relative, concrete – abstract, element – system, private – public and many other.

It is quite possible that antipodal pairs exhibit not only the diversity of nature but also different facades of the same phenomenon, called the *development of open stationary systems*.

We will analyze how the two types of dual phenomena, first discovered in the natural sciences (Biology and Physics) are realized relatively to the functioning and development of economic systems. And we will use original terminology of the authors of the corresponding discoveries, namely duality by Werner Arber in biology and dualism in physics by Louis de Broglie. However, it should be remembered that this terminological distinction is largely conditional, since the words used are very close in meaning.

Duality in Hereditary Systems' Memory

Research by Nobel Prize Winner Dr. Werner Arber allowed us to understand the information mechanism for the development of open stationary systems (Arber, 1978). The scientist introduced the most important thing: He outlined approaches to rethinking the role of *memory* in this process. Very schematically it can be explained as follows.

Systems' development is realized through the alternation of a system states: *stability* (stationarity) and *variability* (the transition to the new stationary state). This is not accidental. Mutual conversion of energy and information is behind it. At the stage of stationary state, the

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system maintains homeostasis, i.e. narrow, stable range of its parameters. In this state, the system operates in the most effective way (in particular, the activity of the economic system is the most profitable). This allows the system to accumulate energy (if we talk about the company, it is quasi-energy – capital). Energy is required for the subsequent qualitative (increasing or decreasing) *information* transformation by the system of its parameters and transition to a new stationary state with new homeostasis.

Thus, through the stationarity mechanism the system's nature solves the problem of energy accumulation. The latter is needed for rebuilding of the material basis of the system. Energy is required just for the work and implementation of the qualitative (information) jump to the new system's homeostasis. However, for information transformation the system needs not only energy – it is just a source for this work. The main target is to accumulate new *information* that defines the parameters of the upcoming system's homeostasis. Changes (mutations) in the system are fundamental ground for new information.

From the theory of systems we know that any process in a system is maintained by *memory*. In particular, it provides stationarity. A system «memorizes» its level of homeostasis, caring over its state in a very narrow range of parameters. Memory mechanisms must also somehow create preconditions for the emergence and accumulation by the system's memory its *changes*, which carry new information.

For biological organisms, this dual task of ensuring relative *stability* of the parameters of the system and the simultaneous generation of its variability is resolved through *genetic duality*, i.e. combination of two different mechanisms of memory. They operate at the *population* and *individual* levels. The first provides genetically transmitted resistance of parameters of organisms that belong to certain biological species. Because of this a trout is always born only as a trout, frog – as a frog, a bear – as a bear, and pine grows as a pine. Genetic inheritance is the «groove» of the characteristics of the population's organisms, which allows them to operate with maximum efficiency in certain ecological niches. This relative stability provides a direction (vector) of the species' evolution.

At the level of the *individual* organism memory mechanism is created to perform a very different mission. This mission is to ensure a sufficient number of *changes* for the evolution. The changes are the driving force for the development of the species, setting up the pace of evolution. Uniqueness of biological organisms (individuals) is the basis for the implementation of variability. In nature, there are no two absolutely identical biological organisms. Appearance of any biological organism necessarily means the production of a new spontaneous (i.e., uncertain and random) information. This is a pre-requisite to further biodiversity increase.

Exactly this mechanism was discovered by Dr. W. Arber in the form of *genetic duality* of bacteria and higher organisms. The duality phenomenon implies that every biological organism carries genetic information of its own life programme as well as related to evolution of the population to which it belongs. Consequently, both the relative *stability* of the parameters of the body (providing properties of its stationarity), and its ability to generate *changes* (and therefore the new information) is transferred with the help of genetically inherited information.

Most of the above mentioned dual pairs are realized in this process, for example: *abstract – specific* (at the level of specific individuals), *common – individual*, *relative – absolute*; *public – private*, *constant – variable*, and *similar – different*. In the end, in the chain of the listed dual pairs another (perhaps central) dual pair: *energy* (material principle) – *information* is realized.

All common properties for a certain species are fixed by the genetic memory (in natural selection) and are transmitted by genetically inherited information.

Socialized animals (bees, ants, birds, gregarious mammals, etc.) genetically transmit (Эфроимсон, 2004) behavioral standards for their social feature. People are at the top of the evolution of social organization. Due to the social lifestyle a human being has evolved as an individual, formed only by the information origin in the material body.

The formation of social systems is also largely based on the information codes, inherited from other generations. These codes have a completely different nature of implementation, and they can be called «genetic» only conditionally. However, the transformation of social genetic information is subject to the same principle – to ensure the duality of *relative constancy* and *variability* of social forms of life. The former is passed through institutions (legal norms, household traditions, cultural practices, generally accepted ethical norms, religious norms, etc.). The latter is provided by the individual characteristics of a personality. They are formed in the context of biological parameters and constraints of a specific human organism under the influence of specific conditions of a certain family and the socio-cultural environment in which personality is formed.

It turns out that both social foundations (stationarity) of the company and a generator of innovation (new information) coexist in a person. Of course, in every person the ratio of the mentioned essentials is different. Moreover, it varies depending on the specific conditions and circumstances. *Biological duality* therefore is enforced by *social duality* of a human being.

Information Duality in Economics

Some scholarly publications have suggested that in human society there is a mechanism of inheritance of social information, which is similar to genetic mechanism of transmission of biological information, and it was even named close to the «gene» – «meme».

Scientists' arguments

- Dawkins (Dawkins, 1989) calls fine structure of information, based on human memory, the «*meme*». The «Soup of Human Culture» is therefore cooked from «*meme*». Like genes, memes are distinct in certain properties (*longevity, fecundity, copying-fidelity*). «The *old-gene* selected evolution, by making brains, provided the soup in which the first memes were born. Once self-copying memes had arisen, their own much faster kind of evolution took off».
- Faber and Proops (1991) described the rapid and unpredictable formation of the «*genotype*» of the physical system we now use as various physical constants to explain and evaluate various physical processes. They postulated a «*unique genotype*» for physical systems as well as increasing diversification of natural systems (corresponding in this case to at least the genetic potential of all species) and economic systems. The «*genomes*» of economic systems determine such things as *preferences of economic agents, technology, the legal system and economic and social institutions*.
- Jörg Köhn (Köhn, 1996) calls the systems of economic characteristics stocks of information (the «*genomes*» of human progress). Based on this the economic «phenotype» is the expression of a *memone*, to use Dawkins term, under some given conditions. Economic «memone», summarizes J. Köhn, can adapt to specific economic conditions (technologies in current use, capital consumption per unit of a good, quantities and prices of goods, market structures, etc.). Its phenotypic expression must consequently be based on «presence» in a way analogous to how biological species adapt (using the species' potential in a biogeographical region) by partly absorbing and storing additional (and currently unused) information.

Thus, we have every reason to believe that in economics there is a transmission mechanism of hereditary information. It can be conditionally called *information duality*. Like the duality of the genome in biology, it aims to address the dual task to ensure stationarity and

variability of economic systems.

Stationarity is provided through standards and restrictions for the products (existing in the areas of production and consumption), basic technologies, labour skills, habits, preferences and cultural background of potential customers, etc.

On the other hand, information factors form pre-conditions for *variability* of economic systems. They are caused by individual qualities of workers, of their ability to do something that cannot be done at other enterprises (or vice versa, the inability to do what is done everywhere, and because of it the necessity to look for their own way to succeed). Originality of social and natural environment in which economic system operates is also important as well as many other aspects, which ultimately underlie the ground for innovation. However, in order for this «fruitful soil» to produce innovation, it is necessary to plant «motivational seeds» – private and public interests in a context of individual and common. And these, in turn, are necessary conditions for stimulating factors in the form of emerging problems, limitation, and competition.

It turns out that the first two fundamental elements discovered by Ch. Darwin in his evolutionary triad *variability – heredity – selection* are actually founded in the previously mentioned duality that ensures stationarity and variability of economic systems.

Physical Dualism of economic Systems

Physicists know the so-called effect of dualism, when particles at the same time exhibit properties of discreteness and field (photon wave) (Фейнман, 2004). However, if certain effects are inherent in the microworld, do they work as well at the macro level – at the level of economic systems? In particular, do economic agents show qualities similar to properties of discrete particles and fields? Most likely, we can say yes to that, to some extent any part of any system, including economic has the property similar in its manifestation to dualism.

The phenomenon of dualism lies in the fact that a particular element has both properties: a) *discrete unit (corpuscle)*, which coordinates can be uniquely determined in space and time as a certain *point*, and b) *field-essence*, which has a substantial length in space and duration in time.

Such considerations provoke the idea of dualism of economic systems. It is known that any system exhibits significantly greater qualities (properties) than those possessed by its subsystems. What is the source of this new quality? Let us assume that they are carriers of the same parts (subsystems) that make up a whole new system, but do not act as discrete units, and field essence. Prior to the formation of this whole the mentioned qualities occur in each subsystem (part of the whole) but on the virtual (ie, potentially possible) level not on the real one.

Economic systems exhibit their field properties in space and time (fig. 1):

- *in space* as medium of economic relations: first, with *suppliers* of inputs, and secondly, with *consumers* of goods, thirdly, with *state* that provides social services and fourth, with *population* of the concrete territory (administrative region) delegating the right to dispose public (natural and infrastructure) assets of the area elected to the local authority and administration; fifth, with a variety of *competitors* (for resources, for potential customers, with the possibility of using limited natural resources and infrastructure), *sixth* with *lower-level structures* (subsidiaries and conjugated enterprises);

- *in time* as subjects, which are the subjects of cause-effect relationships: first, as a result of the events that took place *in the past* (being the carrier of heredity, and history of their predecessors), and secondly, as a source (cause) of events extended *in the future*.

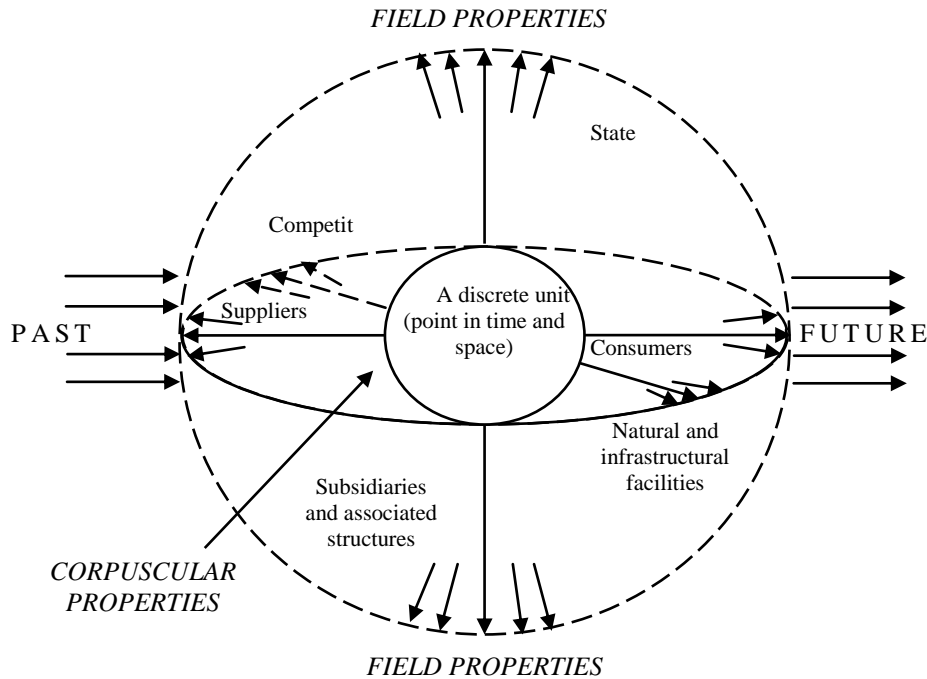


Figure 1. The dual nature of economic agents

Any company, as an economic entity (i.e., a discrete unit) with its address (legal or individual), properties, executives, etc. at the same time affects other areas of economic activity outside their formal presence, as if creating a kind of *economic field*. For example, we can say that every company creates prerequisites for its operation and respectively for its resource suppliers as well as consumers of their goods and services.

The automobile industry in the United States is an excellent illustration. Eventually a car has created infrastructure, related products and services, lifestyle of America, and provided the development of petrochemical industry, road construction, tanker fleet, cars service, training drivers for road police control and nowadays satellite navigation, and many other things.

In the Soviet Union the construction and operation of many enterprises had an enormous impact on the development of entire regions and country as a whole. Cities (it is enough to recall AvtoVAZ with its city of Toliatti, or KamAZ in Naberezhnye Chelny, Norilsk metallurgical plant in the city of Norilsk), highways were built, sea and air routes were laid, infrastructure was formed, natural ecosystems were changed, vocational and technical schools, higher education institutions were opened.

Economic agents can influence policy of the whole countries. The most typical examples are the active U.S. policy to promote poultry companies products (known as «Bush legs») to foreign markets, resource wars in the Persian Gulf, various unstable situation and even «cold wars» by the weapon producing industries, and in modern history – the initiation of revolutions in the North Africa with the «oil» context.

Human being also posses properties of dualism. Their physiological nature is limited by the size of a biological body, and realizes corpuscular properties. Personal (social) essence of

a human being has nonmaterial (information) nature of realization. It is formed by the society (carries information about all social fields) and in turn, itself participates in the formation of the field.

The wave nature of the economic essences. Many activities of economic agents are characterized by wave (cyclic) character, which applies to both corpuscular and field nature of their functioning. Rhythm of economic processes is observed at any level of economic systems existence. The duration of production operations, the frequency of raw materials supply and finished goods shipping, operating hours, seasonal nature of work changes, periods of working capital turnover, capital amortization period, the periods of reproduction of natural factors, the payback investment period, the change of periods of basic technology, the basic goods samples or production modes and others are among the major cycles.

Cyclical nature of economic systems have dynamic wave properties, including magnitude (i.e., differences of economic parameters), the wave length (period between the beginning and the end of the cycle), and the frequency of alternating waves.

Approaches to economic field assessment. Materialized images of the «field» dimension of economic systems can be measured by means of statistical tools. The Nobel Prize Winner of Russian origin W. Leontief's research can be considered as a milestone, which laid the basis for formalizing and quantifying the properties of the «economic field». His «input-output» method based on the inter-sectoral balance allows us to estimate both direct and indirect (materialized) results of the sectors (Leontief, 1997). This means that one can actually estimate the part of the cost of production by enterprises of a given industry, and the part of the past labor cost, i.e. products of related industries, which is materialized in goods of the sector under consideration.

In many countries, this methodology has allowed to perform evaluation of direct and indirect (materialized) energy required to produce goods in various sectors of economy (For example: Kim et al, 1975; Nagai et al, 1984). Direct energy is formed within the framework of ongoing production processes at various enterprises. Indirect energy is caused by the activities of enterprises in other sectors of economic system.

«Energy memory». In the 1970-s, the work of American scientists H. Odum and E. Odum have significantly deepened the research period prior to production history of economic assets. It describes concentration of energy of materialized production factors. The results of the research they have summarized in a book entitled «Energy basis for man and nature» (Odum et al., 1976). Somewhat later Howard Odum coined a new term «emergy» (from the English «energy» and «memory»), which meant energy memory, i.e. amount of energy, materialized in a particular asset in the history of the formation of its material and information content (Odum, 1996).

«Externalities». Economic research of 1960-1970-s produced another evidence of the «field» nature of economic systems. A new economic concept of «externalities» came into existence (Classics, 1997, Markandya, 2002). Externalities are side effects of market activities not reflected in market demand and supply. Most popular interpretation of externalities is associated with environmental impacts. In principle they can be any positive or negative effects of economic activity of economic agents not taken into account by markets (Bithas, 2011; Van den Bergh, 2010; The economics, 2011).

Negative external effects of individual metallurgical and energy companies reach 30–40% of their internal economic costs (Melnyk et al., 2010; Methods, 2004). This is economic damage from pollution by enterprises under consideration. And it has spillover effects on other sectors of economy because companies in those sectors face negative consequences.

Externalities can also be positive. For example, positive external effect of recreational facilities (resorts, parks) is comparable with the income received by these enterprises. External positive effects of forests in 3–4 times and protected territories in 5–6 times exceed the amount of investment into these areas (Melnyk et al., 2010). External effects of beekeeping (according to foreign and domestic research) are from 15 to 20 times higher than the income that beekeeping households receive (Sustainable, 1996).

Thus, each company creates a unique information-energy field. Directing capital flows of different degrees of power into different areas (sectors) of activity (e.g., resource production, or consumption of goods), this field is the source of a specific quasi-energy of companies. And this energy is in a certain way directed and concentrated by the information. The described above facts give us some grounds to talk about the information vector of the energy field. The field spreads in space and extends in time. As we have seen, this field can have both negative and positive value, bringing extra costs or additional benefits.

The role of economic dualism in the evolution of economic systems. The formation of quasi-energy field is a pre-requisite for creating variability in economic systems. Each route of evolution of economic systems must pass natural selection, proving its existence in terms of efficiency and the ability to reduce the production of entropy. In his Nobel speech, and a number of publications, Nobel Prize winner Werner Arber has suggested a genetic dualism which manifests itself at the level of biological organisms. In particular, the genetic mechanism is responsible for not only life and development of each individual biological organism, but also for the evolution of the entire population in which it belongs (Arber, 2000). Similar processes occur in economic systems development since it is determined by the mechanism of evolutionary triad (heredity-variation-selection) operating under tough competition.

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Дуальность и дуализм экономических систем

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По аналогии с биологическими и физическими системами рассматриваются передаваемые через наследственную память свойства двойственности экономических систем. В частности, проводятся параллели между экономическими и биологическими системами в отношении информационной дуальности – способности поддерживать на индивидуальном уровне (особей, экономических субъектов) стационарность, то есть динамическую устойчивость состояния, и обеспечивать на видовом уровне (популяций, отраслей) изменчивость в развитии систем. По аналогии с физическими системами анализируется дуализм экономических систем. Он заключается в том, что экономический субъект обладает одновременно свойствами: а) дискретной единицы – корпускулы, координаты которой могут быть однозначно определены в пространстве и времени как условной точки; б) полевой сущности, имеющей значительную протяженность в пространстве и распространенность во времени.

Ключевые слова: время, дуальность, развитие, система, стационарность.

Дуальність і дуалізм економічних систем

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За аналогією з біологічними і фізичними системами розглядаються властивості подвійності економічних систем, які передаються через спадкову пам'ять. Зокрема, проводяться паралелі між економічними та біологічними системами щодо інформаційної дуальності – здатності підтримувати на індивідуальному рівні (особин, економічних суб'єктів) стаціонарність, тобто динамічну сталість стану, та забезпечувати на видовому рівні (популяцій, галузей) мінливість у розвитку систем.

Ми маємо всі підстави вважати, що в економіці, існує механізм передачі спадкової інформації, який може бути умовно названий інформаційною дуальністю. Він, як і дуальність геному в біології, покликаний вирішити двоєдине завдання – забезпечення стаціонарності і мінливості економічних систем. В економіці спадкова передача властивостей стаціонарності забезпечується: стандартами і обмеженнями на продукцію, що випускається (існуючими у сферах її виробництва і споживання); базовими технологіями; навичками обслуговуючого персоналу; звичками, уподобаннями і культурними традиціями потенційних споживачів тощо. Вони підтримуються соціальною пам'яттю суспільства, є досить стійкими та інерційними.

З іншого боку, діють інформаційні чинники, які формують передумови змінності економічних систем. Вони обумовлені: індивідуальними якостями працівників підприємств, їх здатністю робити щось, що не можуть виробляти на інших підприємствах (або навпаки нездатністю робити те, що роблять скрізь, і необхідністю шукати власні шляхи успіху), самобутністю соціальних і природних умов, в яких функціонує економічна система, і багатьом іншим, що в кінцевому рахунку є живильним середовищем виникнення інновацій.

За аналогією з фізичними системами аналізується дуалізм економічних систем. Він полягає в тому, що економічний суб'єкт володіє одночасно властивостями: а) дискретної одиниці – корпускули, координати якої можуть бути однозначно визначені в просторі і часі як умовної точки, б) польової сутності, що має значну протяжність у просторі та поширеність у часі.

Свої польові властивості економічні системи проявляють в просторі і в часі. У просторі – як носії економічних відносин: по-перше, з постачальниками вихідних ресурсів; по-друге, із споживачами продукції, що випускається; по-третє, з державою, яка надає соціальні послуги; по-четверте, з населенням певної території (адміністративного регіону), яке делегує своє право розпоряджатися суспільними (природними та інфраструктурними) активами даній території обраному органу та місцевій адміністрації; по-п'яте, з різного роду конкурентами (за ресурси, за потенційних споживачів, за можливості використання обмежених природних благ і об'єктів інфраструктури); по-шосте, з нижчестоящими структурами (дочірніми і сполученими підприємствами). У часі економічні системи проявляють себе як суб'єкти, які є предметом дії причинно-наслідкових зв'язків: по-перше, як результат подій, що мали місце в минулому (будучи носієм певної спадковості та історії своїх попередників), а по-друге, як джерело (причина) подій, які поширюються в майбутнє.

Ключові слова: дуальність, розвиток, система, стаціонарність, час.

JEL Codes: A13, B41, O10

Figures: 1; *References:* 25