MONEY FIELD THEORY: IN PURSUE OF FORMALISM

IVANCHENKO IGOR
Professor of Economics
Department of Finance
Rostov State University of Economics
69 B. Sadovaya Str., Rostov-on-Don, 344002 Russia
E-mail: ivanchenko.is@gmail.com, Phone: 7 863 261 3846

MASLOV ALEXANDER
MA in Economics, Research Assistant
Department of Finance
Rostov State University of Economics
69 B. Sadovaya Str., Rostov-on-Don, 344002 Russia
E-mail: alx.maslov@gmail.com, Phone: 7 960 460 1115

Abstract

The article explores the possibility of interaction between financial and industrial sectors of an economy via such a new economic notion as a pervasive money field, which is used to pin down the elusive entropy of financial markets. The theory of a field originally comes from physics and we show the way it can be applied to economic reality. The implementation makes possible not only to reunite separate channels of monetary transmission mechanism into a single mechanism, but it also provides a new glimpse at the formalized mechanism of macroeconomic monetary relationship.

Key Words: money field, money supply, monetary transmission mechanism

JEL Classifications: C02, E10, E12, E13, E51

1. Introduction

The basic concept of the paper is to continue traditions laid down by monetarism by synthesizing them with the new classical school, more exactly - theory of transmission mechanisms, and quantum physics. The ideas proposed here could claim for a post monetarism concept, because money is a pivoting element of the theory. Yet, the goal of the paper is not limited by monetary sector, it is supposed to depict long-run interdependencies between financial and real sector of an economy without giving much attention to the elaboration of problems the monetarists were concerned with. We believe that it is not circumstantial that in physics entropy is usually described within the equations of the field theory. Our task is to interrelate those two categories on the plane of economic and financial realities.

In thermodynamics entropy was initially introduced to describe the measure of irreversible dispersal of energy. In statistical physics entropy serves as a measure of probability relating to fruition of any macroscopic state, while in information theory - a measure of uncertainty of any experience, which may have different outcomes. In thermodynamics entropy was introduced by Klausios in 1865. He formulated this category on the basis of the second law of thermodynamics, which, in its turn, can be written as follows:

$$dS = \frac{dQ}{T} \geq 0 \qquad (1)$$

The equality (1) means that if a subject has temperature T and it receives a certain amount of heat dQ, its entropy or the chaotic molecular motion will increase by dS. In reversible processes entropy remains the same, i.e. dS=0, in irreversible - it can only increase. If a system is combined of several parts the full entropy of the system is equal to the sum of every element's entropy. There are scientists (Sedov, 1976), who argue that the entropy growth in the Universe, determined by the heat energy dispersal, is compensated by informational accumulation. Since heat is a random molecular motion the statement about the imminence of "thermal" death of the Universe is also based on general interpretation of entropy as a measure of disorder. According to this version entropy's growth leads to order's extinction. When entropy of the Universe achieves maximal (balanced) value all structures will be destroyed and chaos will prevail (Haytun, 2005). An outstanding Russian philosopher N. A. Berdyaev has straightly linked the growth of entropy in the Universe and the striving of the society to social equality. The global entropy increase can be seen not only in nonorganic matter but also in the society. If slavery, feudalism and capitalism were characterized by capital's concentration in the hands of a very narrow layer of people (and this layer increases while moving towards the highest social formation), in socialistic revolution Berdyaev saw a natural process of disorder, when all means of production are equally distributed among all members of the society.

"The world will perish from inevitable and insurmountable yearning for physical equality. Is this striving for social equality not the same entropy, decadence of social cosmos and culture in evenly distributed heat energy, irreversible in energy creating culture?" (Berdyaev 1990).

If the surrounding world inexorably moves towards the increase of disorder, it has to bring all its structures to simplification and degradation. Then how can we explain the evolution of living nature, the growth of its self-organization opposing to the entropy increase? It happens that a living system can self-improve at the expense of external environment, absorbing order in the form of matter and information. This process increases the rate of living matter's organization by receiving negative entropy, whereas positive entropy of the external environment increases. "An organism continuously creates order out of order in sense of self-reproduction and order out of disorder due to metabolism...A building, left for its own, dilapidates...Sane activities of a living organism - a human - are directed on overcoming of the second law of thermodynamics. A human does not increase entropy, he decreases it." (Volkenstein 1965).

Besides the thermodynamic idea of entropy there is also an important definition of informational entropy, which serves as a measure of uncertainty of incoming messages. If we use $x_1, x_2, \dots, x_n$ to depict all possible sets of messages and $P_1, P_2, \dots, P_n$ for their conformable probabilities, than informational entropy is written by the next equality:

$$S_u = -\sum_{k=1}^{n} P_k \ln(P_k), where \sum_{k=1}^{n} P_k = 1 \quad (2)$$

The value *Su*=0 if any of the probabilities *Pk*=1, and the others - null, i.e. information is verified, uncertainty absents. Informational entropy reaches its highest value when all *Pk* are equal. In this case informational uncertainty is maximal.

Deriving from the definition of informational entropy (2), interesting analogies between the performance of living matter and world economies can be presented. For instance, the principle of living nature functioning is inherent to the economy of the USA, which enforces the right for emission of world's reserve currency. Before Federal Reserve issues new party of dollars and sets it free, the entropy of the money supply, according to the equality (2), is null. After new money gets into circulation, money supply's entropy begins to rise. Given credit to the fact that more than 80% of cash dollars turnover is outside the boundaries of the US, the largest part of the issued dollars will get into the other countries. According to the formula (2) the entropy of the world financial market, i.e. the chaos in money circulation of the other countries, will increase. Thus, the USA consumes negative entropy from the world economy in the form of material resources accumulated in the process of exchange for unsecured emission of dollars, temporarily increasing resilience of the national economy sacrificing financial entropy of the other countries. However, this increase in stability is local in time, as the economy of the USA cannot escape the accelerated growth of the entropy of the world's economy.

In next section of this paper we will describe the mechanism, which formalizes interactions among money, entropy and macroeconomic variables.

2. Theoretical workout

The surrounding world does not consist only of disconnected clusters of matter but contains different kinds of fields as well. These fields connect matter at micro- and macro levels sustaining certain structures of organization. For years naturalists have been looking into the bio-fields emitted by plants, animals and humans, gravitational fields through which all bodies are pulled to each other, electromagnetic fields generated around charged particles. For example, in the middle of the XIX century G. Maxwell (1865) developed a single electromagnetic theory which included both electric and magnetic phenomena. Later in 1920 A. Einstein made an attempt to develop a theory which would unite electromagnetism and gravity (Einstein and Infeld 1956). We commence the developing of the money field theory by stating the notion “field” in the economic context, describing the field that emerges in the process of money supply movement in an economy. Similar to the field definition given in the encyclopedia (Prokhorov 1992), it is possible to give a definition of the money field as an economic system, possessing infinitely large number of degrees of freedom. Economic values referred to such a system are not localized in a segment, but are continuously distributed in space.

Field is any economic value, which has different values in sundry points of space. For example, refinancing interest rate can be considered neither scalar nor vector field. But money supply perfectly suits this definition. First of all, money supply is unequally distributed in national economy; secondly, in time this distribution changes. In addition, cash flows, moving in the economy, possess both volume and direction of its motion, i.e. moving money supply is likely to be considered as a vector field. Scientists had to be very inventive to help people imagine fields’ behavior.

The most correct view is the simplest and the most abstract one at the same time: fields are to be considered as mathematical functions of position, time or other economic variables. For example, money supply volume in an economy (aggregate M_2) and the direction of its motion depend on a great number (nearly infinite) of variables influencing money circulation process. Money supply is influenced by both demand and its supply, regulated by state monetary institutions (like central banks), as well as it is formed by market environment. Among these variables it is possible to single out the most significant ones: the volume of cash money in circulation, requirements for obligatory reserves, deposit funds, the amount of surplus reserves of the banking system, refinancing interest rate, revenues on public securities, existing price level in a country, volume and cycle of production in the real sector, interest rates, rate of revenues on production investment, exchange rates, inflation level, international capital flows, currency earnings (Mishkin 2006).

However, this article is not aimed at the detailed analysis of money supply generation process as there are a lot of books and manuscripts devoted to this problem. This article, in the first place, investigates those macroeconomic variables which emerge in depths of any financial market and influence money supply dynamics as well as the real sector of the economy. On the other hand, these variables are, to a lesser extent, manageable by the state. First of all this concerns inflation, market process of exchange rate forming, etc. In addition, an integration of separated transmission channels into a single mechanism of transferring monetary impulses to the real economic sector is of scientific and practical interest. Consequently, keeping in mind the structure of main transmission channels for our research, it is necessary to select those money-market variables that influence monetary aggregate, that are held in the transmission chains and that are developed within the market environment.

Interest rate channel was the first transmission channel examined by economists. The structure of this channel originates from the keynesian model of interest rate impact on investment and production dynamics (Mishkin 2006):

$$M\uparrow \rightarrow r\downarrow \rightarrow I\uparrow \rightarrow Y\uparrow \quad (3)$$

where $M\uparrow$ reflects the policy of money supply increase which leads to decrease of real interest rates $r\downarrow$ and it, in its turn, reduces borrowing costs, promotes investment expenditure growth $I\uparrow$ and, consequently, triggers the growth of GDP (*Y*).

The second variant of the interest channel is also investigated. Expansion of monetary weight ($M\uparrow$) leads to the growth of an expected price level ($P^e\uparrow$) and expected inflation ($\pi^e\uparrow$); it results in the decrease of real interest rates ($r\downarrow$) and growth of manufacture ($Y\uparrow$):

$$M\uparrow \rightarrow P^e\uparrow \rightarrow \pi^e\uparrow \rightarrow r\downarrow \rightarrow I\uparrow \rightarrow Y\uparrow \quad (4)$$

It is obvious that the key variable in this transfer mechanism apart from interest rate is inflation.

Credit channel is closely connected with the interest rate channel. This channel manifests the interconnection between shifts in money supply, volume of real sector crediting (L) and production volume (Krjuchkova and Sapjan 2003):

$$M\uparrow \rightarrow L\uparrow \rightarrow I\uparrow \rightarrow Y\uparrow \quad (5)$$

There is also an exchange rate channel that shows the monetary policy impact on aggregated demand and production through changes in national exchange rate, for example, to US dollar (e) and through altering of net export's volume (NX) (Mishkin 2001):

$$M\uparrow \rightarrow e\downarrow \rightarrow NX\uparrow \rightarrow Y\uparrow \quad (6)$$

Nowadays, the asset value transmission channel based on James Tobin’s q theory is popular among the economists from developed countries. This theory explains how monetary policy can influence an economy via share prices.

J. Tobin defined the parameter q as companies’ market price divided by replacement capital cost. When q is high, companies’ market price exceeds replacement capital cost and new investment expenditures are stimulated (Mishkin 2006):

$$M\uparrow \rightarrow P_s\uparrow \rightarrow q\uparrow \rightarrow I\uparrow \rightarrow Y\uparrow \quad (7)$$

where P_s is a market share price. It is possible to give structures of additional channels but all of them, to a certain extent, are concrete cases of the transmissions mentioned above.

Next, we will analyze the chains of transmission channels presented here, look into common elements, and concisely discuss existing differences. Classical transmissions start from changes in the money supply volume which consequently affects the growth rate of real production.

Last but one element in almost all chains is the volume of real investment in the real sector of an economy. Among the crucial transfer links bank interest rates (r) can be singled out for the first channel, bank interest rates (r) and inflation (π) for the second, crediting volume for the third channel (L), exchange rate for the fourth one (e), and a market share price (P_s) for the fifth channel. In other words, a shift in volumes of the money supply has a direct impact on these variables. It should be mentioned that bank interest rates, inflation and exchange rates are the most important variables for the transmission mechanism. According to the stock market theory, the growth of interest rates stimulates the drop of a market share price, and a decrease in interest rates results in an increase of the market share price (Chepurin and Kiseleva, 2002):

$$P_S = \frac{d}{r} * 100\% \qquad (8)$$

where *d* – is the sum of the dividend paid for one share.

Thus, market share price (P_s) and lending volume depend on bank interest rates. Therefore, for further economic analysis we will take an interest rate (r), inflation (π) and an exchange rate (e). It is possible to use these variables as axes of the Cartesian three-dimensional coordinate system, which determines properties of the economic space where money supply is moving. The dimensionality of this space can be scaled up, for example, to five-dimensional space by adding lending volume (L) and market share price (P_s) to the list of variables. Fundamental structure of the money field equations, which are given below, is not going to change but each of the equations will obtain an additional summand. That is why, to avoid cumbersome calculations and don't heap up the paper with high dimensionality of the space where the interaction between financial and real sectors is taking place, we will limit ourselves with the three basic variables: interest rate on credit, inflation and an exchange rate. Moreover, in this case we will be able to illustrate the logic of the analysis in the Cartesian system of coordinates for 3 variables (XYZ).

Besides, these selected variables, while being a part of different structures of transmission channels, are not only affected by money supply dynamics but also influence money supply volume on their own. An important feature of the money field is that, like a gravitational field, it defines the geometry of spatiotemporal coordinates for the money supply. Moving money supply influences the axes (bank interest rates, exchange rate, inflation), changing their values. It results in shifts of the money supply volume and the volume of investment in the real sector of the economy. Figure 1 illustrates this process ($\vec{H}$ indicates the intensity of the money field).

Therefore, money field can be presented as the following field function: $M(r, e, \pi, t)$, where *t* is a time parameter. The field, sustaining the interaction, is an economic reality in itself. Money supply is moving among economic systems and this is the way how the interaction among them is conducted by the money field. If the carrying agent of the electromagnetic interaction is a quantum of the electromagnetic field – photon, it is natural to assume that a kopeck is a quantum of the Russian money field, and correspondingly a cent is a quantum of the American money field.

The money field is as real as, say, gravitational field. As the terrestrial gravitational field attracts all objects and prevents them from flying away to the outer space, the money field like chains of a slaver fixes people to the instruments of production. It is not a secret that most of the employees and employers work for money. The money field attracts some firms and rejects the others, penetrates all economic relationship, puts an economy into a single complex. If money circulation and money field disappear the whole civilized world will collapse: transaction costs for production and circulation will grow dramatically, the production volume will reduce, and those, not being able to transfer to the natural economy, will simply extinct. However, skeptics can argue that gravitational and electromagnetic fields are everywhere in the Universe, but the money field exists only on Earth and only in a civilized society. But this relative locality in time and space does not mean it is not objective. The evolving human society, at a certain stage of its development, is able to create, in accordance with synergetic laws, an absolutely new form of the money field, which is able to exist and influence economic development. We have already mentioned that there are scalar and vector fields. The most ordinary are scalar fields. The field is a magnitude, dependable on its position in space. A scalar field is a field which is characterized by a sole number – scalar.

Air temperature that falls down along the increasing height is an example of a natural scalar field. One way to imagine a scalar field is to imagine its "outlines", in other words, equipotential surfaces similar to horizontal lines on the map connecting points at the same height above the sea level. Financial sector and real economic sector are exchanging with cash flows. Moving to both sides, money supply creates the money field within the economic system which can both promote and decelerate production development. Money supply is generated not only in the financial sector, which comprises a central bank, numerous commercial banks of a country and other financial mediators, but the money supply volume has a direct impact on the dynamics of industrial production (Ivanchenko 2006).

We are not going to discuss the basics of the money circulation theory; we only mention that not all cash flows generated within the financial sector, while going through the financial market, reach boarders of real economic systems. A part of funds, going from the financial to the production sector, might not attain the target and have to go back. Both economists and accountants can give a number of such examples. The central rounded arrow depicts these cases in Figure 1. Therefore if we take a kind of a snapshot of the money supply's density which moves between the two mentioned economic sectors, we will get the lines of the same levels of the money supply, marked with dotted lines in Figure 1.

Thus, scalar magnitude, for example, money supply (aggregate M_2), given as a function of a point, determines the scalar field. We introduce the term "gradient of the money field". Let us assume that at a certain point of the scalar money field money supply has a value *m*. Changing of the money supply, forced by a point's moving to the segment ds in the Cartesian coordinate system (bank interest rates – exchange rate – inflation) depends on the dislocation's direction, i.e. derivative $\frac{dm}{ds}$ obtains infinite number of values depending on the direction of the ds dislocation which can be represented as:

$$ds = dr\,\vec{i} + de\,\vec{j} + d\pi\,\vec{k} \tag{9}$$

where dr, de, $d\pi$ are respectively directions of money supply dislocation along the axes of coordinates, and $\vec{i}$, $\vec{j}$, $\vec{k}$ - unit vectors along these axes. On the other hand, the increase of money supply, with precision to infinitely small values, can be presented as:

$$dm = \frac{\partial m}{\partial r}dr + \frac{\partial m}{\partial e}de + \frac{\partial m}{\partial \pi}d\pi \tag{10}$$

As it comes from the equality (10), the expansion of money supply dm can be considered as a scalar product of ds and the vector grad m, called gradient:

$$grad(m) = \frac{\partial m}{\partial r}\vec{i} + \frac{\partial m}{\partial e}\vec{j} + \frac{\partial m}{\partial \pi}\vec{k} \tag{11}$$

Thus,

$$dm = ds * grad(m) \tag{12}$$

The economic essence of the money supply gradient means the following. All points of space with same money supply values *m* form level surfaces (as mentioned before). These surfaces are characterized by the constancy of the money supply value with the point moving along them. Consequently, if ds lies in the tangential plane to level surface, then scalar product $ds * grad(m) = 0$, as the angle between vectors ds и $grad(m)$ is 90° and the cosine of this value equals zero. But neither ds nor $grad(m)$ must not turn to zero. Therefore, vector $grad(m)$ is to be perpendicular to the level surface (Kochin 1961).

Figure 2 shows the position of the vector of the gradient relative to the level surface of some money supply m_0. The scalar product of the two vectors (equation 10) means that with the same value ds the increase of dm reaches the highest value when ds's direction coincides with $grad(m)$. In other words, vector $grad(m)$ shows the direction of the greatest change (the fastest growth) of the function *m*. In Figure 2 there is a perpendicular to the money supply level surface in the point P_0. The length of the segment on this perpendicular line equals the absolute value $grad(m)$.

On the segment (as on the diameter) we will construct a sphere touching the level surface in P_0. The derivative value of $\frac{\partial m}{\partial s}$ in any direction equals the length of the chord going from the point P_0 to ds.

Economic meaning of the gradient is the following: gradient *m* is the vector calculated by the equation (11), directed to the fastest money supply increase and its value equals the derivative of this direction. Having calculated the derivative of the analytically selected function $M(r,e,\pi,t)$ it is possible to estimate the direction of the fastest growth of the money supply in an economy. If it starts to drift away from the real sector, the government intervention is to regulate the money supply volume and its velocity. The technique of the construction of the function $M(r,e,\pi,t)$ is given in the paper by Nalivaisky and Ivanchenko (2004).

Besides the values characterized by one number (such as money supply) and called scalar ones, there are such variables in the economy, which cannot be defined by one value. To estimate them, it is necessary to know both their absolute value and the direction of their changing. These are vector fields, which idea is simple enough. Every point of space specifies a vector which changes from point to point. Let us consider the velocity of money circulation as an example. However, in this research we will not examine the velocity of money circulation itself, but the product of money supply and velocity of money: $m\vec{v}$, i.e. the money impulse, which a financial market, reflecting most of the financial sector, and industrial production exchanges when the money supply flows between them.

The letter *v* indicates the velocity of money and the arrow above it is a vector symbol. The money supply continuously moves between those two economic sectors both in forward and reverse directions (fig. 1). For example, the funds, which a company obtains from the allocated on the securities market corporate bonds, possess certain money supply (m_1) and certain velocity ($\vec{v}_1$); consequently this company gets the money field impulse equal to $m_1\vec{v}_1$. There are also internal money streams within the limits of the financial market and the real sector of an economy. Therefore, we can derive the magnitude of a general money impulse in an economy after summation, conducted by rules of vector calculations of all such streams. As stated above the financial market and industrial sector exchange this impulse.

There are also internal cash flows within the financial market and the real economic sector. Thus, from the summation of all such flows in an economy we get a general value of an impulse the financial market and the industrial sector exchange with each other:

$$M\vec{V} = \sum_{i=1}^{n} m_i \vec{v}_i \qquad (13)$$

Fisher’s equation is well known from economics (Fisher 2006). It is equality between money supply, taking into account the dynamics of the money circulation velocity, and its commodity supply:

$$MV = PQ \qquad (14)$$

where P – price level in the country, Q – production volume. Many well-known Russian scientists have doubts about the validity of this equation in the conditions of Russian open economy (Krasavina 2006); yet, we verified it using panel data from Russian economy and showed its significance (Ivanchenko 2005).

The cyclical fluctuations of the global financial market have great impact on the process of money supply in our country. The equilibrium of Fisher’s equation is violated only in those years when favorable cyclical fluctuations of the global financial market cause anomalously high inflows of currency earnings in the country as well as foreign loans and credits used by Russian companies. In general, Russian economy is consistent with the equality (14).

The equality (14) can be presented in the vector form:

$$M\vec{V} = P\vec{Q} \qquad (15)$$

Thus, in the left part of Fisher’s equation (15) the money field impulse is written. The impulse is a product of the money supply and its velocity. It is known from physics that if we take time derivation of impulse it is possible to calculate a new characteristic of the field called force. So, the force of the interaction between the financial market and the real sector of the economy $\vec{F}$ is defined in the following way:

$$\vec{F} = \frac{d(M\vec{V})}{dt} \qquad (16)$$

On the other hand, the force of the interaction can be realized via such a characteristic as the intensity of the money field. We will indicate it as $\vec{H}$:

$$\vec{F} = C \cdot \vec{H}, \qquad (17)$$

where «C» is the total capital accumulated in the industrial sector. Thus, the intensity of the money field placed on the given point of the field is a vector value equal to the force influencing the capital value put in this point of the field.

It is possible to imagine a field drawing it along the vector in many points of space in such a way that each of them would show the intensity and direction of the field in any point. Besides, it is possible to draw lines which at any point would be tangents to these vectors as if they followed the arrows and preserved the field direction. If it is done, the information about the length of vectors will be lost. But it is possible to preserve it in a different way by drawing sparser lines in those parts of the space where the field intensity is feeble and by drawing more lines where it is strong. Usually it is assumed that the number of lines in the unit of area lying across the lines is commensurable to the field's intensity. In the following way the money field is presented in the Figure 1.

We have two realities: capital and money field. Capital in the broad sense can be defined as material and non-material values which bring a flow of revenues. The cost of capital is expressed in the money form. Capital (as mass in physical world) is the supply of values for production, accumulated at a certain period of time. Money field is the energy (cash flow moving in the economic space), which, under certain conditions, transforms into investment. Money field provokes the increase of the existing supply of capital goods in a certain period of time (Chepurin and Kiselev 2002). Capital is a huge supply of energy, and the energy of the money field is a potential production capital. Consequently, in most cases it is impossible to differentiate between the capital accumulated in the industry and the money field formed by cash flows moving towards the real sector. The largest part of money energy is concentrated in capital, but the money field surrounding production capital is energy too, though in much lesser quantity. That is why it could be said: the capital is there, where the concentration of the money field is high; the field is there, where the concentration is low. If it is true, than the difference between the capital and the money field, which essential part transforms into investment, is quantitative rather than qualitative.

The money field's intensity follows from the equations (15, 16 and 17):

$$\vec{H} = \frac{\vec{F}}{C} = \frac{1}{C}\frac{d(M\vec{V})}{dt} = \frac{1}{C}\frac{d(P\vec{Q})}{dt} = \frac{d}{dt}\left(\frac{P\vec{Q}}{C}\right) \qquad (18)$$

The value in parentheses is the ratio of GDP to the total capital (fixed and working), accumulated by all economic entities in the framework of a national economy. This parameter can be called, for example, a coefficient of gross capital usage. Let us indicate this coefficient by the Greek letter χ . Latin letter q indicates the unit vector of production ($\vec{q}$). In this case (18) transforms into following equation:

$$\vec{H} = \vec{q}\,\frac{d\chi}{dt} \qquad (19)$$

The equation (19) means that the money field's intensity (or the force of the money supply's impact on the unit of industrial capital) is directly proportional to the growth speed of the coefficient of gross capital usage. The qualitative transformation of a company’s fixed and working capital after increase and decrease of the volume of investment in industry is one of the reasons why the value of this coefficient is changing. A part of the money supply moving from the financial market to the industrial sphere transforms into investment, and the other part is used for other purposes (Fig. 3). The unit vectors $\vec{i}$, $\vec{j}$ and $\vec{k}$ are directed along main axes of coordinates and form the right system of coordinates.

Consequently, the force of the financial market's impact on the functioning process of a given company by means of the introduced notion “money field” can be expressed as follows:

$$\vec{F}_i = c_i\,\vec{q}\,\frac{d\chi}{dt} \qquad (20)$$

where c_i is the capital of the company involved. In other words, any company in a developed market economy is continuously affected by a financial market even though it does not attract external investment. In the latter case the company will, as a rule, steadily lag behind in its development in comparison to those businesses, which actively control the structure of their capital and attract cheaper investment from financial markets than their equity value. In general, the direction of a financial market's impact on the production dynamics is determined by how the coordinates (r, e, π) of the vector $\vec{q}$ for a given company are located in space.

Along with an impulse the money field possesses two important characteristics: divergence and rotor. The divergence of the vector field $M\vec{V}$ of the money supply M moving with the speed V we will call the following value:

$$div(M\vec{V}) = \frac{\partial(MV_r)}{\partial r} + \frac{\partial(MV_e)}{\partial e} + \frac{\partial(MV_\pi)}{\partial \pi} \qquad (21)$$

where MV_r, MV_e, MV_π are projections of the vector $M\vec{V}$ on the coordinate axes.

The divergence is a measure of sources of the field $M\vec{V}$, i.e. the sources of money supply generation. If, in a certain area of an economy, there are no sources to form new values of money supply then in this area $div(M\vec{V})$ is equal zero. In general, the process of money supply's multiplication in financial and real sector of an economy is continuous, that is why, for example, within the limits of a financial market, the money field divergence is not equal to zero. Equation (21) allows us to calculate an increase in money supply, for example, in a certain area of the industrial sector for a period of time *t*. If inflows exceed outflows (Fig. 3), than the increase in money supply equals:

$$div\{M(r, e, \pi, t) * \vec{V}(M, t)\} = \frac{\partial M}{\partial t} \qquad (22)$$

Rotor of the vector money field $M\vec{V}$ (marked as $rot(M\vec{V})$) determines the field's circulation along the closed curve. If in an area $rot(M\vec{V})$ = 0, it means that there are no local rotary motions there; and the field is called vortex-free in this area. In general case, a rotor of the vector money field $M\vec{V}$ is calculated as a determinant of the following matrix:

$$rot(M\vec{V}) = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ \frac{\partial}{\partial r} & \frac{\partial}{\partial e} & \frac{\partial}{\partial \pi} \\ MV_r & MV_e & MV_\pi \end{vmatrix} \qquad (23)$$

Or

$$rot(M\vec{V}) = M * rot(\vec{V}) + grad(M) \times \vec{V} \qquad (24)$$

where "×" denotes a vector product of two vectors: the money supply gradient $grad(M)$ and the money circulation velocity $\vec{V}$ (Kochin 1961). It is natural to suggest that the higher the value of the money field's rotor, i.e. the higher its twisting, the lower, taking the other conditions equally, the probability that the money flow, generated in a financial sector, will reach the borders of the real economic sector.

To sum up our theoretical work let us form a structure of the united transmission channel of monetary policy taking into account the introduced notion "money field":

$$M \uparrow \rightarrow \vec{H} \uparrow \rightarrow I \uparrow \rightarrow Y \uparrow \qquad (25)$$

where $\vec{H}$ is the vector of the money field's intensity. Increasing volume of money supply influences the value and the direction of the vector of the money field's intensity, which, in turn, influences investment volume in the real sector of an economy and eventually results in changing of GDP volume. This universal channel of transmission includes the structure of all existing channels.

3. Conclusions

We introduced main definitions of the money field such as the coordinate system, intensity, impulse, interaction force between money field's and company's capital, gradient, divergence and rotor. It is possible to describe in details all statistic and dynamic characteristics of money supply and cash flows that major economic sectors exchange. Moreover, the elaborated money field model has allowed us to unite separate channels of monetary transmission into a single mechanism through which a national financial sector influences the process of accumulating of fixed and working capital by companies; and it has great impact on production dynamics of goods and services in industry and agriculture. Just like gravitational field affects masses in physical world, money field affects capitals in economic world. The intensity of this attraction is commensurable to the mass (capital) of the body (company).

In the work of I. Prigozhin "Introduction to thermodynamics of irreversible processes" it is argued that the speed of entropy's increment in a certain body along with *n* chemical reactions can be expressed by the sum of multiplications of generalized forces *Xi*, affecting molecules, on conformable rates of motions *Ji*:

$$\frac{dS}{dt} = \sum_{i=1}^{n} J_i X_i \qquad (26)$$

The rate of the entropy increase shows the intensity of irreversible processes. These processes transform into each other by different forms of interaction. Applying the equality (3) for moving money supply in an economy, we can pin down the increment of the entropy a county's financial market is subject to.

$$\frac{dS}{dt} = \sum_{i=1}^{n} \vec{V}_i \vec{F}_i \qquad (27)$$

where *Vi* - rate of money circulation, *Fi* - force, influencing motive money supply *mi* within the money field.

$$\vec{F} = m_i \vec{H} \qquad (28)$$

where *H* - money field's intensity. The expression (4) can be rewritten in the following order:

$$\frac{dS}{dt} = \sum_{i=1}^{n} (m_i \vec{V}_i) \vec{H}_i \qquad (29)$$

Therefore the rate at which entropy increments within the money field depends on the rate of money supply's velocity and intensity of the money field. The latter is defined by an averaged coefficient of capital usage in national economy (value of production / value of operating capital). Thus, we can conclude that entropy of a financial market is closely linked to the economic growth of a country. If an economy thrives, money supply's velocity increases, savings transform into investment at a greater rate, volumes of earnings related to the used productive and rural capital are boosted as well.

REFERENCES

Berdyaev N.A. The purport of history: experience of the philosophy of a human fate. M:Misl' 1990 - 173

Bernanke Ben and Gertler Mark (1989) Agency costs, net worth and business fluctuations. *American Economic Review* 79, 14-31.

Bernanke Ben and Gertler Mark (1995) Inside the black box: the credit channel of monetary policy transmission. *Working paper 5146* http://www.nber.org/papers/w5146.

Brunner, Karl (1974) Monetary Management, Domestic Inflation, and Imported Inflation. In Aliber, Robert Z., (ed.), *National Monetary Policies and the International Financial System*, pp. 179-208. Chicago: University of Chicago Press.

Chepurin M.N. and Kiseleva E.A. (2002). *Economics: textbook – 5th edition*. Kirov: ACA (in Russian).

Cagan Phillip D. (1969) The Non-Neutrality of Money In the Long Run: A Discussion of the Critical Assumptions and Some Evidence. *Journal of Money, Credit and Banking*, Vol. 1, No. 2 pp. 207-227.

Einstein A. and Infeld L. (1956) *Physics Evolution*. Moscow: Technical and Theoretical Literature (In Russian).

Fisher Irving (2006) *The Purchasing Power of Money: Its Determination and Relation to Credit, Interest, and Crises.* CA: Cosimo Classics

Friedman M. *The methodology of Positive Economics* (1953) http://academic2.american.edu/~dfagel/Class%20Readings/Friedman/Methodology.pdf

Haytun S.D. Human Phenomenon at the Universal Evolution. M:KomKniga 2005, p. 536

Ivanchenko I.S. (2005) Application of Fisher's equation for the Russian Money supply Dynamics Analysis. *Statistics Issues* 2, 66-70 (in Russian).

Ivanchenko I.S. (2006) Research on the Russian Transmission Mechanism of Monetary Policy. *Finance and Credit* 14, 2-11 (in Russian).

Keynes John Maynard (1965) *The General Theory of Employment, Interest, and Money*. GA: Mariner Books

Kochin N.E. (1961) *Vector Calculus and Fundamentals of Calculus of Tensors*. Moscow: The USSR Academy of Sciences (in Russian).

Krasavina L.N. (2006) Reduction of Inflation Rate in Strategy of Innovative Development of Russia. *Money and Credit* 9, 12-20 (in Russian).

Krjuchkova I.P. and Sapjan M.U. (2003) Transmission Mechanism of Monetary Policy and Pecuraties of its Functioning in Russian Economy. *Bankovskoe Delo* 9, 6-17 (in Russian).

Laidler David (1981) Monetarism - An Interpretation and an Assessment. *Economic Journal* 91, 1-21.

Laidler David (1978) Money and Money Income - An Essay on the Transmission Mechanism. *Journal of Monetary Economics* 4, 151-191.

Maxwell James Clerk (1865) A Dynamical Theory of the Electromagnetic Field, *Philosophical Transactions of the Royal Society of London* 155, 459-512.

Meltzer Allan (1969) Money, Intermediation and Growth, *Journal of Economic Literature* 7, 27-56.

Mishkin Frederic S. (2009) *Theory of Money, Banking and Financial Markets*, 9th edition.

Mishkin Frederic S. (2001) The transmission mechanism and the role of asset prices in monetary policy. *Working Paper 8617* http://www.nber.org/papers/w8617.

Naidysh V.M. (2002) *Modern Concepts of Natural Sciences*. Moscow: Gardariki (in Russian).

Nalivaisky V.U. and Ivanchenko I.S. (2004) Analysis of the Russian Money Supply Mechanism. *Finance and Credit* 20, 11-23 (in Russian).

Prokhorov A.M. (1992) *Physical Encyclopedia*. Moscow: Big Russian Encyclopedia (in Russian).

Poteev M.I. (1999) *Modern Concepts of Natural Science*. Spb.: Piter (in Russian)

Sedov E.A. Evolution and Information. M:Nauka 1976 - p. 232

Vernon Smith (1994) Economics in the Laboratory. *Journal of Economic Perspectives* 8, 113-31.

Volkenstein M.V. Molecules and life. Introduction to molecular biophysics. M:Nauka 1965 504

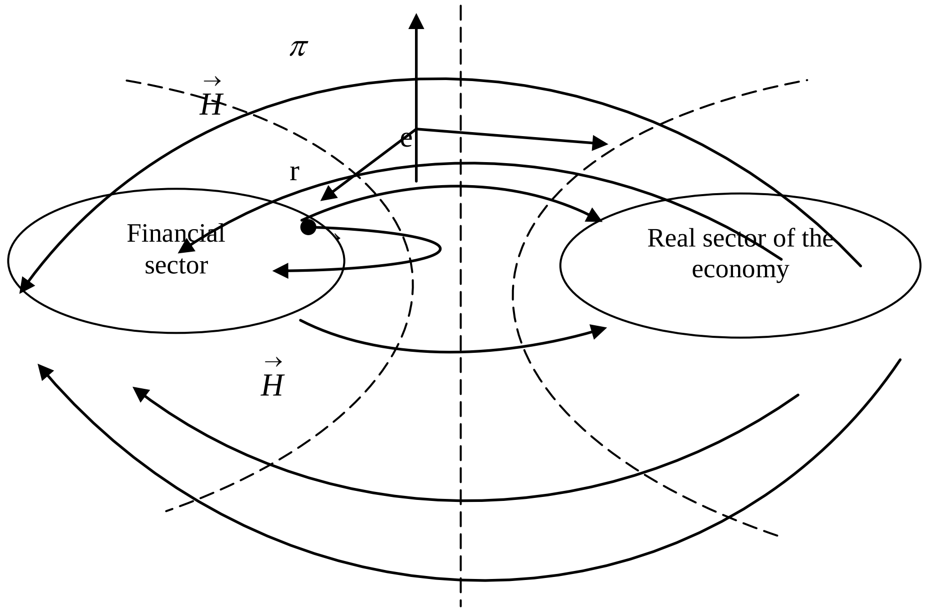

Figure 1. Schematic depiction of the money field connecting financial and real sectors of an economy

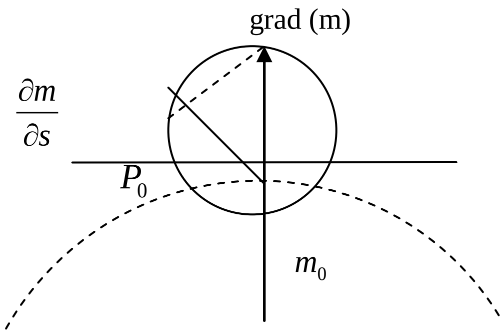

Figure 2. Construction of the derivative $\frac{dm}{ds}$ in the direction of the maximum shift of m

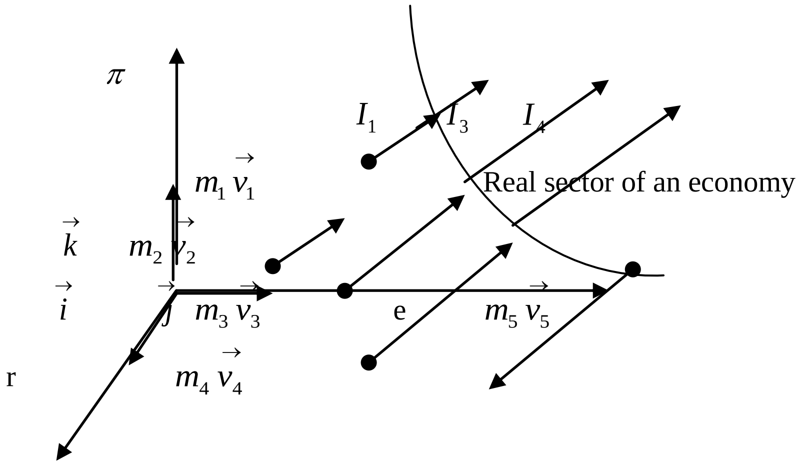

Figure 3. Transformation of the money field into investment