Precise measurement of macroeconomic variables in time domain using three dimensional wave diagrams

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Abstract – Article considers a research problem on the precise measurement of the macroeconomic variables changes in the time domain in the macroeconomics science. We propose to use the three dimensional (3D) wave diagram in the macroeconomics science for the first time, aiming to accurately characterize and to clearly visualize the GIP(t)/GDP(t)/GNP(t)/PPP(t) dependences changes in the time domain. We explain that the three dimensional (3D) wave diagram in the macroeconomics science has been created, using the theory on the continuous-time waves with the rotating polarization vector in the electrodynamics science. We show that the three dimensional (3D) wave diagram in the macroeconomics science can be used to accurately characterize and finely display the GIP(t), GDP(t), GNP(t), PPP(t) dependences changes in the time domain in the two possible cases: 1) the continuous-time waves of GIP(t), GDP(t), GNP(t), PPP(t) and 2) the discrete-time waves of GIP(t), GDP(t), GNP(t), PPP(t). We conclude that an introduction of the three dimensional (3D) wave diagram in the macroeconomics science can help to solve a challenging research problem on the precise measurement of the macroeconomic variables changes in the time domain.

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Keywords: Ledenyov three dimensional (3D) wave diagram, Ledenyov economic activity modulation vector, dependence of general information product on time GIP(t), dependence of general domestic product on time GDP(t), dependence of general national product on time GDP(t), dependence of purchase power parity on time PPP(t), spectrum analysis of continuous-time signals, amplitude / frequency / wavelength / period / phase of continuous-time signal, mixing / harmonics / nonlinearities of continuous-time signals, continuous-time waves with rotating polarization vector, continuous-time signal generators, spectrum analysis of discrete-time signals, amplitude / frequency / wavelength / period / phase of discrete-time digital signal, mixing / harmonics / nonlinearities of discrete-time digital signals, Ledenyov discrete-time digital waves, discrete-time digital signals generators, *Juglar-Ledenyov* fixed investment cycle, *Kitchin-Ledenyov* inventory cycle, *Kondratieff-Ledenyov* long wave cycle, *Kuznets--Ledenyov* infrastructural investment cycle, nonlinear dynamic economic system, economy of scale and scope, macroeconomics / econometrics / electrodynamics / econophysics sciences.

Introduction

In the *natural sciences*, the *cut, color, clarity, carat weight* of a *pink/yellow/white diamond* determine the *value* of a *pink/yellow/white diamond* precisely.

In the *social sciences*, the ***level of philosophical thinking*** **on the** ***problems of fundamental economics science*** defines a *state of economical/social progress* in the *economy of scale and scope* in any *country of research interest* accurately. The *high level* of *philosophical thinking* on the *problems of fundamental economics* resulted in a *formulation and implementation* of a *set of progressive state policies* towards the *new limitless opportunities* to build the *economical/social prosperity* in the *economies of scale and scope* in the *leading countries*. The *philosophical thinking* on the *problems of fundamental economics* in the process of research by the talented scientists with application of an *accumulated knowledge base* has been conducted in *Joseph Penso de la Vega (1668, 1996), Mortimer (1765), Smith (1776, 2008), Menger (1871), Bagehot (1873, 1897), von Böhm-Bawerk (1884, 1889, 1921), Hirsch (1896), Bachelier (1900), Schumpeter (1906, 1911, 1933, 1939, 1961, 1939, 1947), Slutsky (1910, 1915 1923), von Mises (1912), Hayek (1931, 1935, 2008; 1948, 1980), Keynes (1936, 1992), Ellis, Metzler (1949), Friedman (1953), Baumol (1957), Debreu (1959), Krugman, Wells (2005), Stiglitz (2005, 2015).*

The ***macroeconomics, microeconomics and nanoeconomics*** are the *integral parts* of the *fundamental economics science*. In the ***macroeconomics***, the research on *the business cycles* - the *fluctuations* of the *economy output* in the form of the *oscillating quantity* of the *produced goods* and *provided services* over the *specified time period* in the *economy of scale and scope* – has been conducted in *Juglar (1862), George (1881, 2009), Kondratieff (1922, 1925, 1926, 1928, 1935, 1984, 2002), Kitchin (1923), Schumpeter (1939), Burns, Mitchell (1946), Dupriez (1947), Samuelson (1947), Hicks (1950), Inada, Uzawa (1972), Kuznets (1973a, b), Bernanke (1979), Marchetti (1980), Kleinknecht (1981), Dickson (1983), Hodrick, Prescott (1997), Baxter, King (1999), Kim, Nelson (1999), McConnell, Pérez-Quirós (2000), Devezas, Corredine (2001, 2002), Devezas (editor) (2006), Arnord (2002), Stock, Watson (2002), Helfat, Peteraf (2003), Sussmuth (2003), Hirooka (2006), Kleinknecht, Van der Panne (2006), Jourdon (2008), Taniguchi, Bando, Nakayama (2008), Drehmann, Borio, Tsatsaronis (2011), Iyetomi, Nakayama, Yoshikawa, Aoyama, Fujiwara, Ikeda, Souma (2011), Ikeda, Aoyama, Fujiwara, Iyetomi, Ogimoto, Souma, Yoshikawa (2012), Swiss National Bank (2012, 2013), Uechi, Akutsu (2012), Central Banking Newsdesk (2013), Ledenyov D O, Ledenyov V O (2013c, 2015d, 2015e), Union Bank of Switzerland (2013), Wikipedia (2015a, b, c).*

The ***five main types*** **of the** ***business cycles*** in the *macroeconomics science* have been discovered:

1. ***3 – 7 years Kitchin continuous-time inventory cycle*** *in Kitchin (1923);*
2. ***7 –11 years Juglar continuous-time fixed investment cycle*** *in Juglar (1862);*
3. ***15 – 25 years Kuznets continuous-time infrastructural investment cycle*** *in Kuznets (1973a, b);*
4. ***45 – 60 years Kondratieff continuous-time long wave cycle*** *in Kondratieff, Stolper (1935); and*
5. ***70+ years Grand continuous-time super-cycle***.

For many years, an *old scientific opinion* was that the above *business cycles* belong to a group of the *continuous waves* (the *continuous-time signals*), because *their main parameters* such as the *amplitude / frequency / wavelength / period / phase* change continuously in the *time domain*. In addition, it was generally accepted to think that the *dependence of the General Domestic Product on the time GDP(t)* can be viewed as a *continuous-time fluctuation* of the *economy output* in the form of the *oscillating quantity* of the *produced goods* and *provided services* in the *economy of scale and scope* over the *specified time period*, hence the *GDP(t)* can be used with the purpose to *accurately characterize* the *macroeconomic processes* in the *economies of scales and scopes* in *Kuznets (1973a, b)*.

The *interesting research proposal* in *macroeconomics science* is that the *digital waves* (the *discrete-time digital signals*) rather than the early considered *continuous waves* (the *continuous-time signals)* originate and propagate in the *nonlinear dynamic economic system* in the *time domain* in *Ledenyov D O, Ledenyov V O (2015e).* It was shown that these discrete-time *digital waves* may have the *multiple origins* and can be generated by the *discrete-time economical, financial, political and social events* such as the *disruptive innovations* in *Christensen, Denning (December 2015)* in the *economies of scales and scopes* in the *time domain* in *Ledenyov D O, Ledenyov V O (2013c, 2015d, 2015e)*. In other words, it was suggested that the *dependence of general information product on time GIP(t)*, *dependence of general domestic product on time GDP(t)*, *dependence of general national product on time GDP(t)*, *dependence of purchase power parity on time PPP(t)* can be considered as the *discrete-time fluctuations* of the *economy output* in the form of the *oscillating quantity* of the *produced goods* and the *provided services* and the *purchasing power* and the *generated information streams* in the *economy of scale and scope* over the *specified time period*, which can quite accurately characterize the *macroeconomic processes* in the *economies of scales and scopes* in the *time domain* in *Ledenyov D O, Ledenyov V O (2013c, 2015d, 2015e).*

Therefore, as it was discovered in *Ledenyov D O, Ledenyov V O* (*2013c, 2015d, 2015e*), the ***five main types* of the *business cycles*** in the ***modern macroeconomics science*** are:

1. ***3 – 7 years Kitchin-Ledenyov discrete-time inventory cycle*** *in Kitchin (1923);*
2. ***7 –11 years*** *Juglar****-Ledenyov discrete-time fixed investment cycle*** *in Juglar (1862);*
3. ***15 – 25 years Kuznets--Ledenyov discrete-time infrastructural investment cycle*** *in Kuznets (1973a, b);*
4. ***45 – 60 years Kondratieff-Ledenyov discrete-time long wave cycle*** *in Kondratieff, Stolper (1935);*
5. ***70+ years Ledenyov discrete-time grand super-cycle.***

In this *research article*, we would like to discuss the *precise measurement of macroeconomic variables* in the *time domain* using the *three dimensional wave diagrams*. Thus, completing a *short insightful introduction*, let us begin a *more detailed scientific discussion* and present *our original research thoughts* on the *subject of scientific interest* in this *research article*.

Precise measurement of macroeconomic variables in time domain using three dimensional wave diagrams

Let us consider the *research problem* on the *precise measurement* of *changes* of the *macroeconomic variables* in the *macroeconomics science* in the *time domain.* In the *macroeconomics*, the *dependence of the general information product on the time GIP(t)*, the *dependence of general domestic product on the time GDP(t)*, the *dependence of the general national product on the time GDP(t)*, the *dependence of the purchase power parity on the time PPP(t)* are usually shown in the form of the *two dimensions charts* of *GIP(t), GDP(t), GNP(t), PPP(t).*

However, the *scientific problem* in the *macroeconomics* is that, looking at the *dependences of GIP(t)*, *GDP(t)*, *GNP(t)*, *PPP(t)*, it is not possible to answer the question: ***What are the separate contributions by the output of the real sector of the economy of scale and scope and by the output of the speculative sector of the economy of scale and scope to the general information product on the time GIP(t), the general domestic product on the time GDP(t), the general national product on time GDP(t), the purchase power parity on the time PPP(t)?***

In the macroeconomics, the clear separation of the contributions by the *real sector of the economy* of scale and scope and by the *speculative sector of the economy of scale and scope* to the total resulting magnitude of *GIP(t)*, *GDP(t)*, *GNP(t)*, *PPP(t)* is quite important. Presently, the

reported quantities of *GIP(t), GDP(t), GNP(t), PPP(t)* can be considered as meaningless by the *economists* in view of the fact that it is frequently not possible to distinguish the contributions by the *real sector* of the *economy of scale and scope* and by the *speculative sector* of the *economy of scale and scope* to the *total resulting magnitude of GIP(t)*, *GDP(t)*, *GNP(t)*, *PPP(t).*

Let us explain that a ***huge increase of the monetary base by means of the money supply increase during the quantitative easing programs implementation by the central banks in the economies of scales and scopes in the developed/developing countries may lead to the economic crisis situation***, when:

1. the ***financial sector of the economy of scale and scope*** with the *investment banks*, *investment funds*, *commerce banks*, which obtains a lot of *money* from the *central banks*, contribute to the "*fictional growth*" of *GIP(t), GDP(t), GNP(t), PPP(t)* mainly;

2. the ***real estate sector of the economy of scale and scope*** with the *home owners/leasers/renters/buyers*, *building leasing companies*, *construction companies*, which becomes *hugely overvalued* and absorbs a lot of *money* from the *home owners/leasers/renters/buyers*, which get the *mortgages/loans* from the *investment banks* and *commercial banks*, which in turn obtain a lot of *money* from the *central banks*, contribute to the "*fictional growth*" of *GIP(t), GDP(t), GNP(t), PPP(t)* mostly;

3. the ***IT sector of the economy of scale and scope*** with the *IT software/hardware development companies*, *IT service providing companies*, which becomes *hugely overvalued* and obtains the *big money* from the *institutional/private investors* such as the *commercial banks*, *investment banks*, *investment boutiques*, *pension funds*, which in turn obtain a lot of *money* from the *central banks*, contribute to the "*fictional growth*" of *GIP(t), GDP(t), GNP(t), PPP(t)* mainly.

In other words, let us sum up by saying that the *GIP(t), GDP(t), GNP(t), PPP(t)* may increase disproportionally, because of the *increasing contributions* by the *speculative sectors* of the *economies of the scales and scopes* as a result of *huge increase of monetary bases* due to the *quantitative easing programs implementations* by the *central banks* in the *economies of scales and scopes* in the *developed/developing countries*. At the same time, when the *GIP(t), GDP(t), GNP(t), PPP(t)* increase disproportionally, the *contributions* by the *real sectors* of the *economies of the scales and scopes* to the changes of *GIP(t), GDP(t), GNP(t), PPP(t)* in the *economies of the scales and scopes* actually may *strongly decrease / modestly decrease / not change / modestly increase*, depending on various *financial / economic / technological / political factors*.

Therefore, ***we propose to use the three dimensional (3D) wave diagram in the macroeconomics science for the first time, aiming to accurately characterize and to clearly visualize all the contributions by the real sector of the economy of scale and scope as well as***

the speculative sector of the economy of scale and scope to the final resulting change of GIP(t)/GDP(t)/GNP(t)/PPP(t).

Let us explain that the *three dimensional (3D) wave diagram* in the *macroeconomics science* has been created, using the *theory on the continuous-time waves with the rotating circular polarization vector* in the *electrodynamics science*. We would like to comment that, in the *electrodynamics science*, the *continuous-time electro-magnetic waves* with the *rotating circular polarization vector* have been well researched over the *years* in *Wikipedia (2016i, j)*. The *continuous-time electro-magnetic waves* with the *rotating circular polarization vector* are usually used in the process of the *information transmission* over the *ground-to-space* and the *space-to-ground satellite communication links*. Also, the *continuous-time electro-magnetic waves* with the *rotating circular polarization vector* are normally applied in the process of the *information transmission* over the *fiber optics communication channels*.

We would like to let know that the *three dimensional (3D) wave diagram* in the *macroeconomics science* has been created, using the *theory on the digital communications science.* We would like to comment that, in the *digital communications science*, the *Imaginary-Quadrature (IQ) modulation vector diagram*, which displays the position of the *digital modulation vector* has been researched for many years in *Wikipedia (2016k, l), Matlab (2014).*

Let us write the a set of *mathematical expressions* for the *GIP(t), GDP(t), GNP(t), PPP(t)*, selecting and defining the *GDP(t)* as an example:

$$\boldsymbol{GDP_{Total}}\left(\boldsymbol{t}\right) = \sum \boldsymbol{GDP_{n}}\left(\boldsymbol{t}\right)$$

$$\boldsymbol{GDP_{total}} = \boldsymbol{A}^{2} = \left(\boldsymbol{A_{real}}\right)^{2} + \left(\boldsymbol{A_{speculative}}\right)^{2}$$

where : ***GDP is the Gross Domestic Product***, ***which is a scalar value***;

t is the time;

A is the economic modulation activity vector, ***which is a vector value***;

$\boldsymbol{A_{real}}$ ***is the real economic modulation activity vector component***;

$\boldsymbol{A_{speculative}}$ ***is the speculative economic modulation activity vector component***.

In *Fig. 1*, we would like to show schematically the proposed *three dimensional (3D) wave diagram* in the *macroeconomics science,* which can be used to accurately characterize and to finely display the *GIP(t), GDP(t), GNP(t), PPP(t) dependences* changes in the *time domain* in the two cases:

1. the *continuous-time waves of GIP(t), GDP(t), GNP(t), PPP(t), and*

2. the *discrete-time waves of GIP(t), GDP(t), GNP(t), PPP(t).*

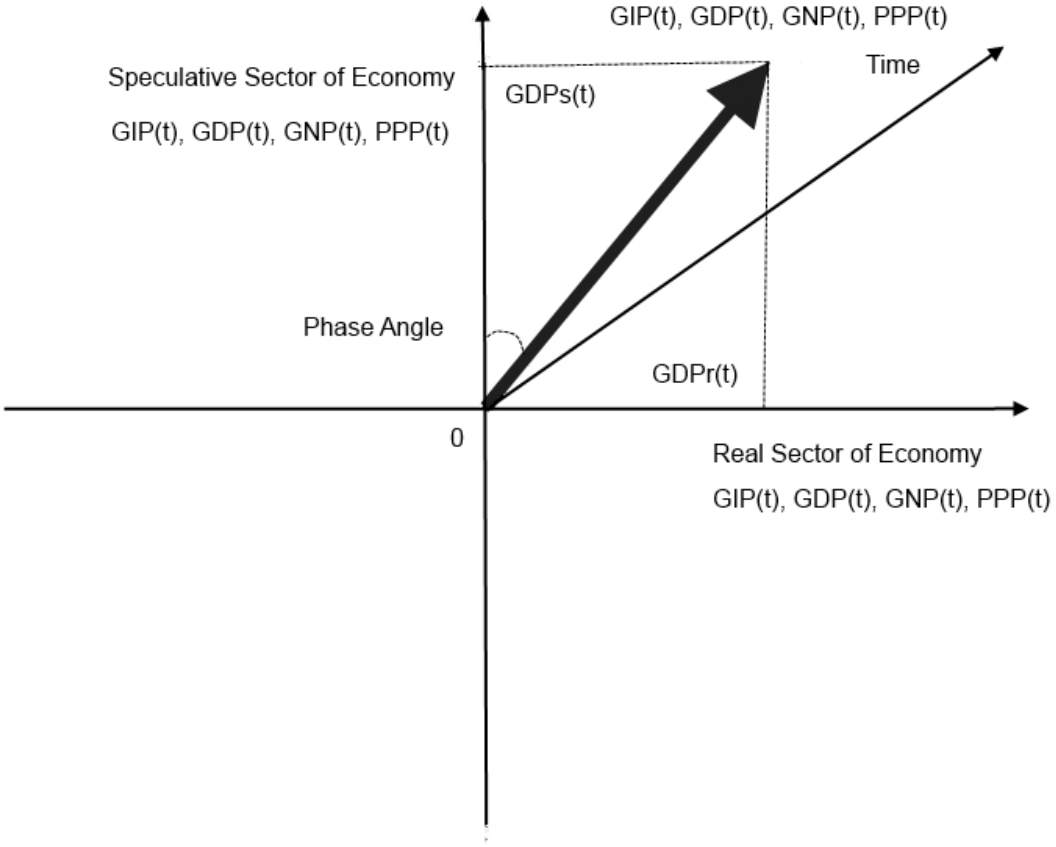

Fig. 1. *3D wave diagram shows case no 1 with possible changes of dependences of GIP(t), GDP(t), GNP(t), PPP(t) in time domain.*

In *Fig. 1*, the *3D Wave Diagram* shows the *total GIP(t), GDP(t), GNP(t), PPP(t)* as a sum of the *two components*, including the *positive real GIP(t), GDP(t), GNP(t), PPP(t)* and the *positive speculative GIP(t), GDP(t), GNP(t), PPP(t).*

The *total magnitude of GIP(t), GDP(t), GNP(t), PPP(t)* can change as the *continuous-time wave* in agreement with the *old economic representations in Kitchin (1923), Juglar (1862), Kuznets (1973a, b), Kondratieff, Stolper (1935)* or as the *discrete-time wave* in accordance with the *new economic representations* in *Ledenyov D O, Ledenyov V O* (*2013c, 2015d, 2015e*).

The *phase angle* $\boldsymbol{\varphi}$ defines the tilt of *GIP(t), GDP(t), GNP(t), PPP(t)* and it depends on the *magnitude* of the *real GIP(t), GDP(t), GNP(t), PPP(t)* and the *magnitude* of the *speculative GIP(t), GDP(t), GNP(t), PPP(t).*

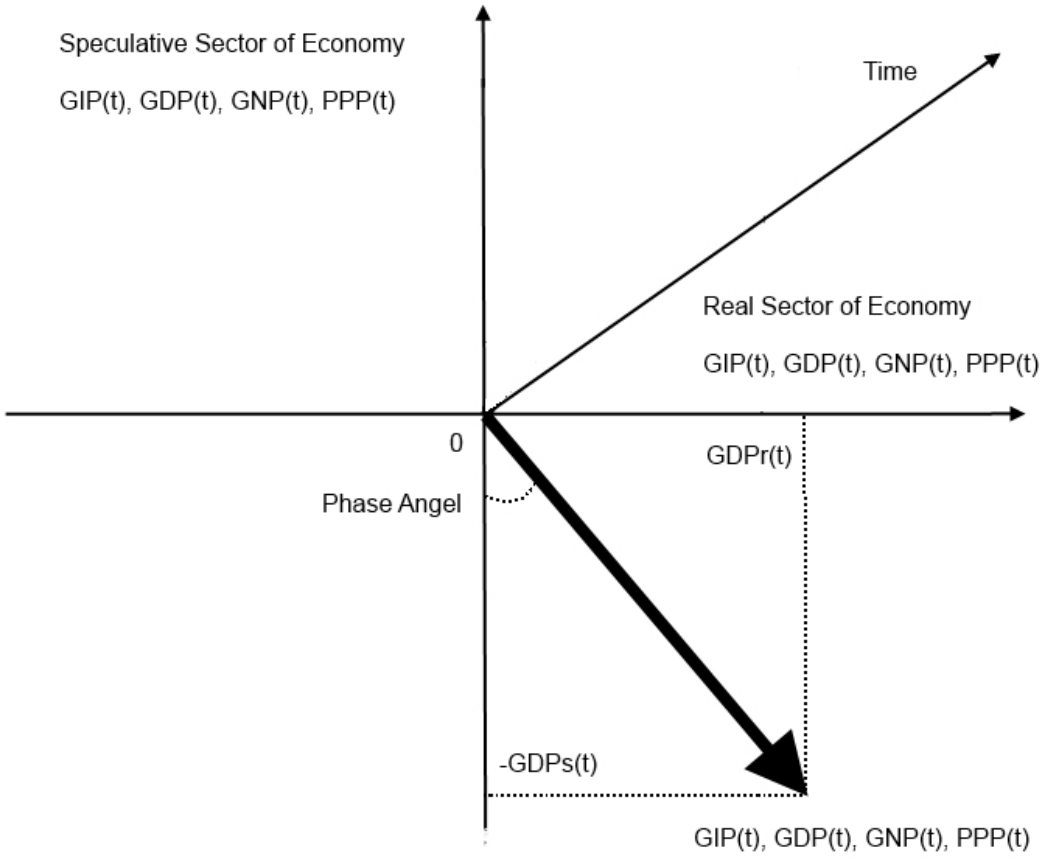

Fig. 2. *3D wave diagram displays case no 2 with possible changes of dependences of GIP(t), GDP(t), GNP(t), PPP(t) in time domain.*

In *Fig. 2*, the *3D Wave Diagram* displays the *total GIP(t), GDP(t), GNP(t), PPP(t)* as a sum of the *two components*, including the *positive real GIP(t), GDP(t), GNP(t), PPP(t)* and the *negative speculative GIP(t), GDP(t), GNP(t), PPP(t)*.

The *total magnitude of GIP(t), GDP(t), GNP(t), PPP(t)* can change as the *continuous-time wave* in agreement with the *old economic representations in Kitchin (1923), Juglar (1862), Kuznets (1973a, b), Kondratieff, Stolper (1935)* or as the *discrete-time wave* in accordance with the *new economic representations* in *Ledenyov D O, Ledenyov V O* (*2013c, 2015d, 2015e*).

The *phase angle* $\boldsymbol{\varphi}$ defines the tilt of *GIP(t), GDP(t), GNP(t), PPP(t)* and it depends on the *magnitude* of the *positive real GIP(t), GDP(t), GNP(t), PPP(t)* and the *magnitude* of the *negative speculative GIP(t), GDP(t), GNP(t), PPP(t)*.

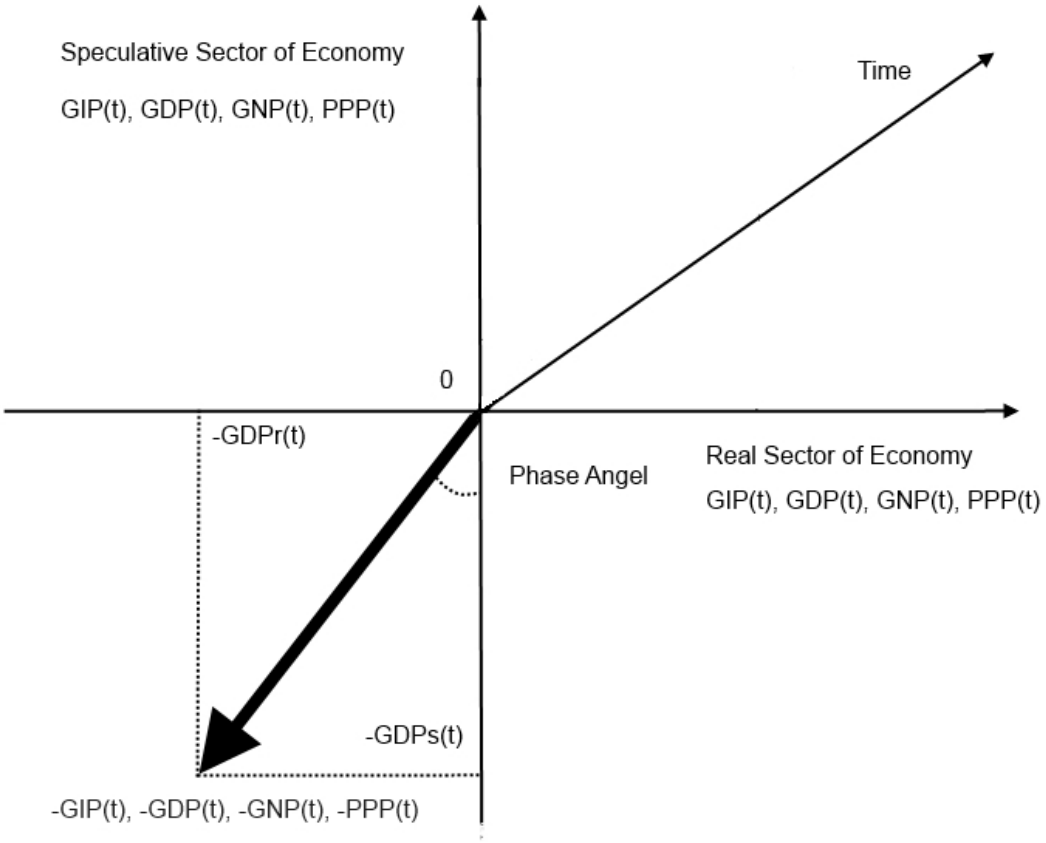

Fig. 3. *3D wave diagram demonstrates case no 3 with possible changes of dependences of GIP(t), GDP(t), GNP(t), PPP(t) in time domain.*

In *Fig. 3*, the *3D Wave Diagram* demonstrates the *total GIP(t), GDP(t), GNP(t), PPP(t)* as a sum of the *two components*, including the *negative real GIP(t), GDP(t), GNP(t), PPP(t)* and the *negative speculative GIP(t), GDP(t), GNP(t), PPP(t).*

The *total magnitude of GIP(t), GDP(t), GNP(t), PPP(t)* can change as the *continuous-time wave* in agreement with the *old economic representations in Kitchin (1923), Juglar (1862), Kuznets (1973a, b), Kondratieff, Stolper (1935)* or as the *discrete-time wave* in accordance with the *new economic representations* in *Ledenyov D O, Ledenyov V O* (*2013c, 2015d, 2015e*).

The *phase angle* $\boldsymbol{\varphi}$ defines the tilt of *GIP(t), GDP(t), GNP(t), PPP(t)* and it depends on the *magnitude* of the *negative real GIP(t), GDP(t), GNP(t), PPP(t)* and the *magnitude* of the *negative speculative GIP(t), GDP(t), GNP(t), PPP(t).*

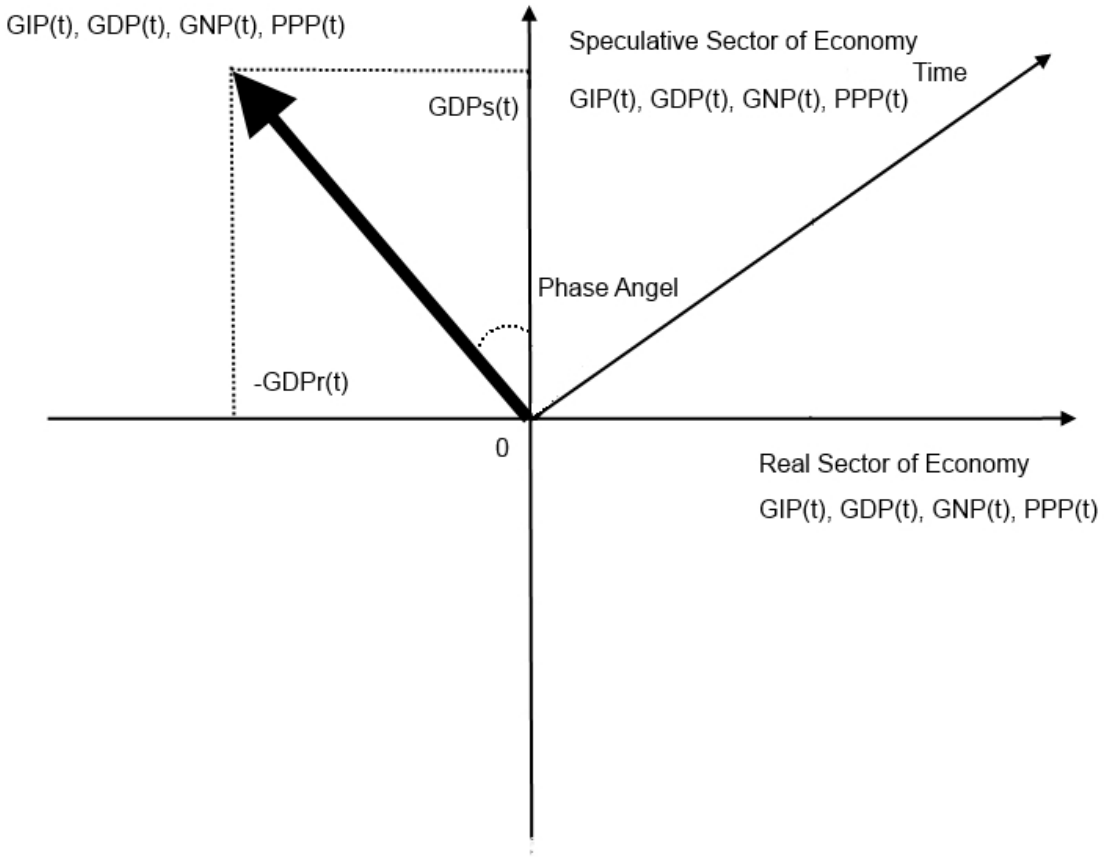

Fig. 4. *3D wave diagram depicts case no 4 with possible changes of dependences of GIP(t), GDP(t), GNP(t), PPP(t) in time domain.*

In *Fig. 4*, the *3D Wave Diagram* depicts the *total GIP(t), GDP(t), GNP(t), PPP(t)* as a sum of the *two components*, including the *negative real GIP(t), GDP(t), GNP(t), PPP(t)* and the *positive speculative GIP(t), GDP(t), GNP(t), PPP(t).*

The *total magnitude of GIP(t), GDP(t), GNP(t), PPP(t)* can change as the *continuous-time wave* in agreement with the *old economic representations in Kitchin (1923), Juglar (1862), Kuznets (1973a, b), Kondratieff, Stolper (1935)* or as the *discrete-time wave* in accordance with the *new economic representations* in *Ledenyov D O, Ledenyov V O* (*2013c, 2015d, 2015e*).

The *phase angle* $\boldsymbol{\varphi}$ defines the tilt of *GIP(t), GDP(t), GNP(t), PPP(t)* and it depends on the *magnitude* of the *negative real GIP(t), GDP(t), GNP(t), PPP(t)* and the *magnitude* of the *positive speculative GIP(t), GDP(t), GNP(t), PPP(t).*

Going to the next point, let us make a few important scientific comments on the *special features* and the *main differences* between the *continuous-time waves of GIP(t), GDP(t), GNP(t), PPP(t)* and the *discrete-time waves of GIP(t), GDP(t), GNP(t), PPP(t)* at the *3D wave diagrams*:

1. The *continuous-time wave of GIP(t), GDP(t), GNP(t), PPP(t) changes* its *amplitude / frequency / wavelength / period / phase / polarization* continuously in the *time domain*. Therefore, in this case, we assume that the *continuous-time wave of GIP(t), GDP(t), GNP(t), PPP(t)* can be modulated by the *continuous-time economical, financial, political and social events* in agreement with the *old philosophical scientific views* in the *macroeconomics*.

2. The *discrete-time wave of GIP(t), GDP(t), GNP(t), PPP(t) changes its amplitude / frequency / wavelength / period / phase / polarization* discretely in the *time domain*. Therefore, in this case we permit that the *discrete-time wave of GIP(t), GDP(t), GNP(t), PPP(t)* can be modulated by the *discrete-time economical, financial, political and social events* such as the *disruptive innovations* in *Christensen, Denning (December 2015)* in the *economies of scales and scopes* in the *time domain* in *Ledenyov D O, Ledenyov V O (2013c, 2015d, 2015e)*. We can draw some limited analogy with the *IQ diagram* for the *digital modulation technique* in *Wikipedia (2016k)*, aiming to demonstrate the *phase transitions* by the *economic activity vector* on the *Ledenyov three dimensional (3D) wave diagram*. In addition, we would like to say that the *economic activity modulation vector* can take *any position* on the *Ledenyov three dimensional (3D) wave diagram* in distinction from the *digital modulation vector* on the *IQ diagram*, which can take the *pre-defined positions* only.

We have developed the *software program*, *MacroSoft*, which creates the proposed *three dimensional (3D) wave diagram* to accurately characterize and to finely display the *GIP(t), GDP(t), GNP(t), PPP(t) dependences* for the *G7 economies of the scales and scopes* in the *time domain* for the *two possible cases*:

1. the *continuous-time waves of GIP(t), GDP(t), GNP(t), PPP(t)*, and

2. the *discrete-time waves of GIP(t), GDP(t), GNP(t), PPP(t)*.

Presently, we report a *first successful application* of the *MacroSoft program* to perform a comprehensive analysis on the *economic output* of the *United States of America economy of scale and scope* in *real-time domain*, having embedded the *multi-channel trusted independent economic data fusion technical capabilities* into *Macrosoft program* and obtaining the *Ledenyov three dimensional (3D) wave diagram* for the *US economy of the scale and scope* in the *real-time domain*. The obtained *Ledenyov three dimensional (3D) wave diagram* gives us an opportunity to evaluate precisely the *US economy of scale and scope* in the *time domain* and to forecast accurately the *possible developments* in the *US economy of scale and scope* in the *time domain.*

Let us conclude that an *introduction* of the *three dimensional (3D) wave diagram* in the *macroeconomics science* can help to solve a *challenging research problem* on the precise *measurement* of the *macroeconomic variables* in the *time domain*.

Conclusion

This article considers a *research problem* on the *precise measurement* of the *macroeconomic variables changes* in the *time domain* in the *macroeconomics science*.

We propose to use the *three dimensional (3D) wave diagram* in the *macroeconomics science* for the *first time*, aiming to accurately characterize and to clearly visualize the *GIP(t)/GDP(t)/GNP(t)/PPP(t) dependences changes* in the *time domain*.

We explain that the *three dimensional (3D) wave diagram* in the *macroeconomics science* has been created, using some limited analogy with the *theory on the continuous-time waves with the rotating polarization vector in the electrodynamics science*.

We let know that the *three dimensional (3D) wave diagram* in the *macroeconomics science* has been created, using some limited analogy with the *theory on the Imaginary-Quadrature modulation diagram* in the *digital communications science*.

We show that the *three dimensional (3D) wave diagram* in the *macroeconomics science* can be used to accurately characterize and finely display the *GIP(t), GDP(t), GNP(t), PPP(t) dependences changes* in the *time domain* in the *two possible cases*:

1. the *continuous-time waves of GIP(t), GDP(t), GNP(t), PPP(t)*, and

2. the *discrete-time waves of GIP(t), GDP(t), GNP(t), PPP(t)*.

We have developed the *software program*, *MacroSoft*, which creates the proposed *three dimensional (3D) wave diagram* to accurately characterize and to finely display the *GIP(t), GDP(t), GNP(t), PPP(t) dependences* for the *G7 economies of the scales and scopes* in the *time domain* for the *two possible cases*:

1. the *continuous-time waves of GIP(t), GDP(t), GNP(t), PPP(t)*, and

2. the *discrete-time waves of GIP(t), GDP(t), GNP(t), PPP(t)*.

We have the *technical capabilities* to obtain the *three dimensional (3D) wave diagram* for the *US economy of the scale and scope* in the *real-time domain*, which gives us an opportunity to evaluate precisely the *US economy of scale and scope* in the *time domain* and to forecast accurately the *possible developments* in the *US economy of scale and scope* in the *time domain.*

We make a conclusion that an introduction of the *three dimensional (3D) wave diagram* in the *macroeconomics science* can help to solve a *challenging research problem* on the *precise measurement* of the *macroeconomic variables changes* in the *time domain*.

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