

I. CYCLICAL DYNAMICS AND THEORIES

1

The Mathematical Model of Juglar Cycles and the Current Global Crisis*

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Abstract

The article presents a verbal and mathematical model of medium-term business cycles (with a characteristic period of 7–11 years) known as Juglar cycles. The model takes into account a number of approaches to the analysis of such cycles; in the meantime it also takes into account some of the authors' own generalizations and additions that are important for understanding the internal logic of the cycle, its variability and its peculiarities in the present-time conditions. The authors argue that the most important cause of cyclical crises stems from strong structural disproportions that develop during economic booms. These are not only disproportions between different economic sectors, but also disproportions between different societal subsystems; at present these are also disproportions within the World System as a whole.

The proposed model of business cycle is based on its subdivision into four phases:

- recovery phase (which could be subdivided into the start sub-phase and the acceleration sub-phase);*
- upswing/prosperity/expansion phase (which could be subdivided into the growth sub-phase and the boom/overheating sub-phase);*
- recession phase (within which one may single out the crash/bust/acute crisis sub-phase and the downswing sub-phase);*
- depression/stagnation phase (which we could subdivide into the stabilization sub-phase and the breakthrough sub-phase).*

The article provides a detailed qualitative description of macroeconomic dynamics at all phases; it specifies driving forces of cyclical dynamics and the causes of transition from one phase to another (including psychological causes); a special attention is paid to the turning point from the peak of over-

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heating to the acute crisis, as well as to the turning point from the downswing to recovery.

The proposed mathematical model of Juglar cycle takes into account the following effects that are typical for the market economy:

- positive feedbacks between various economic processes;
- presence of a certain inertia, time lags in reactions of the economic subsystem to the change in conditions;
- amplification by the financial subsystem of positive feedbacks and time lags in the economic subsystem;
- excessive reaction to changing conditions during the acute crisis sub-phase.

The authors suggest that the current crisis turns out to be rather similar to classical Juglar crises; however, there is also a significant difference, as the current crisis occurs at a truly global scale. Yet, due to this truly global scale of the current crisis, the possibilities of regulation with the national state's measures have turned out to be ineffective, whereas the suprastate regulation of financial processes hardly exists. It is shown that all these have led to the reproduction of the current crisis according to a classical Juglar scenario.

Keywords: business cycles, Juglar cycles, crises, current crisis, financial globalization, phases of business cycles, macroeconomic dynamics, depression, stagnation, boom, overheating, upswing, bust, recession.

Introduction

Though the issue of economic cycles has been subject to numerous studies, this problem has retained its high importance. What is more, the current crisis has confirmed in an extremely convincing way the point that notwithstanding all the successes achieved by many states in their countercyclical policies, no economy is guaranteed against uncontrollable upswings and unexpected crises and recessions that tend to follow such upswings. In addition to this, the financial globalization has increased substantially the risks of such cyclical fluctuations.

The notion of economic cycles is regarded ambiguously in economic science. In modern theories, business cycles are frequently defined as fluctuations of actual output around its potential value which is achieved in full employment conditions (see, e.g., Fischer, Dornbusch, and Schmalensee 1988). However, quite frequently economy does not achieve on the rise the potential GDP volume when a recession phase starts (such situations are described in more detail in Grinin and Korotayev 2010a: ch. 1). Thus, *economic cycle*, in our opinion, can be defined as *periodical fluctuation around medium line of production volume, where repeating phases of rise and decrease can be specified*.

In the model that we propose below we have tried to briefly describe the main features of medium-term cycles of business activity, or business cycles (7–11 years)¹ that are also known as Juglar cycles after the prominent 19th-century French economist Clement Juglar (1819–1905), who investigated these cycles in detail (Juglar 1862, 1889).²

On Some Approaches of Economic Science to the Problem of Cyclicity and Economic Crises

Juglar investigated fluctuations of prices, discount rates and gold reserves of banks in France, England, and the USA and showed their correlation with cycles of increasing business activity, investments (and speculations), and employment (*Ibid.*). The first edition of his book was published in 1862. In the *Introduction* he wrote,

It appears that crises, like diseases, are one of the conditions of the existence of those societies where trade and industry are prevalent. One can predict them, alleviate them, delay them up to a certain moment, one can facilitate the recovery of economic activities; but it has turned to be impossible to eliminate them notwithstanding all the possible methods that have been applied (*Idem.* 1862: vii).

Juglar's most important achievement lay in presenting substantial evidence that crises were periodical, *i.e.* in support of 'the law of crises' periodicity'. According to this law, crisis is preceded by the epochs of recovery, well-being, and price growth, which are followed by years of price decrease and trade slowing down that bring economy into a depressed state (*Idem.* 1889: xv). It is namely with Juglar's contribution to the analysis of periodical crises that the transition of economics as a whole from crisis theory to business-cycle theory is frequently connected (Besomi 2005: 1).

Thus, crisis does not occur randomly (it is erroneous to ascribe its occurrence to random factors).³ It is preceded by an intensive increase in business activities and prices, which sometimes allows one to predict a crisis in advance.⁴ According to Tugan-Baranovsky (2008 [1913]: 294), Juglar successfully coped with this task on a number of occasions.

¹ Many economists maintain that business cycles are quite regular with the characteristic period of 7–11 years. However, some suggest that economic cycles are irregular (see, *e.g.*, Fischer, Dornbusch, and Schmalensee 1988). As we suppose, comparative regularity of business cycles is observed rather at the World System scale than in every country taken separately. This corroborates the important role of exogenous factors for the rise and progress of business cycles (for more details see below).

² Medium-term cycles (7–11 years) were first named after Juglar in the works by Joseph Schumpeter, who developed the typology of different-length business-cycles (Schumpeter 1939, 1954; see also Kwasnicki 2008).

³ Notwithstanding the belief of some influential modern economists in the contrary (see, *e.g.*, Zarnowitz 1985: 544–568; Mankiw 2008: 740).

⁴ It is worth mentioning here that, before Juglar, prevailing views were based on Adam Smith's ideas of 'invisible hand' and on Say's law of markets. According to such views, equilibrium state

A few notes on Juglar cycles (which will be also denoted as **J-cycles** below). Let us turn to a brief description by Tugan-Baranovsky of the economic cycle scheme proposed by Juglar:

Industrial crisis never comes unexpectedly: it is always preceded by a special heated state of industry and trade whose symptoms are so specific that an industrial crisis may be forecasted in advance... What causes these regular changes of booms and busts? Juglar indicates one main cause: periodic fluctuations of commodity prices. The prosperous epoch that precedes the crisis is always characterized by the growth of prices: 'Annual savings of civilized nations (that enlarge their wealth) also lead and sustain the constant growth of prices: this is a natural state of the market, a prosperous period. The crisis approaches when the upward movement slows down; the crisis starts when it stops... The main cause (one may even say – the only cause) of the crises is the interruption of the growth of prices' (Juglar 1889: 33). The overall mechanism of the crisis development is specified by Juglar in the following way. The increase in commodity prices naturally tends to impede the sales of respective commodities. That is why with the growth of prices the foreign trade balance becomes less and less favorable for the respective country. The gold starts to move abroad to pay for the imports whose amounts start to exceed those of exports. At the beginning the amounts of gold moving abroad are negligible and nobody pays attention to this. However, the higher the prices, the greater is the amount of gold that moves abroad. Finally, the commodity prices reach such a high level that selling the respective goods abroad becomes highly problematic. As the traders cannot cover the import expenses with the export revenues, they have to renew their promissory notes in banks after the payment deadline, and this accounts for the intensification of the discounting operations of the banks in the period that directly precedes the crisis. Yet, the payments cannot be delayed forever; sooner or later they should be made. The commodity prices fall immediately, this is followed by bankruptcies of banks and traders, and the industrial crisis begins (Tugan-Baranovsky 2008 [1913]: 294–295).

It can be seen that the central mechanism of cyclical fluctuations, in Juglar's opinion, is the fluctuation of prices, their increase leading to recovery and upswing, their decrease being followed by crisis and depression. The exceptionally important role of price fluctuations is indisputable; it has been noticed by the economists belonging to various schools (see, *e.g.*, Haberler 1964 [1937]). Among them one can mention such contemporaries of Juglar as Karl Marx and Friedrich Engels. In Tugan-Baranovsky's opinion (Tugan-Baranovsky 2008 [1913]), which

is considered to be the main one for the market, various shifts from it being caused by some external factors. Consequently, crises are also caused by random factors. However, currently these ideas (those of external shocks) are rather popular again. We will consider this issue in more detail further on.

we share, Juglar's theory, however, does not explain adequately enough the main point, namely the increase in commodity prices in the period that precedes the crisis. Subsequent researchers described numerous mechanisms of such an increase, ranging from interest rate fluctuation, credit expansion and reinvestment to the behavior of aggregate demand and aggregate supply curve, as well as psychological factors such as ungrounded optimism. Nevertheless, the issue is still subject to vigorous academic discussions. Tugan-Baranovsky himself suggests that crises are caused by lack of capital, as in the upswing period capital is spent faster than it is accumulated. As a result, both credit and impulse to development are exhausted, while structural disproportions lead to crisis phenomena (not necessarily in the form of an acute crisis; he was right to argue that the crisis intensity depends on the intensity of upswing). Tugan-Baranovsky emphasizes (and we would agree with him on this point to a certain degree) that the school of Marx and Engels suggested the deepest understanding of crisis for their time. According to them, crises are caused by overproduction (which is a consequence of the main contradiction of capitalism). Overproduction itself is stipulated, first of all, by the anarchic character of capitalist production; secondly, by poverty of masses, their exploitation, and the tendency of salaries to decrease. As a consequence of constant growth of capital's organic structure (*i.e.* the decline of the proportion of salaries in total production expenses), according to Marx, the profit rate falls.⁵ Capitalists try to overcome the profit rate reduction by introducing new machines, which leads to labor productivity growth. This leads to the expansion of the commodities' supply and, consequently, to their overproduction (because of the 'anarchy' of capitalistic production). Crisis is namely the explosion of capitalistic production contradictions, and, consequently, the restoration of equilibrium. Some Marxist economists provided fundamental descriptions of the history of crises (see, *e.g.*, Mendelson 1959–1964; Varga 1937; Trachtenberg 1963 [1939]). However, Marx and Engels, in our view, did not manage to show the true connection between the processes of production and circulation (the latter were ignored as an allegedly less fundamental part). Thus, they were not capable of revealing the causes of crisis explosiveness and dramatic change of situation at so-called turning points (*i.e.* from boom to acute crisis and from the bust to recovery and boom).

In the first half of the 20th century, numerous theories explaining economic cycles were already present. In fact, the under-consumption theory was one of the oldest, as such views appeared long ago (actually, together with the science of political economy itself). Among its earliest followers, Lord James Lauderdale, Thomas Malthus and Jean Sismondi were the most prominent. In the first

⁵ Phenomenon marked by the economists of various schools but explained differently.

half of the 20th century, a significant contribution to scientific re-consideration and diffusion of the under-consumption theory was made by John Atkinson Hobson, William Foster, Waddill Catchings, and Emil Lederer. Essentially concordant with its ideas were some of the abovementioned approaches of the Marxist orthodox school, which assumed that the working class condition, according to the law of working class absolute impoverishment put forward by Marx, must worsen.⁶

Monetary theories saw causes of cyclicity mainly in the cumulative character of business activity expansion and contraction depending on the amounts of money in the economy.⁷ The most vivid example is Hawtrey's theory (see, *e.g.*, Hawtrey 1926, 1928). For him, trade-industrial crises appeared to be purely monetary phenomena, as, in his opinion, monetary flow change suffices to explain the transitions from upswings to depressions (and *vice versa*). On the whole, undoubtedly, the monetary component of cyclicity and crises is very important. However, the representatives of monetary theories attributed too dominant a role to monetary factors, thus ignoring non-monetary causes.

One of the versions of the over-accumulation theory is based on the ideas of Tugan-Baranovsky. Haberler (1964) divides representatives of the theory into the followers of its monetary and non-monetary versions. The first group includes those economists who suggest that monetary factors, acquiring great importance with credit expansion, cause strong disproportions between economy sectors producing consumer items and capital goods (or, more exactly, between sectors of the whole manufacturing chain). The followers of this version of the theory in question have made a particularly valuable contribution to the analysis of disproportions in production structure caused by the credit expansion at the phase of boom and prosperity, as well as to the interpretation of crisis as a result of those disproportions. The representatives of this direction include Friedrich von Hayek, Fritz Machlup, Lionel Robbins, Wilhelm Roepke, and Richard von Strigl. Numerous representatives of this direction belong to the so-called Austrian School, which started from the works by Ludwig von Mises (1981 [1912], 2005). It sees the most important cause of crises in state interference into economic processes, particularly in artificial credit expansion.

⁶ However, such explanation has become an anachronism long ago. The given theory correlates very badly indeed with a long-term trend to an unprecedentedly fast (against the general historical background) increase in life standards (and real incomes) of 'direct producers' in general, and of the 'working class' in particular. This trend is rather typical for 'capitalist' countries and is observed in reality.

⁷ It should be noted that, from the point of view of General Systems Theory, this point is essentially related to the issue of positive feedback loops, which will be considered in more detail further on. The action of these feedbacks can lead to phenomena perceived as 'booms', 'collapses', and 'breakdowns' (see, *e.g.*, Sornette 2003).

Special attention is given to the role of central banks in crisis generation (see, *e.g.*, Huerta de Soto 2006; Skousen 1993; Rothbard 1969; Shostak 2002).⁸

The other, non-monetary direction of over-accumulation theory is represented by the authors whose theories are based on taking into account non-monetary factors: inventions, discoveries, creation of new markets *etc.*, (*i.e.* factors securing favorable conditions for new investments). This direction is represented by Gustav Cassel, Peter Hansen, Arthur Spiethoff, and Knut Wicksell. The works by Arthur Pigou and Joseph Schumpeter are essentially close to this direction as well.

Psychological theories are also worth mentioning. Even though every economic phenomenon has its psychological aspect, some theories (not without grounds) when interpreting different cycle phases assign a special importance to 'psychological reaction' that can considerably increase disproportions, make a new phase occur faster or slower, contribute to business activity increase or hinder it, *etc.* Among the representatives of psychological theory, one may mention such prominent economists as John Keynes, Frederick Lavington, Arthur Pigou, and Frank Taussig. In some aspects they ascribe to psychological factors (such as optimism, pessimism, euphoria, panic) a capacity to produce a relatively independent impact (for more details see Grinin 2009a).

The theories of economic crises can be classified in a variety of ways. For example, they can be segregated into exogenous and endogenous ones (see, *e.g.*, Morgan 1991), which are closely connected with approaches to the explanation of the nature of equilibrium state in economy. We take it as a basis that, though cyclicality has an endogenous structure being connected to occurrence of structural disproportions, still crises cannot occur without exogenous impacts. Essentially, the economy of a given country cannot be regarded in an isolated way, as the economic field is always much broader than the one of an isolated economy. It serves as a part of the World System economic field, so in reality external impacts must necessarily be observed (for more details see Grinin and Korotayev 2010a). The following important aspect must also be taken into consideration: while crisis in a given country may have first of all an endogenous character, its process and characteristics may possess substantial peculiarities in comparison to the crisis in countries where it is caused by exogenous factors. In particular, in modern conditions many countries, for example, China, India, or Russia, have not exhausted their development resource. Crisis in these coun-

⁸ A group of economists who developed the so-called 'acceleration principle' may be specified as a separate direction. According to this principle, the changes in consumer goods production cause, due to technological reasons, much sharper fluctuations in goods production sector, as investments into main capital require much more time and expenses. This causes a general demand increase, which eventually turns out to be greater than required for optimal development, which creates prerequisites for crisis origin (see, *e.g.*, Haberler 1964).

tries occurred just under the influence of a sharp change in external conditions. And, as external conditions of every country form a unique combination, crisis would have important peculiarities in each particular case. At the same time, in the USA the crisis was more of endogenous origins, as the country's economic development resources had been worn out to a greater extent than that in many developing countries. Such a situation is generally (though, of course, not always) typical for the development of crises in the World System core, on the one hand, and in its periphery, on the other. In the center crises have a more endogenous character, while in the periphery their origins are usually more exogenous, as they tend to be caused by economic fluctuations in the World System center. Thus, every crisis always has both endogenous and exogenous causes, but their combination is specific for each particular society in every particular period, which makes the situation unique for any society and for any crisis.

Kondratieff (2002: 11–14) divided all approaches firstly into ones regarding economic phenomena as static, considering static equilibrium state in economy as basic, and all deviations from such equilibrium as disturbances. Among the followers of this approach Kondratieff named William Jevons, Leon Walras, Vilfredo Pareto, Gregory Clark, Alfred Marshall, Knut Wicksell, *etc.* Secondly, in Kondratieff's view, research of some other economists was oriented mostly to the study of economic dynamics. These economists state that the equilibrium moment is not a basic one; they may even consider it as random, whereas, according to them, the economic dynamics goes through a whole range of regular development phases. Among those economists Kondratieff mentions Karl Marx, Clement Juglar, Mikhail Tugan-Baranovsky, Arthur Spiethoff, Jean Lescuré, Albert Aftalion, and George Mitchell. He indicates, however, that these researchers elaborated on particular problems of economic dynamics, their work standing somewhat apart from general development of economic theory. Nevertheless, it should be added here that namely these researchers made an especially important contribution to the development of the economic cycle theory.

As regards the above-mentioned division, it should be noted that, in the view of some economists, the essence of Keynesian revolution is in Keynes' ideas (1936) destroying the belief in perfect inner regulatory forces of the market mechanism (Adam Smith's 'invisible hand'), which meant the true end of the *laissez-faire* doctrine (see, *e.g.*, Blaug 1985). Discussions between the Keynesians and Neoclassicists are centered mainly on the question whether economy possesses self-regulating forces.⁹ Classical theory pays particular attention to long-term economic growth, dwarfing the meaning of economic cy-

⁹ In classical economic theory, self-regulating forces are stated to be ones connected with the behaviour of economic agents: entrepreneurs, workers, buyers, sellers, *etc.*, stipulated by elasticity of salaries and prices, which are capable of supporting the economy in a state of full employment.

cles. Keynesians insist that crisis-less economy growth is only possible in the presence of adequate monetary and fiscal policies playing the role of countercyclical stabilizer. In other words, Keynesians maintain that economic growth directly depends on *the state's* economic policy, without which such growth may not occur altogether. As Samuelson and Nordhaus note (2009: 486–487), in Keynesians' opinion, the economy is prone to lengthy periods of recurring unemployment followed by speculation and inflation growth. While for a classical economist the economy is similar to a person leading a healthy way of life, for a Keynesian, economy is a manic-depressive personality periodically inclined either to boundless rage and groundless gaiety, or to hopeless sullenness.

Since the 1950s, but especially in the 1970–1990s, discussions concerning cyclicity problems were connected with choosing the parameters through which economists proposed to influence it in order to diminish the negative consequences of uneven economic development. Expansion and development of the Keynesian theory contributed to the advancement of the idea about the economy's immanent proneness to falls and booms (*i.e.* to cycles). However, on the other hand, the popularity of the idea about the possibility of influencing cycles through state policy led to the economic thought focusing mainly on influence instruments. The problems of the cycles' nature and their deep causes gradually shifted to the periphery of the economic science.

Best-known in modern economic thought are the Keynesian (more exactly, neo-Keynesian) and monetary schools. The first after-war decades showed that the state policy of influencing economic parameters (such as aggregate demand, aggregate supply, discount rates, *etc.*) is not entirely successful. First of all, it is not always effective; secondly, it is not always based on long-term economic interests; thirdly, it has a certain lag, as necessary laws and decisions must be subject to a long procedure of coordination, approval, and enforcement. This led to growing popularity of the monetarist theory, which suggests that the state should exercise less direct influence on economy, while its interference must be more subtle and concentrate mainly on regulating money supply, money circulation velocity, state debt volume, and interest rates.¹⁰ An important contribution of this school to the macroeconomic theory is in the development of the idea about the necessity of following the stable rules of money circulation and not relying on voluntary fiscal and monetary policy.

Thus, the main difference between the views of Keynesians and monetarists lies in their approaches to defining aggregate demand. Keynesians suggest that aggregate demand changes are influenced by numerous factors, while monetar-

¹⁰ It is no coincidence that dominating positions in global economic science (and practice) went from Keynesians to monetarists in the early 1970s at a transition period from upswing to a downswing phase of the fourth Kondratieff cycle. On the other hand, such position transition was stipulated by refusal from attachment to the gold standard in dollar, which led to great changes in behaviour of finances devoid of such an anchor.

ists believe the main factor having impact on output and prices to be the change of money supply. Monetarists believe that the private sector is stable, and state interference often simply takes resources from it; macroeconomic fluctuations appear mainly because of fluctuations of money supply. In general, one can observe different views as regards the questions of which instruments should be used to influence the cyclicity, and what should be the role and economic policy of a state in short-term and long-term perspectives.

However, some more radical views on direct state interference into the economy are also present within the neoclassical theory. One of its tenets is based on the so-called theory of rational expectations (Robert Emerson Lukas and others), which essentially suggests that, as people use all available information, they can figure out in advance the predictable state policy and use it for their own benefit, as a result of which state policy turns out to be ineffective. Roughly speaking, 'no government can outwit the taxpayers'. Neoclassicists also assume price and salary flexibility (that is why the theory is called neoclassical, as, similar to the classical pre-Keynesian one, it is based on the idea of economy self-regulation). Like monetarists, they suppose that state influence should concentrate mainly on indirect economy regulation via various monetary instruments.

However, it is important to understand that in the last 10–15 years the process of definite and substantial synthesis of old and new economic theories has been going on (for more details see Samuelson and Nordhaus 2009: 505–507).¹¹ In particular, economists started paying more attention to expectations, as neoclassical theory suggests.

General Systemic Model of Crisis

Thus, there currently exist numerous theories of medium-term economic cycles. However, despite this diversity, we can generally agree with Haberler (1964) in his statement that there is evident multiplicity of causes of recurrence of economic cycles (and, accordingly, their crisis phases). The theories, meanwhile, differ mostly in the value put upon the same factors (this is especially true for modern theories), so real differences in opinions were often overestimated. However, the differences do exist and are rather essential.

It is appropriate here to recollect Pitirim Sorokin's saying on an equally great difference in views on factors (driving forces) of history. His conclusion is also rather just with regard to approaches to theories on the causes of economic cycles: '...the number of factor theories is very great, and namely this fact leads one to the conclusion that each sociologist is biased and not completely right. However, each of those theories has been elaborated and tested so thoroughly that one could hardly deny that each of those theories is partly right' (Sorokin 1992: 522).

¹¹ Actual synthesis of Keynesian and monetary theories started much earlier.

That is why it appears reasonable to try to find some more general causes in order to understand how the crises develop. Those causes might be linked with the point that the general foundations of economic crises are connected with the peculiarities of the capitalist industrial production (which, by definition, must expand). On the one hand, the very stability of modern society depends on the presence of economic growth. On the other hand, the constant economic growth implies (and this point is less frequently taken into account) that the social system must also constantly change. Yet, the economy usually develops more rapidly than the other subsystems (for more details see Grinin 2003, 2007), which tend to lead to deformations, tensions, and crises. Thus, the very 'motor' securing the development of modern societies implies the recurrence of crises. In this sense, it may be said that the crises are immanent for the industrial economy.

Such a situation became systemic after a partial completion of the Industrial revolution (that is, starting with the 1820s in Britain, and later in other industrializing countries). In Gellner's (1984) words, the production forces started feeling a great insatiable thirst for the economic growth.

It seems relevant to note that this was a rather novel historical situation, when the very reproduction of the social system implied constant economic growth; on the other hand, it had to adapt constantly to this growth, to restructure itself in accordance to it, to change constantly. *That is, it becomes necessary to take into account the point that growth and expansion are not automatic processes; they must be constantly sustained, whereas without adequate efforts the growth slows down/stops.* Yet, constant expansion cannot proceed endlessly, it tends to encounter obstacles and patent/latent resistance (objective unpreparedness/inability) of various institutions, social groups, *etc.*; and in order to overcome those obstacles one has to change respective social institutions. Social actors must also make substantial efforts to overcome those obstacles.¹²

On the other hand, as we have already mentioned this, crises can be usually regarded as results of active growth; as such, growth inevitably creates structural tensions not only in the economy, but within the social system as a whole (because the social institutions fit certain scales and volumes of phenomena and processes). This is proved by the point that the amplitude of a crisis correlates positively with the strength of a preceding economic upswing (cf., *e.g.*,

¹² For example, if there is a powerful network of corrupt officials, then entrepreneurs' opportunities for production expanding encounter the obstacle of corruption and dishonest rivalry. What has been said about the importance of the whole society striving to provide opportunities for production growth is also important for understanding contemporary phenomena in some Western countries, where a range of factors appeared to be absent, which are necessary for this (in particular, the need for full guarantees does not contribute to growth at all, as it extinguishes activity and energy; the same can be said about the unwillingness to give up anything for the sake of growth). For example, the aspirations of the French government to review currently groundless benefits for various officials (in particular, railway transport employees) have more than once stumbled on desperate counteraction.

the Great Depression or the 1873 crisis). If the growth was unpronounced, the crisis would manifest itself as stagnation rather than a pronounced downswing, or the downswing phase of an economic cycle could be hardly visible. According to our calculations with respect to many economic cycles, the output (and, hence, the size) of many economies (or at least their industrial sector) could grow 1.5–2.5 times within 7–10 years. Moreover, sometimes key industries could increase 5–7 and even more times within ten years. This, of course, could lead to significant disproportions in economy and society. This also specifies rather well the distinction between the economic crisis and circulation crisis (notwithstanding the presence of some common features): the former is always a crisis caused by a real growth (and thus connected with structural problems), whereas the latter does not touch upon the general structure of a social system (and sometimes it could be rather superfluous).

Constant and even movement to increase and expansion is impossible, as sooner or later it leads to the occurrence of great disproportions, various system elements starting to aim at coming back to their previous state. The result of this is the occurrence of some type of crisis, economic crises being among the most important types. Indeed, if in the course of 7–10 years of rapid economic growth the economy increased 1.5–2 times, this can hardly be regarded as painless for social structure. Even if, for example, there exist substantial resources of, say, labor force in villages in order to support industrialization in the city, rapid urbanization will invariably generate acute problems that can lead to social explosions and revolutions (on the connection between urbanization and bloody political upheavals see Grinin and Korotayev 2009).

Thus, we can conclude that economic crises are always a system phenomenon, a break of system proportions due to one or several system elements having rushed too far forward (see, *e.g.*, Grinin and Korotayev 2010a; Grinin, Malkov, and Korotayev 2009). These are manifestations of a situation in which social efforts do not suffice to continue economic growth, as at some point the forces of an attacking army may no longer suffice to continue the attack. The reasons for a possible breakdown of a military attack can vary, but in general they are usually engendered by lack of resources and forces, wrong direction of the main blow, underestimation of difficulties, overestimation of own capacities, *etc.* In the same way, economic crises occur due to various reasons, but their general reasons are resource exhaustion, difficulty underestimation, and capacity overestimation within the existing economy. Just as the army has to regroup, activate reserves and change commanders-in-chief, society and economy have to regroup, substantially change their structure, and find new resources and forces, as well as new people.

Thus, economy moves from crisis to crisis, from cycle to cycle, because economic growth does not occur automatically, but requires great efforts and stimu-

lation, which encounter numerous obstacles. In order to continue the move to a higher point, recession appears to be necessary to bring the system to a new equilibrium, along with some rebuilding.

Even the most insightful crisis researchers somewhat misunderstand the fact that each given economic cycle is not a repetition of previous cycles, it is an essentially new phenomenon only partly similar to the previous cycles and largely different from them. For example, Tugan-Baranovsky presents the following interesting comparison:

One may compare the action of this mechanism with a steam engine. The role of the steam is played by the accumulation of the free monetary capitals; when the steam pressure reaches a certain marginal value, the resistance of plunger is overcome, the plunger moves, comes to the end of the cylinder, the steam finds its way out, and the plunger returns to its initial position. In a similar way the free monetary capitals (after they grow to a sufficient size) penetrate into the industry, move it, then those capitals are spent and the system returns to the initial position. Naturally, in such condition crises must repeat periodically. Capitalist industry must constantly go through one and the same development circle (Tugan-Baranovsky 2008 [1913]: 326).

However, plunger movement in a cylinder symbolizes the simplest repetition without qualitative change, while in industrial economy we observe a pronounced expanding (and in no way simple) reproduction. The economic cycle, as we understand it, is altogether not a simple repetition, but essentially only a repetition of some common elements of development combined with structural change, expansion and/or complexity growth. Thus, after each J-cycle territories active in global economic relations expanded, complexity of interactions within the World System increased, its structure altered: the centre expanded or shifted, periphery became semi-periphery, hinterland became periphery, *etc.* (for a systematic analysis of such change from cycle to cycle see Grinin and Korotayev 2010a). The same occurred in separate societies, where reforms, revolutions, alliances, *etc.* accompanied every cycle.

Taking into account the fact that capitalist large-scale machine production could only take place within a sufficiently developed world system, crises must be regarded as processes that take place within the supra-societal framework. Therefore, external factors which influence the functioning of society's economic system should not be regarded as something extraneous to the 'essential' model of crisis (as, *e.g.*, Schumpeter 1982 does). On the contrary, external factors always substantially influence the course of crisis. It can be said that it is even often required for the crisis to go on in vividly expressed 'classical' forms. Besides, in some countries the economy's capacity for dynamic development weakens as time passes, along with capacity to innovate. That is why sometimes the World System center is replaced by one of the leading rival centers. Dynamism leaves

the economy of these countries (as it happened at some point in England, Germany, Japan and seems to be happening now in the USA).

Let us now investigate how the general systemic model of crisis occurrence can be represented on the basis of what has been said (see Fig. 1). Thus, after a depression phase, there finally begins a recovery phase (for the description and sequence of cycle phases see below). Let us suggest that, normally, development during the recovery phase should not proceed further than the highest point of the previous cycle. It is during the upswing phase, after the economy has received additional impulses for development, that growth can exceed the highest development point of the previous cycle. The question is: how far can the economy develop? In principle, the growth should go up to a conditional point that is *optimal for this system*. It is a point which: a) is situated higher than the highest one in the previous cycle, as due to innovations and counter-crisis measures the economy's level has risen; b) its achievement does not threaten the system with collapse.

However, the development does not usually go the optimal way. Quite often, the upswing continues, going beyond the limits of the point of normal economy growth. This occurs because of the production cycle being lengthy in time; substantial time lags exist connected with the time of new capacities' introduction, getting feedback from innovations, *etc.* Time is necessary for negative trends to express themselves; more time is necessary for them to be perceived by market participants, *etc.* As a result, even if the entrepreneurs aspired to such growth optimization (while in reality they aspire to maximizing this growth), the optimal (*i.e.* crisis-less) development point would be very likely to get missed. The more actively the growth goes on, the wider the credit expansion is; the more energetically participants of an upswing trend act, the further this point will be missed.

Thus, crisis and fall appear to be unavoidable, as the development in the upswing phase jumps over *the point of optimal growth*. *This point, meanwhile, should be regarded as a temporary attractor to which economy aspires to return in normal conditions. In the meantime, the further the jump is over the attractor, the more painful is the decrease afterwards. In its turn, according to the pendulum law, downswing movement now not only achieves this attractor, but slips down over it* (see Fig. 1). The system eventually achieves equilibrium only when the depression phase finishes and the recovery phase starts.

Fig. 1 shows that a) optimal points of both upswing and downswing lie approximately on one line; b) the point of the lowest downswing is usually situated higher than the upswing starting point (= the highest point of recovery); this shows that due to such fluctuations we still observe an overall forward movement of economy.

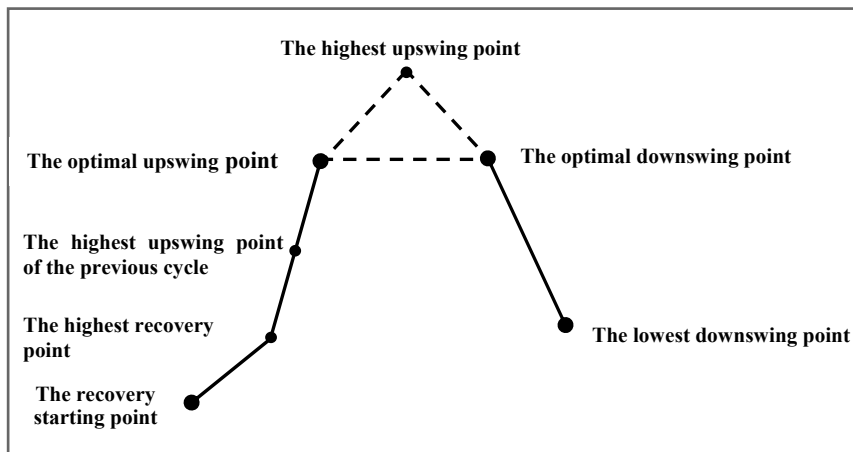


Fig. 1. Scheme of crisis occurrence within economic development cycle

On Some Important Specific Features of Cyclical Economic Crises

It should be evident already that all crises vary but still possess substantial common features. These features of cyclicity will be viewed below in more detail. At the same time, some important characteristics of economic cycles ending in crisis are given insufficient attention (or none at all) by numerous researchers in their theoretical constructions. In our opinion, this does not always give the possibility of understanding the situation adequately. Therefore, we suppose it is reasonable to indicate the following points.

Economic crises and financial sector. Crises occur most often and in a most acute (panic) form in the financial-credit sector (including the stock exchange). This is not accidental. Economy consists of numerous branches and spheres; in each of them things may go differently. However, common upswing and common difficulties (or, at least, difficulties concerning a whole range of branches) invariably display themselves in universal equivalents, such as money, bonds, gold, *etc.*, as well as in general price index. That is why both increasing and falling demands for resources in a major part of the economy are expressed in financial market strain, price increases, or *vice versa* in the decrease of rates, indices and prices, which is evidently expressed in general euphoria in stock exchanges, credit market, *etc.*, or, on the contrary, in panic and escape from financial instruments.

Thus, almost all cyclical crises are connected with disorder (or even fall and collapse) of monetary (gold and exchange currency) circulation, stock prices of shares and other securities (bonds, bills of credit, *etc.*), with various specula-

tions (including those with shares, raw materials, real estate, lands rich in minerals, *etc.*).¹³

Thus, it is exceedingly important to understand that practically no purely economic (in the meaning of purely industrial) crises exist, and possibly cannot exist at all. Economic crises are always connected with crises in the circulation sphere of numerous, and sometimes all, branches of economy: banking and crediting, gold and foreign currency, stock exchange, foreign commerce, wholesale trade and retail, capital movement sphere, securities emission, the sphere of speculation in various values including real estate. In some cases these spheres are leading as regards the main crisis vector; in other cases this role is played by processes going on in light or heavy industry, construction, and transport (where excessive inventories are created, volumes of production and long-term investments, excessive debts on credits, *etc.*). The balance of such ‘responsibility’ for crisis in each particular case (and in each particular country even during one global crisis) may be greatly different. Crises in circulation sphere connected with disorders in the sphere of finance, funds, stock exchange, trade operations can precede industrial (economic) ones, happen simultaneously with them, or occur later. In this case, circulation crises usually have a depressive impact on the economy as a whole. Thus, downswing in different economy sectors and circulation crisis act as interrelated expressions of recession and depression phases in an economic cycle.

However, non-cyclical crises occurring in the spheres of banking, foreign currency exchange, stock exchange, specific branches of trade, speculations, and other institutes which do not concern national economy and economy as a whole to the same extent as cyclical ones do, are rather frequent. Non-cyclical circulation crises have a comparatively narrow or special character. In other words, such crises can be strong and acute, not being a part of cyclical economic crises. Such crises may not influence the cycle course altogether; for example, they may not interrupt the upswing phase.

The very tight connection between circulation and industry becomes even more understandable with regard to the importance of inventory sizes for the industrial development, as well as the importance of the commodity transportation costs, fluctuations of demand for industrial goods, costs of rent and various relevant services, this all being most intricately interwoven with credit, currency, and other spheres. If a disorder or sharp drop occurs in some part of this complex mechanism, it starts working in a completely different way from

¹³ This gives grounds for some analytic researchers to state that all financial crises starting from the 17th-century famous ‘tulip fever’ in Holland developed according to one and the same scheme (see, *e.g.*, Minsky 1983, 1985, 1986, 2005). This conclusion being essentially true (from the psychological aspect as well), it is still a great simplification as each financial (and still more economic) crisis is produced by a combination of factors (see Haberler 1964). What is more, every crisis is produced by its own specific combination of factors, which always makes it different from others.

what is expected by its participants. For example, if speculators hope that prices of raw materials, fuels or other resources will rise, and if (because of that) they start buying up these resources in order to increase their scarcity and, thus, to raise their prices artificially, while prices, contrary to their expectations, stop growing, this can lead first to an excessive supply of those resources (as one has to return funds), the decline of their prices, bankruptcy of some speculators and the respective banks, and further to a general bust (as a result of which many other economic actors will suffer, including industrialists, investors, traders, banks that have supplied them with credits, *etc.*). There are also some other spheres where industrial and financial interests are tightly intertwined, like the establishment of new firms and joint stock companies (that accumulate capital of a large number of financial institutions and private persons), housing construction, real estate operations, *etc.*

External factors. They have been already discussed above, but some things are to be added and summarized. Almost every cycle and cyclical crisis possess, so to say, some external expansion, *i.e.* they are never secluded into the framework of one single country, but always rely on such an important element as external economic relations, while the economies of a whole range of countries cannot develop without outward economic orientation. In other words, we suppose that without an external economic component many crises just cannot occur (even if, first of all, they have internal causes and bases). On the other hand, without this component a pronounced upswing phase often cannot occur as well, because economy has no space for development in the environment limited by national frames. Practically, cycle evolution and crisis always involve external trade. Cyclical dynamics (rise and subsequent fall) are connected to capital import/export, to rivalry for markets with other countries, whereas crises are amplified as a result of disturbances of monetary, trade balances, or as a result of fluctuations of imports of important resources, *etc.* Thus, the British cotton industry (that, at a certain level of analysis, can be regarded, of course, as a purely British internal phenomenon) originated and developed as an industry that worked for the world market as it exported from 2/3 to 4/5 of all the produced textiles (see, *e.g.*, Mendelson 1959, Vol. 1: 143–144; Trachtenberg 1963: 114). That is why the expansion (or contraction) of the external markets was bound to affect the British industry in the most significant way. On the other hand, it depended on the imports of cotton; thus, any disruptions in these supplies led to crisis phenomena. ‘The factory owners of Lancashire got to know about disturbances in their own homes from the news on the disruptions of trade, decline of prices, and bankruptcies in countries that were separated from England by hundreds and thousands of kilometers, by seas and oceans’ (Mendelson 1959, vol. 1: 143–144).

For three quarters of a century the main branch of the British industry was represented by the cotton processing, and up to the mid-19th century the British

crises were first of all crises of the cotton industry. Yet, even when the heavy industries became the main branch of the British economy, its dependence on exports did not decrease, as Britain exported most of its heavy industry products. For example, in 1850 Britain exported almost 45 percent of the pig iron produced in this country (*Ibid.*). Simultaneously with this, one could observe the growth of export of capital from Britain (to a lesser extent from other countries), which, incidentally, affected the proceeding of its own internal cycle (Tugan-Baranovsky 2008 [1913] paid special attention to this aspect of England's economic life).

Limitations on directions of super-profitable capital application. As within an economy during the period of its relatively not fast development large amounts of capitals are stored (and their owners usually get thereupon only modest profits), numerous capital owners would commonly like to substantially increase the profitability of their capitals. This creates a situation which we have named *the scarcity of especially profitable capital investment directions* (such a scarcity is exacerbated by credit expansion [Grinin and Korotayev 2010a]). Given a high demand for a profitable investment, from time to time such directions appear. Such directions can appear, for example, as a result of the development of new industrial or transportation technologies. However, such directions can appear as a result of creation of new *financial, trade, etc. technologies*, and this fact goes almost completely unnoticed. In our opinion, almost every crisis is preceded by important changes in these technologies, their powerful expansion or development of essentially new technologies. This is a point of crucial importance, but for some reason this regularity has been almost completely ignored. In our monograph (*Ibid.*) we try to show which changes in financial technologies appeared in each new J-cycle. This is still more important in view of the fact that contemporary crisis is closely connected with new financial technologies.

It should also be noted that many financial innovations are directly connected to technological ones (on this close connection see Gille 1976); for example, the widespread introduction of telegraph and telephone communications radically changed the work of stock exchanges, dramatically increasing their importance, working speed, volumes of people involved, *etc.* This fact, however, has been given next to no attention (see, *e.g.*, Doronin 2003: 103; Held *et al.* 1999: 192).¹⁴

Social changes connected with the crisis. As follows from what has been said above, for a new cyclical upswing to start after bust and depression, substantial changes in society are necessary, not only in the economy, but also in social, legal, political, and other relations. Sometimes such changes occur

¹⁴ On the other hand, it appears appropriate to mention the important role of the development of technologies of consumption and marketing (see, *e.g.*, Lancaster 1993).

spontaneously (this can be connected with demographic processes, for example, migration to cities, with social processes, such as peasants and craftsmen becoming hired workers *etc.*, with the creation of new industry types and so on). Economic growth always means that some groups grow richer, while some grow poorer (usually relatively, but sometimes absolutely). These poorer groups can include some former representatives of higher (aristocratic) classes, which may generate elite conflicts. However, such changes sooner or later cause adjustments in legal, political, and ideological subsystems. If such adjustments do not take place, revolutions and disturbances can occur. On the other hand, after crises states tend to change legislation in order to prevent new crises (or decrease their magnitude). Such legal changes are not always successful, but effective decisions are usually found only by trial and error. However, in this or that way, without essential (including structural) changes in the society, a new economic cycle can turn out to be weak. This partly accounts for the point that in old industrial societies economic cycles and crises are manifested in a less pronounced way, whereas their magnitude increases in other societies. This could take place particularly in case of movement of centers of the World System's economic processes, as happened with the transition of the world economy's center from Britain to the USA in the first decades of the 20th century.

The crisis definition. As the notion of *economic (cyclical) crisis* has no universally accepted understanding, it appears necessary to mention that within this article we denote as economic (cyclical) crisis *the whole period of recession and a part of the depression period (that can have even more serious consequences than the recession itself)*. Thus, we consider the *cyclical crisis as a substantial part of the economic cycle, within which the potential for growth becomes temporarily exhausted and a compulsory re-establishment of proportions takes place; those proportions are more appropriate for the extant potential of social system. We consider it as a part of cycle, within which socio-structural contradictions and incongruences become unsurpassable for a certain period of time, whereas later they are solved creating a potential for a new cycle.*

Hence, the acute crisis sub-phase can be regarded as a part (albeit the most dramatic) of the overall cyclical crisis period.

It should be taken into consideration that within the real economic process one could observe different trends and cycles with different periods. Within an economic cycle various modifications occur, intermediate crises and recessions develop; in addition, the timings of cycles in different countries may differ significantly, *etc.* That is why it is not always easy to identify boundaries of J-cycles. In particular, the first crises of the 19th century were more evident in Britain (as the most developed industrial country) than in other countries that followed in the fairway of Britain. On the other hand, in the late 19th

and early 20th centuries economic cycles (and especially cyclical crises) became less evident in Britain than in Germany or the USA.

The Verbal Model of the J-Cycle

Our model takes into account a number of approaches to the analysis of such cycles that are specified in the publications by Juglar (1862, 1889); Lescure (1907); Marx (1961 [1893, 1894]); Tugan-Baranovsky (1954, 2008 [1913]); Hilferding (1981 [1910]); Mitchell (1927), Keynes (1936); Varga (1937); Haberler (1964 [1937]); Mendelson (1959–1964); Minsky (1983, 1985, 1986, 2005); Hicks (1946 [1939], 1993: 432–442); Samuelson and Nordhaus (2005: 403–552); Schumpeter (1939); von Hayek (1931, 1933); von Mises (1981 [1912], 2005); Cassel (1925); Pigou (1929); Friedman (2002); Abel and Bernanke (2008), as well as a number of other economists. In the meantime this model also takes into account some of our own generalizations and additions that we believe are important for understanding the internal logic of the cycle, its variability and its peculiarities in the present-time conditions. On the peculiarities of the current cycle see in particular Grinin 2008, 2009b, 2009c, 2009d; Grinin and Korotayev 2010a; Grinin, Malkov, and Korotayev 2009; Khaltourina and Korotayev 2010: 98–122.

Our model of business cycle is based on its subdivision into four phases (according to a point of view that is quite widespread but not universally accepted [see, *e.g.*, Haberler 2008: 220]):

- recovery phase (which we could subdivide into the start sub-phase and the acceleration sub-phase);
- upswing/prosperity/expansion phase (which we subdivide into the growth sub-phase and the boom/overheating sub-phase);
- recession phase (within which we single out the crash/bust/acute crisis sub-phase and the downswing sub-phase);
- depression/stagnation phase (which we could subdivide into the stabilization sub-phase and the breakthrough sub-phase).

It is possible to start the analysis from any phase; we have decided to start it with the recovery one.

The Recovery Phase

This phase starts after (and as a result of) the liquidation of disproportions (and the establishment of new proportions) that almost inevitably take place during preceding phases of recession and stagnation (which often lead to a significant restructuration). That is why a new cycle starts at a new level of equilibrium (Schumpeter 1939). The recovery and certain growth can start because, as a result of the preceding downswing, excessive commodity inventories have been dissolved and have come into correspondence with extant demand, some unsat-

isfied demand for commodities has been formed, problematic firms have disappeared, bad debts and fictive capitals have been 'burnt out', businessmen have become much more cautious (see, *e.g.*, Minsky 1983, 1985, 1986, 2005), *etc.*

As we have already mentioned above, some psychological factors (in particular, businessmen's expectations, panics, sharp transitions from excessive hopes to fears of collapse) play a very important role in the changes of business cycle phases (see, *e.g.*, Mills 1868; Minsky 1983, 1985, 1986, 2005; for an analysis of such theories see Haberler 2008: 125–131; Grinin 2009d). Note that the growth of such expectation (*e.g.*, that the prices will continue to grow or fall) and economic dynamics frequently form positive feedback loops. For example, the growth of prices against the background of the expectations that the prices will continue to grow may lead for some time to continuation of the upward trend notwithstanding any objective factors. On the other hand, the fall of prices against the background of expectations that the prices will continue to fall may lead to the fall of prices far below the level dictated by any objective factors. Psychological factors are exceptionally important in speculations that play an immense role in the business cycle dynamics. In particular, the fall does not occur against the will and senses of a large number of businessmen if they believe that situation is good for growth. That is why panics and temporary crises frequently pass away fast in conditions that are favorable for growth; whereas when disturbing trends have been formed in the real economy, even some apparently ordinary events (like a bankruptcy of a corporation, or a bank) can serve as a trigger for mass panics, bankruptcies, and the start of a general crisis.¹⁵

Hence, the **psychological factor** (factor of expectations, moods of the mass of businessmen and general population) is not only an important factor, it is also **the most dynamic and labile factor** that can serve as a trigger.¹⁶ This appears in the most salient way in stock exchanges, with currency fluctuations, *etc.*

The growth that begins during the recovery phase is determined by the following changes that took place during the preceding phases of recession and depression:

a) formation of large stocks of various unexploited resources (capitals, labor, machinery) and some increase in demand for various commodities and services (see, *e.g.*, Tugan-Baranovsky 2008 [1913]; Mendelson 1959, vol. 1);

¹⁵ The psychological factor is equally important for the understanding of the crises' causes as it is for the understanding of the causes of military victories and defeats, or, which might be more obvious, the causes of revolutions. Whatever objective causes for revolutions could exist, the revolution will not occur until there appears a certain mood in the society to overthrow the government (blame it for everything, disbelieve it in everything). However, on the other hand, the stronger such a mood, the more banal can be the particular pretext for the start of disorders.

¹⁶ That is why much importance is attributed in economic science to such indicators as various 'business expectations indices'.

- b) formation of confidence among businessmen/investors that the situation is improving (*Ibid.*; see also Varga 1974);
- c) liquidation of various obstacles in the course of preceding recession/depression;¹⁷
- d) establishment of new stimuli (through, *e.g.*, tax reductions, decrease of interest rates, *etc.*);
- e) invention/diffusion of new technologies, commodities, and services during the preceding recession/depression phases (see, *e.g.*, Marx 1961 [1893, 1894]; Shumpeter 1982);
- f) re-equipment of enterprises, re-start of exploitation of assets that were not exploited during recession.

Note. The transition from the depression to the recovery phase can take place quite spontaneously, but in this case it may take quite a long time for a recovery to begin. That is why such a transition usually needs a certain impetus that can be manifested in some favorable external or internal conditions, in some special stimulation (major construction works, discovery of new resources, breakthroughs in particular economic sectors, *etc.*). In the years of Great Depression in the USA a theory of 'pump-priming' was rather popular. According to this theory, a pump should be primed with water in order that it could start working automatically; the economy should be also 'primed' in order that it could start growing automatically (for more detail see Lan 1976). This image is rather appropriate for understanding the economic recovery mechanism. A positive impetus produced under objective conditions favouring the start of recovery begins to form positive expectations. This triggers positive feedback loops when the increase in demand stimulates the economic growth, whereas the economic growth stimulates the further increase in demand and the reduction of unemployment that further stimulated the increase in demand, and so on (for more detail see below the description of the upswing phase). In general, various 'starters' are necessary in order that a steady economic expansion could begin (see, *e.g.*, Haberler 2008: 245).

The way the recovery phase proceeds depends on the depth of the restructuring of the economy and society (see below), as well as on various circumstances that play roles of stimuli or obstacles (on stimulating factors see, *e.g.*, Tugan-Baranovsky 2008 [1913]: 92). Sometimes the recovery phase does not grow into a phase of steady growth; instead a new crisis starts. This indicates that the restructuring was insufficient (or that within the given social system capitals and other resources moved to more profitable zones/countries and that this system lacks sufficient resources for the start of a new breakthrough [one could mention here as examples the 1882 crisis in Britain, or the 1937 crisis in

¹⁷ Amazing as it may be, this circumstance is often not taken into consideration.

the USA]). We believe that, for the recovery phase to be able to grow into the phase of steady growth, purely technological innovations are insufficient; they should be accompanied by a significant restructuring of the social system (naturally, including its economic subsystem).

Long-term investments start the recovery phase; they play an especially important role at the upswing phase when they stimulate the demand and create a time lag that amplifies the disproportions of demand and supply.

The Upswing Phase

The conditions and mechanisms of sustained growth

Before the start of our description of the upswing phase, we find it appropriate to specify schematically some mechanisms (positive feedback loops) that usually contribute to the economic growth at this phase; they are also relevant to the start of the economic growth at the preceding recovery phase.

1. It is evident that the growth of demand leads to the growth of supply that, in its turn, leads to the increase in demand.

2. The growth of production leads to the decrease of unemployment, which leads to additional growth of production/supply, this resulting in an additional decrease of unemployment, and so on.

3. The expansion of production leads to the increase in positive expectations, which in its turn results in the growth of long-term investments, whereas this contributes to the production growth, and so on.¹⁸

4. The growth of production leads to the increase in expectations that it will grow more and more, and, hence, that the demand will grow more and more, which results in growth of the credit supply (including credits for consumers); this stimulates the demand and results in the acceleration of economic growth; and so on.

5. The growth in production of consumer commodities leads to an even more conspicuous growth in production of the means of production; this stimulates the growth of production of consumer commodities (including ones produced to satisfy demands of the expanding sector producing the capital goods), and so on.

It appears necessary to mention that during recession all processes go in a very similar way, but with the opposite trend.

For an economic system capable of becoming a significant upswing (let alone its reaching the highest 'overheating' sub-phase¹⁹), a number of conditions should be satisfied.

¹⁸ It is important to take into account the fact that, along with other things, this leads to a lengthening of the upswing period.

¹⁹ The 'overheating' (boom) sub-phase may be conventionally demarcated by the moment when the output exceeds the highest point achieved during the previous business cycle (see Fig. 1).

Firstly, for a certain period of time there should be a certain surplus of resources, *e.g.*, capitals, according to the theories of Tugan-Baranovsky (2008 [1913]) and Marx (1961 [1893, 1894]); technological innovations, according to Schumpeter (1939), labour force, territories rich in mineral resources *etc.*, without which a take-off turns out to be impossible. Later on the movement can be supported by other means (including special stimulation of demand).

Secondly, there should be wide opportunities for an effort application. For example, as a result of preceding changes one could observe the decrease of prices for commodities produced by advanced sectors (*e.g.*, in the 19th century this could be certain textiles, whereas in the late 20th century these were computers²⁰), as wide masses of people start buying them. In other words, the market expands dramatically, and at first it could seem limitless. Limits are perceived empirically, that is why supply expansion frequently goes far beyond the limits of the new market. This simultaneously creates a powerful impulse to the development and leads to the creation of disproportions in resource accumulation. Frequently, hopes for greater market expansion or profitable investments suffice for the capital to flow disproportionately in a particular direction (*e.g.*, investing into some seemingly very perspective shares).²¹ This can also be a simple speculation, but for the phase of upswing it is extremely important that real development stands behind it, at least partly (taking into account the availability of corresponding means of industrial expansion). In that case substantial economic growth will eventually take place.

Thirdly, new people (including innovators) should appear; this is a point emphasized by Schumpeter (1949 [1911]). It seems appropriate to mention that some entrepreneurs either lack the experience of previous crises or have partially forgotten it, so a great number of them gradually lose caution (strongly influencing the others through example and rivalry). This is one of the reasons for excessive expansion at the overheating sub-phase.

Fourthly, an upswing trend should appear with respect to the growth of demand, investments, as well as prices (especially with respect to some particularly 'sensitive' commodities and resources [Hicks 1993: 433]), which creates a powerful driving force and development inertia. Juglar (1889) was one of the first economists to indicate the growth of prices as a cycle characteristic (Juglar 1889); in general, the issues regarding the price increases or decreases were al-

²⁰ Demand expands still more if there occurs a sharp fall in prices for goods the possession of which previously used to substantially increase of the owner's social status.

²¹ An interesting case occurred in the economy of England in 1842 when, after the first opium war was over and Chinese ports had been opened for trade, the society became confident that China would become an unlimited market for English cloths. New textile factories started being built, while the old ones were being modernized. This contributed to the economic growth, but the hopes for the Chinese market capacity turned out to be greatly exaggerated (Tugan-Baranovsky 1954).

ways in the center of analysis of both theoreticians and historians of cycles. For example, Tugan-Baranovsky (1954) maintains that the level of commodity prices serves as the best barometer of the economic situation of a country.²²

Yet, it appears important to note that the increased demand for various resources and commodities (developing at this phase) not only leads to rapid price growth, but also could lead to the situation when economic system turns out to be unable to cover the increased demand for many resources and commodities (for example, some complex equipment, real estate objects, raw materials, *etc.*). This is accounted for (in addition to the fact that many resources are naturally limited, or need a considerable time to be produced [*e.g.*, agricultural products]), firstly, by the point that demand growth can be sometimes explosive, the buyers want to get the commodities as soon as possible, while in order to satisfy the rapidly increasing volume of demand some definite, sometimes lengthy, time period is technologically and organizationally necessary. Secondly, such discrepancy of expectations creates additional boom demand, a certain resource scarcity, which is sometimes increasing, and prices for these resources go up. In this case, speculators step in, aiming at buying off the products in order to resell them. The buyers increase ordered commodity volume in order to create necessary stock for the case of supply failures.

Thus, the situation is created which we call *supply scarcity situation* (for details see further). It plays a very important role in accelerating the processes of rapid price increase. The latter makes production exceedingly profitable, increasing manufacturers' aspirations to expand production and supply (through massive investments as well), which additionally stimulates demand for resources and economic growth. The growth itself causes additional supply scarcity (as supply is invariably late), *etc.* Thus, a positive feedback spiral unwinds fast, creating economy overheating. Even greater boom demand and supply scarcity occur in the sphere of free speculative capital application, which will be described below.

Overheating Sub-Phase

It should be noted that in the course of the recovery phase and the beginning of upswing, temporary relative equilibrium of the depression phase is distorted

²² However, in modern conditions in view of inflation activities of governments and other conditions, a price increase does not always indicate economic health. Situations when output declines were accompanied not by price decrease (deflation), but by price increase (inflation) were observable in the USA in the course of some after-war crises (for more details see Grinin and Korotayev 2010a: ch. 2), but this unusual combination was particularly visible during the 1974–1975 crisis. The situation of output fall combined with price increase was called 'stagflation'. Its strong manifestation was largely accounted for by sharp increase in oil prices, while possibilities for their falling were handicapped by cartel agreements amongst the OPEC countries.

(without which growth is naturally impossible). Equilibrium distortion increases as a result of the fact that entrepreneurs, having run out of free capital (gathered during crisis and depression) for their business and having employed all the free capacities, start investing more and more loan money.

Akaev and Sadovnichy (2009) emphasize that the change of equilibrium level (as in Schumpeter's [1939] theory) defines the long-term trajectory of economic development, in the course of which economic system is in a *dynamic* equilibrium. However, we assume that such a dynamic equilibrium starts being distorted as early as during the upswing phase, especially at transition to the boom (overheating) sub-phase. Thus, obvious structure-price distortion develops, which is usually connected with various 'bubbles' (related to prices, investment, stock exchange, currency, *etc.*). In our opinion, distortion must invariably create some 'bubbles', for example, through excessive speculative prices of raw materials or fuels, real estate, some financial instruments or gold. However, the distortion itself (*i.e.*, structure-price disproportion) can arise only if a certain source of demand growth appears. In most cases, credit expansion serves as such a source for demand growth, as this expansion – this point is often left out of attention – is in itself a form of banking and financial sector growth.²³

An exceedingly important role is also played by different forms of free cash accumulation in various joint-stock companies, financial and pension funds, insurance companies, *etc.* (on modern financial technologies see Grinin 2009b, 2009c; Grinin and Korotayev 2010a, 2010b). All this is greatly spurred by 'founders' fever', speculative boom and other phenomena, due to which economic expansion usually proceeds at the overheating sub-phase. Government efforts to stimulate demand (as well as various random conditions) are frequently added to those. Gigantic financial assets (accumulated in some way and – most importantly – emitted, dubbed in second, third *etc.* degree due to various complex financial technologies, *e.g.*, derivative instruments) are capable of radically changing the proportions of demand and supply, taking into account the more and more expanding credit. Meanwhile, just as in the price increase period technologies and resources that are unprofitable in usual time start being used, in the period of increasing demand for financial resources such resources start being used which in usual time seem dangerous, unreliable, or, using the modern term, 'toxic'.

²³ In modern conditions, when the financial sector of developed countries produces from 25 % to 33 % of GDP (see, *e.g.*, Akaev and Sadovnichy 2009), it must itself perform such an expansion. In the modern world, the GDP growth cannot occur without it altogether. In our opinion, credit and other financial technologies can be viewed as mechanisms for resource mobilization, without which economic expansion practically cannot exist. It should be noted that, in the modern economy, credit itself becomes an increasingly important and especially rapidly growing form of economic expansion.

At the same time, credit, accumulation, and emission of stocks, as well as financial players' direct coming to a certain market cause both sharp distortion of proportions and radical increase in business activity plus substantial increase in the length of the boom's period.²⁴

Note. It should be noted that within the analysis of business cycles, there is a tendency to separate economic growth and decline from speculations and various 'bubbles'; the latter are often considered as a kind of separate and essentially random part of the process (actually, this is typical not only for Marxists). Meanwhile, in our opinion, speculations, 'bubbles', *etc.* are constituent components of cycle that are almost always present within it (the same is true for the collapse of those speculations). This is explained by the fact that, in the period of powerful expansion and overheating, difficulties of economy growth and resource mobilization are rather salient. In order for such growth to continue, strong stimuli are necessary. Such stimuli are created namely in the sphere of circulation, speculations and various pyramids. Speculative boom engenders powerful process of asset re-evaluation. The effect of asset re-evaluation at some point involves great masses of people into the process of chasing after profit (*i.e.*, into the process of expansion). Thus, speculations turn out to be a kind of luring lights of movement, expectation measurers. However, if speculations are not put into strict frames, they may lead the economy far on the way to crisis. Consequently, such a process is an organic part of the expansion (overheating) process, and not only a speculative 'scum' (see also our explanations above). Further on, as we shall see below, it is namely in this sphere that a great number of participants is cut out, which creates initial conditions for acute crisis. From what has been mentioned above it follows that, as in the process of rise and overheating there always occurs strong re-evaluation of funds (expressed in increasing quotes or rising monetary evaluation of symbolic assets), so cyclical crises are organically connected to large-scale collapses of funds, banks, *etc.* (and to some extent must be accompanied by such processes) and generally by monetary crises. In other words, stock market crashes may occur without cyclical crises (*e.g.*, in the form of a simple stock market crash or a foreign currency crisis, which do not lead to economic decline). However, cyclical crises are usually connected with such collapses (stock market crashes, collapsing real estate prices, *etc.*).²⁵ This approach allows, as we assume, to include increases in speculation activities more naturally into

²⁴ This, it should be noted, leads to a sooner introduction of new capacities, investments into which were engendered by the upswing.

²⁵ The fact that the expansion period before the first global crisis in 1825 was accompanied by some definite clear symptoms is very remarkable, as this showed that the speculation had become part of the expansion phase, without which this phase would either occur at all, or proceed in a substantially different way. By 1825 economy overheating was accompanied by 'such typical features as intensive industrial construction, sharp increase in prices and stock prices, wide credit expansion, blooming speculation in all its forms' (Mendelson 1959–1964, vol. 1: 128).

the general scheme of overheating, collapse, and crisis. However, this does imply that it is not necessary to counteract destructive speculations and to put them into certain strict frames – on the contrary, this must be definitely done. *Thus, measures affecting speculation activities can be a very important factor for changing the character of the cycle and for diminishing crisis's intensity.*

In the period of general boom and price increase most economic players feel well. However, it is important to take into account the fact that the upswing is accompanied by formation of some spheres that secure the highest profit levels (their profit norm can be substantially higher than that in other spheres). Namely these spheres are the first responsible for excessive price increase, general assets overestimation, and supply scarcity strengthening. As a result of processes described above, a great amount of capital is created, which tends to be invested first and foremost into the most profitable branches and spheres. If those are industrial or material spheres, the trend to investment in them strengthens. As a result, the situation arises when each new investment project only increases the already sufficiently high struggle for access to labor, materials, financial and other resources. Rivalry among speculative financial resources and capitals is even stronger, as the areas of their super-profitable application are strictly limited, and in the same time they are substantially mobile. That is why world financial resources could get focused here in a rather rapid way. As spheres of especially lucrative application of surplus capitals are rather limited, ‘bubbles’ are blown particularly fast, namely in the financial sphere. Huge streams of capital to some particular lucrative spheres (*e.g.*, stock exchange dealings on raw material contracts, foreign currency speculations, investments in real estate *etc.*) are capable of causing extremely rapid price increase (devoid of any real basis) on these assets limited in volume and nomenclature.

This situation (when one can observe a scarcity of the most lucrative spheres of investment, as well as excessive growth of demand for many resources and commodities caused by the overheating that leads to the increase in prices and a tendency for supply to lag behind demand due to technological, labor, transportation and similar limitations) was conventionally denoted by us as a situation of **supply scarcity**. Yet, this is a *business activity restricting* scarcity. It should not be confused with a direct deficit of mass consumption commodities as observed in ‘socialist’ countries.²⁶ That is, the notion of scarcity is applied here in a rather special sense. The thing is that, while in private life

²⁶ Even though in the case of overheating there can sometimes arise direct scarcity of some prestigious goods, such as some car brands, household appliances, housing, hotel accommodation, tickets for some types of transport, particular kinds of services, *etc.* In this case the buyers are ready to pay an increasingly high price for the required goods and frequently have to wait a long time for their orders to be fulfilled, tolerating other discomforts as well.

the problem of lack of some goods can be solved through large overpayments, in commercial affairs this is usually irrational, as in such a case the buyer will not be able to return the funds he spent.

That is why the supply scarcity has the following manifestations.

Firstly, many businessmen simply abstain from their plans on expanding the manufacture, purchasing something, making investments *etc.*, as they either cannot afford it or the increased price makes their projects unprofitable. We will return to this point later.

Secondly, as in business and speculations, actors always struggle between the aspiration to purchase something for the minimum possible price and the time factor, they often prefer waiting, standing in a line, to being overcharged. Besides, in business, especially in large corporations, there exists their own internal order, some definite business ethics and inertia which it is not always possible to avoid even with the increased price. As a result, the manufacturers cannot manage the number of orders and form a waiting line or simply refuse some orders because of being overloaded. In this case, buyers frequently have to turn to manufacturers of goods with lower quality, to place their orders in other markets, to be overcharged with transportation costs, *etc.* Thus, supply scarcity is evidently manifested not only in price growth, but also in physical delay (and sometimes impossibility) of purchasing required resources, goods and assets, *etc.*

Thirdly, an increased (or unsatisfied for a long time) demand for resources (scarcity) is also connected with the fact that production of different economic sectors possesses a greatly varying degree of elasticity, which creates a different degree of its scarcity and, accordingly, a different level of its market supply and a different level of prices (simultaneously, these all substantially exacerbate disproportions in economy which are usually only eliminated as a result of crisis). While some goods still can be produced with a certain time delay, numerous valuable resources (land, buildings, some types of raw materials, certain financial assets, *etc.*) are greatly limited or inflexible altogether.

In all cases supply scarcity (in conditions of boom in economy when we observe full employment of all the production factors) leads to economic growth slowing down and simultaneously to the growth of prices, which creates a positive feedback loop that acts till the moment of acute crisis.

Crisis researchers wrote a lot about the scarcity of certain most remarkable types of resources, such as money, gold, credit, capitals, different types of raw materials. For example, Émile Louis Victor de Laveleye explained crises by increased gold exportation during a sharp increase in demand for imported goods (see Tugan-Baranovsky 2008 [1913]). Tugan-Baranovsky himself (*Ibid.*: 322–324) saw one of the most important crisis mechanisms in the fact that at first capital is available in surplus, then it is spent faster than it is created, which eventually leads to its lack and, as a result, to crisis and downswing. Represent-

atives of the over-accumulation theory and some other schools frequently wrote about increasing scarcity of production factors occurring in conditions of full employment (see, *e.g.*, Haberler 1964).

However, in our opinion, this situation of increased demand for resources should be regarded in a wider aspect than simply a scarcity of capital, raw materials, gold, labour force, or even production factors in general. It can be represented as a trend to growth of **scarcity of necessary resources supply and profitable investment spheres**, as scarcity can be sensed in greatly varying fields. In this context the gap between supply and demand becomes more and more substantial as it includes new market sectors (this is indicated by the growth of prices of more and more types of resources). However, naturally, in some sectors and resources the scarcity is revealed more vividly, usually either in the most rapid-growing sector or the most profitable object of capital application. Such a situation leads to excessive, sometimes tremendous over-estimation of respective assets (*e.g.*, oil or real estate). It is not surprising that it is namely in this place that the collapse occurs when positive upswing-stimulating feedback turns into positive downswing-stimulating feedback (which leads to downfall, as will be shown later).

As a result of rapid demand growth for certain resources, positive feedback arises for some time, which can be schematically outlined as follows. At this phase, an increase in scarcity of certain resources leads to growing scarcity of final products (and corresponding growth of their prices). Aspiration to increase their production, caused by this scarcity (and increased demand for final products) creates a still greater scarcity of resources, *etc.* which leads to expanding growth of prices and demand (for some groups of goods/resources this growth can become general or explosive) and allows to be successful in this period even for those whose business looks to be lagging behind in technical terms (see, *e.g.*, Tugan-Baranovsky 2008 [1913]; Schumpeter 1982).²⁷

The growing demand is partly satisfied as a result of the fact that some capacities that have been invested into earlier begin to produce output (or there appears new capital, accumulation of which was arranged before). However, due to continuing rapid growth of demand and prices, the trend to investment expansion strengthens. As a result, this trumps the recoil effect from previous investments and creates an excessive base for overproduction, but this tends to be only much later. As Kwasnicki (2008: 3) notes, in economic systems involved into Juglar or some other business cycles, future development depends on the state of the system in the more or less distant past, as more or less lengthy time lags occur between different processes (see also Keynes 1936: ch. 22). With respect to the creation of such lags (in addition to natural time

²⁷ It should be noted that such a situation is observed in financial speculations as well. Thus, a financial pyramid can grow for a certain time namely due to a positive feedback: the faster the pyramid grows, the faster people wishing to obtain profit are attracted to it.

expenditures that are necessary for realization of technical, technological, and innovative processes) intermediary structures (and especially credit markets) also play an essential role.²⁸ Thus, it is important to take into account the fact that credit and other intermediary institutes (wholesale traders and speculators buying up and accumulating by themselves commodities, currency, and shares for further resale) play the role of such an element that a) delays the immediate reaction; b) contributes to the continuation of the marketing expansion when it has already gone beyond reasonable limits. Accordingly, this leads to the collapse scale getting exceedingly greater than it could be at greater equilibrium.

Note. In our opinion, in the model of business cycle it is very important to account for the fact that this cycle always proceeds through fluctuations of **supply scarcity** at the upswing phase (when supply in general lags behind the demand, thus restraining the economic growth), and **demand scarcity** at the recession and depression phases, when supply in general substantially exceeds demand, which serves as an obstacle for economic growth (or increases the scale of recession). As a result, business activity cycle also proceeds in the framework of fluctuations between a whole range of oppositions (which largely define the main cycle parameters): inflation – deflation; growth – fall; positive – negative expectations, *etc.* Particular forms of specific supply scarcity or demand scarcity define to a great extent the form and character of crises at the given time in the given place. Rising prices of raw materials (*e.g.*, cotton) more than once led to crises in England in the 19th century (see Tugan-Baranovsky 2008 [1913]; Mendelson 1959, vol. 1; Grinin and Korotayev 2010a).

Recession Phase

Acute crisis sub-phase

As a result of overheating, as has been shown above, there occurs an excessive overestimation of certain key resources (which leads to their more or less strong scarcity). At first this continues to speed up the overheating further on (especially if there are opportunities for expanding the credit and speculations). However, eventually resource/asset overestimation cut off an increasing number of participants, taking the increasing amount of assets out of the game. At the end, the pyramid collapses – interesting examples of such situations can be found in the histories of crises, for example, by Tugan-Baranovsky (2008 [1913]), Mendelson (1959–1964), Varga (1937), and Trachtenberg (1963).

For example, during the current financial-economic crisis excessive increase in prices of real estate in the USA and excessive expansion of mortgage

²⁸ On the role of credit in creating the situation of flurry and speculation, postponing the coming of the crisis, *etc.* see, for example, Juglar 1889; Lescure (1908); Marx (1961 [1893, 1894]); Tugan-Baranovsky (2008 [1913]); Mises 1981 [1912]; Hayek 1931, 1933; Mendelson (1959–1964); Rothbard 1969; Minsky 1983, 1985, 1986, 2005; Haberler 1964.

lending led to crisis phenomena in banking and credit-financial spheres, and to bankruptcy of numerous large financial corporations. Before this bankruptcy, free capital from the mortgage sphere started being actively invested into oil price increasing. As a result, when bankruptcy and panics started, not only did oil prices collapse, but also a number of other assets, as there were no resources in the economy to support their excessively overestimated levels. Thus, the main economists' question remains the same: how can it be defined at which point irrational optimism overstates asset cost to such an extent that the risk of sudden and lengthy falls increases sharply (Greenspan 2009: 441)?

Consider the mechanism of the transformation of the 'overheating' sub-phase into the sub-phase of crash or acute crisis in more details:²⁹

1. At the peak of the overheating sub-phase there arises a situation of economy and financial markets overstraining, which is expressed in the absence of free reserves of resources and capitals, as well as in overburdening by term liabilities that can be fulfilled only provided that the plans are realized under which credits had been taken and resources had been accumulated.

2. Occurrence of the situation of decreasing efficiency of investing new resources and credits into economy and speculations (approaching the verge where ultimate usefulness/output becomes zero or even negative).

3. Decreasing marginal returns (quite in accordance to Ricardo's law of diminishing returns).

As a result the positive feedback loop – *the increase in the strain*³⁰ *leads to the growth of prices and scarcity, whereas the latter leads to the increase in the strain* – brings the situation to its limit.

Let us return once more to the question that the stronger is the scarcity of certain resources and investment spheres, the more fierce is the rivalry for them, and the more difficult it is for the economy to grow, as (due to the indicated rivalry, growth of prices of production factors, *etc.*) many producers are already incapable of getting the necessary resources and are thus obliged to slow down or stop the growth of their output. With regard to this, Haberler maintains that as the transition to full employment takes place gradually (and not immediately everywhere) the simultaneous development in all the points becomes more and more difficult as more and more categories of production factors become more and more scarce. If one branch of industry increases its demand for production factors and succeeds in attracting workers by offering them higher salaries, it distracts them by this from the other branches.

²⁹ We regard the crash sub-phase as a relatively short period including several weeks or months, during which trends sharply break from growth to fall, often characterized by collapses, downfalls, panic, *etc.* The not always distinctly localized point of coming awareness of not a temporary failure but a deep crisis, when crisis is being accustomed to, can be considered as the beginning of the downswing sub-phase.

³⁰ Here we understand the 'ultimate economic strain' as the ultimate involvement of all economic capacities, resources, and opportunities.

The same is true with respect to raw materials and half-finished products. Thus, according to Haberler, in such a situation the expansion of one branch of industry turns out to be possible only at the expense of the contraction of some other industry (Haberler 2008: 235).

It should be added that this has an even greater influence on speculative business branches, where factors of profitable capital application are always limited and scarce.

All this causes: a) impossibility/senselessness of participation in this race for an increasing number of participants in economic and financial activity; b) growing anxiety of an increasing number of participants of economic activity; c) tendency to risk minimization by accumulating additional insurance assets, which causes additional demand for them and an increase in their expensiveness/scarcity.

New positive feedback loops appear. The growth of economic tensions, deficits and prices leads to the increase in the number of those who change their behavioral strategies making them more cautious. This, in its turn, leads to financial resources starting to be secluded from the race, which increases the strain for those continuing, so to say, 'speculate for the rise', in hope of further expansion acceleration, price increase, still greater asset revaluation, *etc.*

One more positive feedback loop develops: increasing number of those changing their behavior strategy leads to the strengthening trend of 'dealing for a fall' both in direct meaning (*e.g.*, at stock exchange) and with respect to those who stop production expansion, *etc.*³¹ The growth of such moods increases the general direction for slowing down the upward trend, which leads to an even greater increase in the number of those changing the behavior strategy.

Growth of the downward trend and the increasing number of participants in the downward direction lead to increasing difficulties for the upward trend. As a result, the participants of financial and economic activity of the upward trend become incapable of gathering enough resources for continuing their expansion. For example, the growth of stock exchange prices on certain assets (such as oil) cannot continue any more, as there are not enough buyers for the increased price. Demand simulation is impossible due to financial resources absence. The same occurs when the growth limit is achieved for prices on real estate or certain investment goods, with consumer credit expansion, goods and services supply increase, export build-up, *etc.*³²

³¹ It should be noted that both trends are constantly represented in the economy, but in the overheating period the downward trend is obviously in the minority.

³² Economic crises frequently start with stock exchange or financial crises, as in the stock exchange, in the financial sector, *etc.* one can observe special conditions for a rapid occurrence of an acute crisis. In particular: a) these institutes are characterized by a high degree of resource concentration; their resources are more mobile than material resources and at the same time possess value for the whole economy; b) overheating scale and the degree of scarcity of highly profitable ap-

However, in the situation when the tension has reached its limit, the equilibrium cannot be achieved. Rollback starts due to upward trend participants being exceedingly tied up with various obligations (most commonly voluminous, urgent and costly ones, which could be fulfilled only with realization of their speculative plans).

One can observe the formation of the positive feedback loop acting in the opposite direction: impossibility of plans' realization leads to the impossibility of obligation fulfillment. This leads to bankruptcy for numerous participants in financial and economic activities, which sharply increases the impossibility of obligation fulfillment. In turn, this leads to impossibility of keeping the existing prices. This leads to additional failures of still more business plans, which leads to the impossibility of obligation fulfillment. Prices go on falling and the devaluation of assets continues.

As general overstrain in economic and financial sphere has achieved an extreme degree, all resources have been involved, there simultaneously occurs a new positive feedback, with opposite (to credit expansion) sign: price decreases cause the decline in opportunity for obtaining the necessary resources, first and foremost credit (demanding its return, its price going up, and money scarcity exacerbating sharply), which were obtained only against the hope for further price growth – this leads to the necessity to sell urgently those very assets that were previously invested in – this leads to further price decreases, *etc.*³³

Marxists and some other economists, starting with Sismondi (see, *e.g.*, Marx 1961 [1893, 1894]; Varga 1937, 1974), consider the commodity overproduction to be the main mechanism of the crisis development. Over-production plays a truly important role, but further on, at the economic downswing sub-phase, causing a remarkable reduction of output.³⁴ However, the commodity overproduction is usually unable to produce an economic bust (acute crisis).³⁵

plication spheres in these sectors are higher; c) there are more opportunities for speculation here, and asset turnover is higher; d) players' behavior changes are expressed in a more pronounced way; e) upward and downward trends are displayed more distinctly.

³³ All this reminds of a situation with an attacking army that has come far off its rears, exhausted its resources and is attacking only by inertia. As soon as the enemy starts counterattacking, the previously attacking army starts a swift rollback. Along with that, expensive military equipment and weapons, recently essential and difficult-to-obtain, are left behind, being an obstacle hindering the rollback.

³⁴ Some researchers (*e.g.*, Spiethoff) pointed to the fact that quite frequently the branches producing consumer goods experience the impact of depression much later than branches producing capital goods. Some economists express doubts on this point, but it is obvious that crises start most frequently in branches that are far from production and marketing of the mass consumption commodities.

³⁵ For example, in Cassel's opinion, disputable as it may be, typical modern trade-industrial boom implies neither overproduction, nor exaggerated estimate of consumer demand, but means the re-valuation of the capitalists' capacity to provide capital in sufficient amounts (Cassel 1932, II: 649).

That is why one may agree with Bauer who pointed out that Marx described the change of economic phases (upswings and downswing, prosperity and stagnation) rather than a dramatic moment of crisis (Kautsky and Bauer 1923: 83). Overproduction of goods can be to some extent regarded as a part of the process of **supply scarcity** turning into **demand scarcity** (it should be taken into account that not only commodities become 'excessive', but also capital and many other things).

Thus, the acute crisis itself is not created by the commodity overproduction. Its mechanism, as has been shown above, is created by increasing difficulties with the resource accumulation for supporting the growth expansion and the resultant impossibility for a substantial part of the market participants to overcome at some point the acute scarcity of financial and other resources.³⁶ This is particularly connected with a sharp credit contraction, panic sales of shares at stock markets, *etc.* Meanwhile, the sharper the reaction, the steeper the collapse. Endogenous events within the credit market may amplify and diffuse macro-economic shocks (Bernanke *et al.* 1998).

This, in its turn, sharply magnifies disproportions (which are already significant due to overheating) which leads to collapse (on the role of disproportions in creating crisis see Tugan-Baranovsky 1954, 2008 [1913]; Hilferding 1981 [1910]; some important disproportions are pointed out by Marx (1961 [1894])). This creates strong structural distortion, which brings the system down.

Then the events may develop in the direction that is opposite to the one that we observe with the economic growth. Demand/price decrease causes the fall in the opportunity for obligation fulfillment and decreases expectations. This, in its turn, leads to investment decline and further decrease of demand (prices, business activities) until the situation comes to some equilibrium.³⁷

As has already been mentioned, reaction to rapidly changing and negative events cannot be fully adequate; on the contrary, it is commonly irrational, inadequate, and panic. With other, more rational reactions, the sharp downfall even might not occur. However, the change of behaviors and expectations occurs very fast, which greatly exacerbates the situation. As Alan Greenspan notes, the innate human inclination to shift from euphoria to panic and *vice versa* seems to be eternal; the experience of numerous generations has turned

³⁶ For example, getting the necessary credit for supporting the stock price, say, in connection with a number of speculators abruptly coming out of the process, with shares being sold in order to fix the profit.

³⁷ Let us note that the acute crisis sub-phase does not appear to be utterly inevitable. Firstly, collapse acuteness is directly connected with the degree of economy overheating. If the measures on overheating reduction are taken in time, the collapse itself can be avoided (though some fall may take place). Secondly, if in the period of credit contraction (characterized by the greatest scarcity of financial resources, major players' bankruptcies, *etc.*) an adequate aid is given in time, there is a hope left that acute crisis and collapse may be avoided.

out to be unable to eradicate it (Greenspan 2009: 442). Such mass movements are somewhat akin to crowd movements. Namely they create the sharp slant which, figuratively speaking, finally overturns the overloaded boat of economy. Such phenomena of sharply inadequate reactions to a changed situation in the economy are denoted by us as the **'board effect'** (see Grinin, Malkov, and Korotayev 2010). If all ship passengers rush to one side (*e.g.*, being afraid of missing something interesting), the ship may overturn, though before that it used to be relatively stable.

Economic downswing sub-phase

Further on, the recession phase moves from the acute crisis sub-phase to the downswing one that involves an increasing number of branches. We would suggest it reasonable to add here that if the economy is to be regarded as a single system or a single organism, it is not surprising that if one particular vitally important sub-system or vitally important organ (here it is, say, banks or stock exchange) is distorted, then the vital activity of the whole economy is disturbed, which sometimes leads to general collapse.³⁸

As has been noted above, at the recession phase much the same positive feedback mechanisms are acting as in the upswing/expansion phase, but in the opposite direction: 1) obviously, at this phase demand decline leads to production decrease, while this latter in its turn brings about a further decline of demand; 2) production decrease causes unemployment growth, while this leads to additional demand decrease, which causes production decrease that brings about unemployment growth, *etc.*; 3) production decrease contributes to crisis expectations growth which in turn leads to a long-term decline in investments, which contributes to production decrease; 4) production decrease creates uncertainty leading to credit supply reduction, which reduces the demand and leads to further economic decline. The downswing leads to further reduction in credit supply, which leads to a general decline in demand and further on to a decrease in output; 5) decrease of production of consumption commodities leads to an even greater decline of production of capital goods, which stipulates still further decline of consumption commodity production (among other reasons due to reducing demand for consumption commodities on the part of workers of the reduced sector of production of the means of production/capital goods).

And, finally, an exceedingly important feature (that is also opposite to the upswing phase) is that though production volume falls, still for a long time due to accumulated reserves and stocks, as well as to still introduced new production capacities, supply still greatly exceeds the demand. As a result, not only do the prices stop growing, but they often start falling. Inflation frequently turns into deflation.

³⁸ As an analogue for explaining the reasons for acute crisis phase occurring due to reasons utterly insignificant at first sight, the situation on a road with heavy traffic can be regarded, where one accident (still more so – several ones) momentarily paralyzes all traffic.

Strong correction is needed in order to return to some equilibrium, as in the previous phase the equilibrium was greatly disturbed. The excess of resources should be eliminated in some way. That is why one often talks about paying for former prosperity and irrational behavior that accompanied it (see, *e.g.*, Mises 1981 [1912]; Rothbard 1969; Mendelson 1959).

Increasing proportion of risky credit in market economy is the central part of the theory of Minsky, a well-known American economist (Minsky 1983, 1985, 1986, 2005). The ‘punishment’ for unrestrained economy stimulation via credit is mentioned by Mises (1981 [1912]) and other economists of different schools. In Rothbard's (1969) opinion, it was as early as the late 18th century, namely in the activity of commercial banks, which first extended credits in an unrestrained manner and then reduced them dramatically, that David Hume and David Ricardo found the key to the mystery of recurring cycles consisting of expansion and contraction, of booms and collapses, which have puzzled the researchers since the mid-18th century.

Depression Phase

As Rothbard (1969) notes, this phase stems almost inevitably from the preceding expansionist boom. According to him, this is the preceding inflation that makes the depression phase inevitable. Thus, the depression is the process through which the market economy gets adapted, it gets rid of extremes and distortions of the previous inflationary boom and restores a stable economic state. Within this perspective, depression turns out to be an unpleasant but necessary reaction to distortions and extremes of the preceding boom (Rothbard 1969).

It is that very phase when economic factors which were extremely important during previous phases (such as capital or credit) do not find full application. In the depression phase, for instance, one can observe accumulation of free assets, for which it is often difficult to find borrowers, and that is why interest rates fall sharply (see, *e.g.*, Tugan-Baranovsky 2008 [1913]). However, at the same time, it is the phase when an active economic reconstruction is taking place. According to Keynes, before the recovery starts, a certain period of time (that is necessary for the restoration of capital efficiency) should usually pass (Keynes 1936: ch. 22). However, in our opinion, for such a recovery not only the time itself is necessary, what is really necessary are the efforts of entrepreneurs and the restoration of equilibrium; it is also very important that certain obstacles and prohibitions are removed and new stimuli for growth appear. The deeper it is, the more remarkable the reserve for growth can turn out to be. In our opinion, the greater the reserve for the development, the longer is the rise and shorter the fall. This also accounts for the fact observed by Lescure, namely that the rises in the USA in the 19th century were longer than in Europe, and industrial downswings came usually 2–3 years later (Lescure 1908: 241). Indeed,

at that time the USA possessed tremendous reserves for development both within the country and due to inflow of immigrants and capitals.

Explanation. In our opinion for a new J-cycle to be characterized by a significant rise it is necessary for limitations to be at least partially removed. Then the development field expands. As it has already been noted, a new cycle starts at a new equilibrium level (Schumpeter 1939), after passing by the 'depression dead point', in Spiethoff's expression (see Haberler 2008: 73). Establishment of this new equilibrium level implies that a part of the problems that led to crisis and downswing has been solved, and opportunities for development have been expanded. However, let us note that such a removal of obstacles or limitations to the development is never achieved by purely technological or technical measures as is implied by the logic of Schumpeter's ideas (Schumpeter 1982).³⁹ Even if the changes are centred on purely technical improvements, they always lead to substantial social changes. Thus, after the 1825 crisis mechanic looms started being actively introduced in England, which led to the decrease of textiles' prices and their production increasing more than 50 % by the next crisis of 1836 (see Mendelson 1959, vol. 1). At that time, there were one million manual weavers in England who generally got sufficient payments. By the next crisis (1836) their numbers were greatly reduced, while by the 1847 crisis there was only a meager number left (besides, the number of weavers also diminished in India). That is why the period of active economic growth (in combination with periodic crises) is commonly accompanied by significant sociopolitical and legal reorganizations. This explains why typical crises should be regarded not just as economic fluctuations, but as crises of structure which no longer corresponds to the grown economy.

Basic Mathematical Model of J-Cycle

In our opinion, a mathematical model of the Juglar cycle must take into account the following effects immanent to market economy:

- presence of positive feedbacks between economic processes;
- presence of certain inertia, time lags between certain changes and the reaction of the economic system to those changes (*e.g.*, changes in investments lag behind changes in demand, changes in output lag behind changes in investments, *etc.*);
- amplification by financial system of positive feedbacks and time lags in economy (due to the impact of credits, speculative operations, *etc.* on economic processes);
- excessive (and too rapid) reaction to changed conditions at the acute crisis sub-phase.

³⁹ Sometimes it can be removed by foreign market expansion, *etc.*

The model is developed in the following way.

The model describes dynamics of output (Y , GDP) of an economic system. Output (Y) is defined by production function that describes dynamics of the amount of produced commodities and services depending on inputs of labor (L) and capital (K). As is quite usual in macroeconomic research, we employ here the Cobb – Douglas production function:

$$Y = A \cdot K^\alpha \cdot L^\beta, \quad (1)$$

where the multiplier A accounts for the impact of technical progress, while α and β are coefficients. Produced output is spent on consumption (C) and investments (I):

$$Y = C + I. \quad (2)$$

Investments are used: a) to compensate for the fixed capital depreciation; b) to increase the amounts of fixed capital (and, hence, to augment the output):

$$dK/dt = I - g_1 \cdot K, \quad (3)$$

where g_1 is the coefficient of fixed capital depreciation.

The positive feedback between investments and the change of demand (and the change of prices, as prices directly depend on demand; high unsatisfied demand leads to price growth, as we have seen) is described mathematically as follows:

$$I \sim b \cdot dC/dt, \quad (4)$$

i.e. level of investments is proportional to demand change (and the change of prices). Coefficient b reflects the impact of financial system: the stronger speculative fever, the more available the credits are, the higher b coefficient is. The lag of change of investment volume I with respect to the change of demand C can be accounted for with the help of the following equation:

$$dI/dt = -a \cdot (I - b \cdot dC/dt - g_2 \cdot K), \quad (5)$$

where the coefficient a reflects the speed of investors' reaction to the change of demand (reaction speed grows with the increase in value of this coefficient), $g_2 \cdot K$ member characterizes the inclination to investment. Lag of change of output Y with respect to change of capital K can be described with the following equation:

$$dY/dt = -r \cdot (Y - A \cdot K^\alpha \cdot L^\beta), \quad (6)$$

where the coefficient r characterizes the velocity of new fixed capital being put into exploitation.

Equations (2), (3), (5), (6) constitute an equation system of economic macrodynamics. With approximation $g_1 \rightarrow 0$, $g_2 \rightarrow 0$, $\alpha \rightarrow 1$, these equations can be transformed into one linear second-order differential equation:

$$(1+ab) \cdot d^2I/dt^2 + (a+r+rab) \cdot dI/dt + ar(1-bAL^\beta) \cdot I = 0, \quad (7)$$

whence it follows that an economic system tends to equilibrium in the course of its evolution, whereas if this system is brought out of equilibrium, then one

will observe within it damped oscillations. Oscillation frequency is equal to $(ar(1 - bAL^\beta)/(1+ab))^{1/2}$; it decreases with an increase in the value of the coefficient b and increases with an increase in values of the coefficients a and r . In this case the damping coefficient is equal to $(a+r+rab)/(1+ab)$, it increases with an increase in values of the coefficients a and r . This means that credit availability increases the period of oscillations and postpones the start of the crisis. Time lags decrease (high values of a and r), on the contrary, contribute to faster reaction of economic system to destabilizing impacts and its faster return to the state of equilibrium (it should be noted that these peculiarities are observed with various values of the parameters g_1 , g_2 and α).

In this light, the most natural phase for the economy is the *depression phase*, i.e. the state of equilibrium and zero economic growth. However, this state does not satisfy the economic agents, as with zero economic growth the profit level is low, and the accumulated capitals do not find an effective application. *A priori* entrepreneurs do not know where to invest their money (investments are both costly and risky, as a resultant output may not find demand, and instead of profit, there will be losses), so they await signals from the market. As soon as these signals appear, recovery starts. The main signal is the increased demand for some certain types of output (e.g., infrastructure, real estate objects, or goods possessing new qualities as a result of application of new technologies). This demand is initially supplied by means accumulated within economy ('autonomous demand' C_a) (*recovery phase*), then it starts being replenished by credits. Autonomous demand strengthened by credit system stimulates investments into those branches of economy that have become profitable and leads to general economic growth (*upswing phase*). Accordingly, equation (5) for investment dynamics with regard to autonomous demand impact acquires the following form:

$$dI/dt = -a \cdot (I - b \cdot (dC/dt + dC_a/dt) - g_2 \cdot K). \quad (8)$$

As investment process and creation of new production units lag behind changes of autonomous demand (Equations 6 and 8), after a certain period of time a situation arises when the demand has been saturated and starts declining, while production capacities continue expanding, this resulting from, among other things, the actions of speculators who additionally exacerbate the existing conditions (*overheating sub-phase*). An acute crisis arises as a result of business expectations of increase being inconsistent with real market trends, which are now tending to decrease, prices of assets and the most important resources fall, credit supply dramatically declines, bankruptcies occur, debts are not paid, declines in output begin, etc. (*recession phase*). After that, the economy enters the *depression phase* and does not grow in volume until a new demand 'shock'. However, this state is different from the one before the beginning of the crisis, as the economy has obtained a new qualitative form: new branches have appeared, new technologies have been introduced, and new needs have formed.

This has some analogies with biological macroevolution: appearance of ecological niches leads to the emergence of new biological species, eventually increasing biodiversity (see, *e.g.*, Markov and Korotayev 2007; Grinin, Markov, and Korotayev 2009).

Figs 1, 2 and 3 present the results of numerical investigations with the use of basic model (2), (3), (6), (8) for several cases.

Fig. 2 shows the reaction of economic system to demand ‘surge’ (Fig. 2a). It obviously causes a surge of investment activity which is later changed by a sharp recession (crisis) and, later, by a depression (Fig. 2b). As a result of all these factors, we observe a temporary increase in GDP with its subsequent decrease (Fig. 2c).

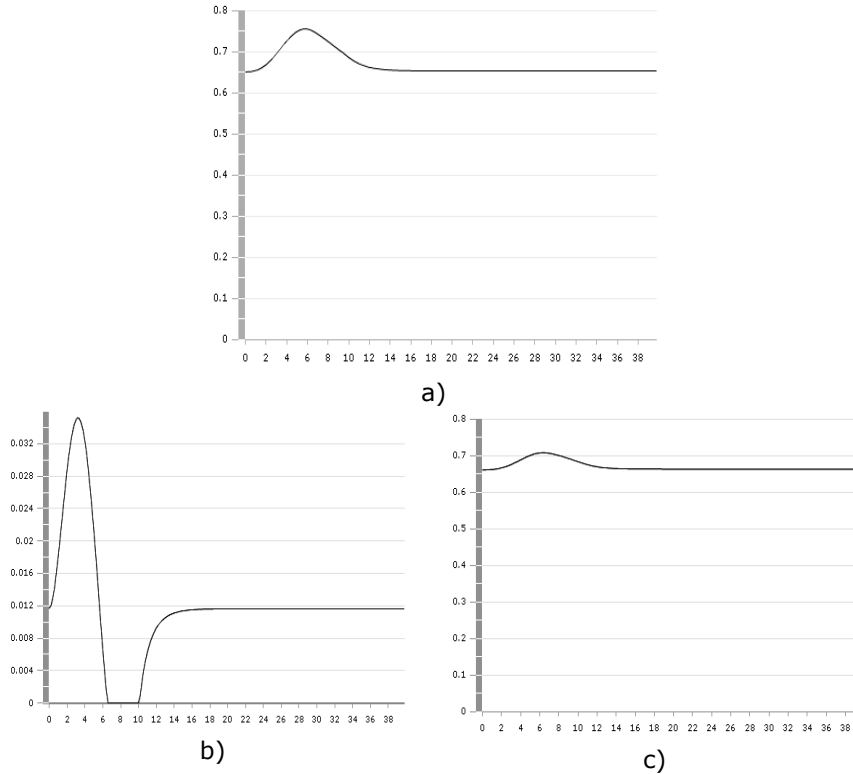


Fig. 2. Reaction of economic system to demand ‘surge’: a) demand change (relative units); b) investment dynamics as a reaction to demand change (relative units); c) GDP dynamics (relative units) (X-axis is an axis of time, years)

Fig. 3 reflects the economic system's reaction to periodically occurring demand activation (Fig. 3a) with a substantial value of positive feedback caused by the impact of financial system. This obviously leads to dramatic changes in investment activity (Fig. 3b) and cyclical dynamics of GDP (Fig. 3c).

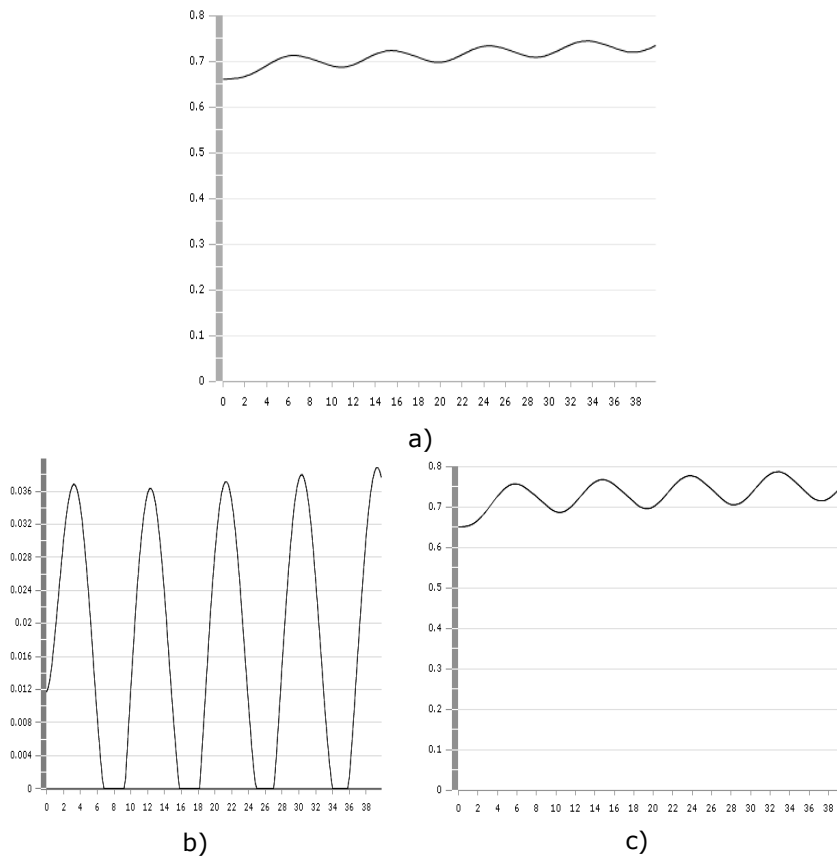


Fig. 3. Reaction of economic system to periodically occurring demand activation with a high value of b coefficient: a) demand change (relative units); b) investment dynamics as a reaction to demand change (relative units); c) GDP dynamics (relative units) (X-axis is an axis of time, years)

Fig. 4 shows the reaction of economic system to periodically occurring demand activation with the same values of parameters as in Fig. 2, but with a low positive feedback value, which is stipulated by the financial system im-

pact. It is evident that the resultant fluctuations possess substantially smaller amplitude, and economic dynamics look smoother.

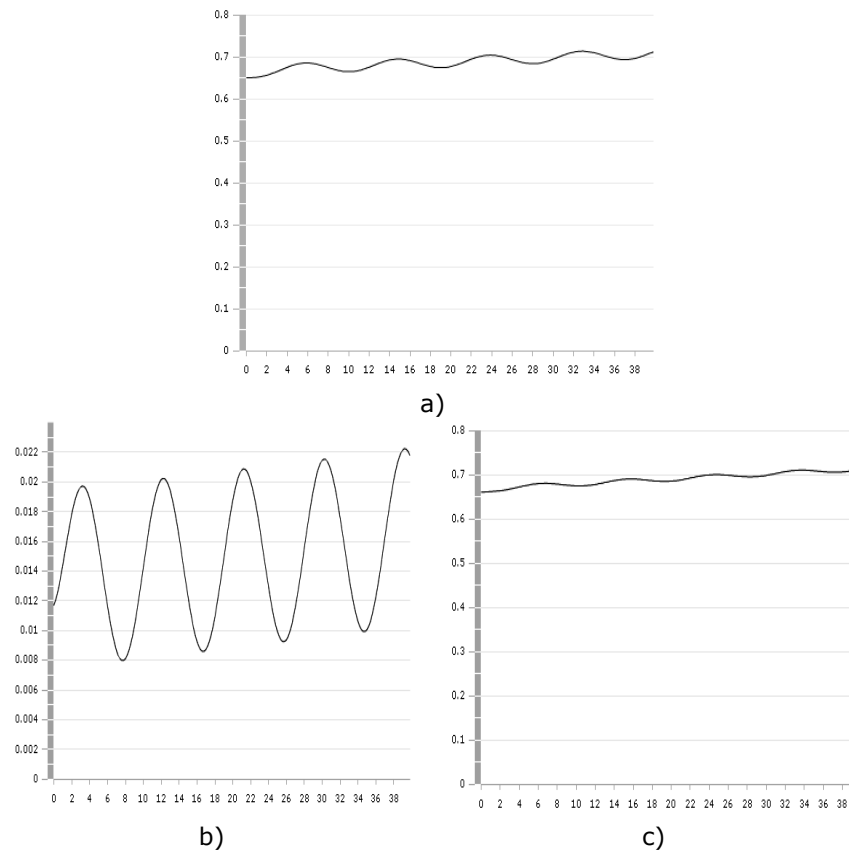


Fig. 4. Reaction of economic system to periodically occurring demand activation at low value of b coefficient: a) demand change (relative units); b) investment dynamics as a reaction to demand change (relative units); c) GDP dynamics (relative units) (X-axis is an axis of time, years)

On the Importance of Further Research on the Theory of J-cycles

After the Great Depression the interest in Juglar cycles grew sharply, and, according to Haberler (2008: 431), there was no other period in the history of economic thought when the problems of economic cycles were studied so in-

tensively. However, later, in the second half of the 20th century (especially, during Phase A of the fourth Kondratieff Cycle), the dynamics of business cycles experienced a significant change (first of all as a result of the active interference of the state into the economic life),⁴⁰ recessions became less deep than before (whereas the crisis became less dramatic), the recovery came relatively fast, *etc.* As a result, economists began paying more attention to long waves of business activities (Kondratieff cycles) than to Juglar cycles, though, mostly by tradition, macroeconomics textbooks still tend to include a chapter on those cycles (yet, they are mostly denoted just as ‘business cycles’⁴¹). We believe that such neglect with respect to the study of J-cycles is unproductive. In our opinion, modern crisis is quite similar in type to classical Juglar's cycle crisis.

The cyclical dynamics of Juglar type in their most pronounced form (that is, not smoothed by state intervention) was determined by the following factors: a) the presence of the gold standard in transactions within a country, as well as at the international level; b) uncontrolled dynamics of prices and interest rates; c) relatively weak interference of the state during upswings and even crises and recessions (though gradually such interference increased). These resulted in fast (sometimes even explosive) upswings (that demanded a great tension on the part of the economic system) and equally rapid downswings. The upswing, boom and overheating were accompanied by rapid and inadequate growth of prices of raw materials and real estate; an increase in intensity of speculations with commodities and stock assets; by a dramatic expansion of credit and risky operations; and the growth of investments beyond any reasonable limits. All these are salient features of the J-cycles that were described many times in the writings of representatives of various schools of economic thought (see, *e.g.*, Juglar 1862, 1889; Lescure 1908; Tugan-Baranovsky 1954; Marx 1961 [1893, 1894]; Hilferding 1981 [1910]; Haberler 1964; Keynes 1936; Hicks 1946 [1939]; Abel and Bernanke 2008; Samuelson and Nordhaus 2005, 2009).

Such an expansion of assets tended to lift temporarily limitations produced by the metallic standard. This is almost always that during the upswing phase we observe the effect of some new financial technology (naturally, in addition to the old ones), or some new type of assets (*e.g.*, in the 19th century this could be railway shares), that could drive the credit and speculations, amplifying

⁴⁰ Even some Soviet economists had to acknowledge this, for example, Varga, a Hungarian by origin, who was influenced originally by the Austrian Economic School (*e.g.*, Varga 1974: 366–400). In particular, he noticed that the depression phase had contracted in a very significant way. The change in crisis patterns in England since the late 19th century was first noticed by Tugan-Baranovsky (2008 [1913]). Mitchell also showed that, though recession is a necessary part of the cycle, not every cycle should be necessarily connected with an acute crisis (Mitchell 1930: 391–392). For a more detailed analysis of post-war cycles see Grinin and Korotayev 2010a.

⁴¹ See, *e.g.*, Mankiw 1994: ch. 14; Sax and Larren 1996: ch. 17; Abel and Bernanke 2008: ch. 8, even though such chapters are present not in all textbooks of the kind. For example, in the textbook by Dornbusch and Fischer (1997) such a chapter is absent.

the overheating of the economic system.⁴² The monetary component of the Juglar cycles was always exceptionally important (though this was the dynamics of real economy that was at the basis of cyclical **upswings**).

The above indicated factors were the main ones to engender very sharp and vividly expressed cyclic features. However, gradually under the impact of the Keynesian recipes (in the framework of national economic development) it became possible to minimize these dramatic distortions of rises and falls and to put speculation under a certain control (*e.g.*, after the Great Depression in the USA the Glass-Steagall Act was passed, forbidding banks, investment firms and insurance companies to speculate at stock exchanges [see Lan 1976; Samuelson and Nordhaus 2005, 2009; Suetin 2009: 41]). This led to smoothing of cyclical fluctuations and to less explosive crises.⁴³ However, currently, the crisis has evidently overgrown national borders, occurring namely as an international crisis, where national norms act in an obviously weakened form, while international regulations have not yet been worked out. That is why a number of old features recur at the new stage, because regulation methods applicable to separate countries would not work at the World System scale, still more so that the rules of such regulation have not been worked out yet.

We suggest that the current recurrence of some features of Juglar's cycle is connected namely with the following features of anarchy and arrhythmia of the non-regulated market economy:

1. Subjects of international law (and their economic agents) largely behave the same way as subjects of national law and the market previously did. As they use foreign currency and foreign currency rates in their dealings, this invariably leads to sharp distortions in international trade, devaluations, *etc.*

2. In the last decades capital movement between countries became free, *i.e.* it is relatively weakly regulated by national law and almost not regulated at all by international law. This causes huge and exceedingly fast capital movements, which lead to a very rapid growth in some places and then to a sharp decline and corresponding crisis phenomena.

3. In the modern economy not only new financial technologies have been developed, but the modern economy itself largely started producing values

⁴² For example, by the Charter of the Bank of England (as renewed in 1833), it was permissible to establish deposit joint stock banks everywhere. As a result, their number started growing rapidly which greatly contributed to the growth of capital accumulation, speculation, and at the same time to the accumulation of conditions for the 1836 crisis (for more details see Tugan-Baranovsky 2008 [1913]: 110–111). For more details on the development of various new financial technologies from cycle to cycle see Grinin and Korotayev 2010a.

⁴³ In 1999 in the USA the law on financial services modernization was accepted, which annulled the Glass-Steagall Act that was in force for more than 60 years (see Suetin 2009: 41). As a basis for introducing the law on financial services modernization, it has been claimed that American credit organizations are inferior to foreign rivals, especially European and Japanese 'universal banks' which were not subject to such limitations (Greenspan 2009: 200).

namely in the financial sphere (financial services). Thus, the financial component of crisis has increased dramatically; this differs from previous decades, when the main growth went on in the sphere of manufacturing. These processes are analyzed in greater detail in the following publications: Grinin 2009a, 2009b; Grinin and Korotayev 2010a; Grinin, Malkov and Korotayev 2009.

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