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OPTIMIZATION OF MACROECONOMIC POLICY AND STABILIZATION OF CYCLICAL ECONOMIC DYNAMICS

This paper demonstrates that, despite the current mandate of monetary policy, its final goal (at least for central banks of developed countries) is the control of three main macroeconomic variables — economic growth, employment and inflation, — regardless on actual mandate for this policy. However, the priorities of realization of the final goal may face the imperfection of macroeconomic models and rules of monetary policy, which will make it impossible to control all three macroeconomic variables at the same time. The article proposes a new instrument for monetary policy — aggregate cumulative market imperfection — to optimize macroeconomic variables and stabilize cyclical economic dynamics. The author demonstrates the main competitive advantages of this instrument of monetary policy as compared with typical models of macroeconomic dynamics and simple rules of monetary policy (Simons, Friedman, and Taylor rules). In particular, this instrument is valid for any combination of market conditions, for any economy and for any moment of real time. It can be used simultaneously as: 1) a target of monetary policy; 2) a simple rule of monetary policy correction in the short-run; 3) a reaction function to evaluate a backward connection between the regulator's actions and the effect of these actions on current economic situation; and 4) an instrument to stabilize cyclical economic dynamics; 5) an instrument to forecast starting (ending) point of recessions and shift in macroeconomic trends. If we can hold the aggregate cumulative market imperfection within a given optimal interval with the help of government regulations (i.e. to target this indicator only) using all possible instruments both of monetary, and (if necessary) of other kinds of regulation policy, we will be able to optimize all three main macroeconomic variables. Optimality of

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these variables means providing maximum economic growth and employment under comfortable inflation for any combination of market conditions and for any moment of calendar time, which will at the same time stabilize cyclical economic dynamics. In doing so, we will not target each of these three variables separately, that is, it is practically impossible to determine quantitatively their optimal values as they change permanently over time together with the constant change of current combination of market conditions.

***Keywords**: monetary policy, regulation instruments, economic growth, employment, inflation, simple rules of monetary policy, economy stabilization*

The ultimate goal of monetary policy is to maximize the rate of economic growth and employment with acceptable inflation, that is, in fact, regulatory policy should have a *triple* goal. And national banks, at least in the developed world, recognize this, although officially the vast majority of national banks do not declare all the three goals, but only one of them, the one related to inflation.

The US Federal Reserve (hereinafter referred to as Fed) is now the only central bank in the world that officially controls two of the three targets (inflation and employment) that have been its mandate since 1977. Under the official mandate, the Fed's main monetary policy goal is to maximize employment and maintain stable prices. Monetary policy is efficient if a central bank, while ensuring price stability, at the same time provides favorable conditions for long-term economic growth and maximum employment [1].

In this regard, A. Okun, a well-known economist and employee of the Fed, described maximum (full) employment as follows: "Achieving full employment should be understood as the striving to maximize output, but without inflationary pressures" [2]. Actually, the Fed sets the task to control all three key macroeconomic indicators, despite the officially dual purpose of monetary policy. That is, one of the most important problems of contemporary monetary policy consists in "ensuring a high level of economic activities and employment, while avoiding constant price rise" [3].

Similar ideas concerning the ultimate goal of monetary policy are shared by the Central Bank of Japan. For example, the Executive Director of the Central Bank of Japan M. Amamiya states that the above mentioned key macroeconomic indicators are the *ultimate* goal of monetary policy [4]. Therefore, despite the fact that the world's leading central banks are presently targeting one of the endpoints (namely, inflation, with the exception of the Fed, which also targets employment), their ultimate goal still is to try to control all three major macroeconomic indicators.

The practical experience of US monetary policy after 2008 clearly shows that the Fed tries to control all the three macroeconomic indicators. For example, from

2008 to 2019, with low inflation (below the target level) and unemployment (below the natural level), the Fed tried to stimulate economy (almost zero interest rates) because economic growth rates were significantly lower than natural level. And in 2021, despite the fact that inflation almost doubled the target level, and growth exceeded the natural level, the Fed did not stop (and did not even reduce) the policy of "quantitative easing" and kept the discount rate at almost zero in order to reduce unemployment.

Similarly, the European Central Bank (ECB) did not stop stimulating the economy in 2021 given the relatively low growth rates and high unemployment, despite the fact that inflation at the end of the summer almost doubled the target level of 2% (set in the ECB mandate as the only objective of monetary policy).

On the whole, the vast majority of central banks that only target inflation actually perform a so-called *flexible* rather than tight inflation targeting. Flexible inflation targeting means that monetary policy seeks to stabilize both inflation (close to target) and the real economy. Instead, *tight* inflation targeting is only aimed at stabilizing inflation, without stabilizing the real economy. At the same time, effective flexible inflation targeting should be based on the forecast of inflation and on the state of real economy. Therefore, flexible inflation targeting can be described as "targeting the forecast " [5]. In other words, trying to achieve the triple goal of monetary policy (or one of its components), central banks also try to reduce the amplitude of business cycle fluctuations to ensure stable economic development [6].

However, in practice it is extremely difficult to attain this ultimate goal. This requires relying on models (theories) that establish causal relationships between them and the numerous intermediate indicators, which define the values of the final indicators and on whose basis the tools for regulating the final indicators are formed. A. Greenspan, former head of the Fed, insisted that analysis of economic situation should be based not only on real-time data, but also on economic models that operate such data [3].

Each of the three final macroeconomic indicators at any given time depends on a large number of intermediate indicators (both macro- and microeconomic ones), being the number and weight of each difficult to identify because they constantly change over time.

For example, according to classical models, investment is a key factor in increasing the rate of economic growth. However, no less important factor is the efficiency of investment, which is in most cases not taken into account in these models. Numerous subjective and objective reasons (corruption, various schemes of embezzlement in the investment process, irrational choice of optimal “points” for investment, etc.) can reduce investment efficiency. Besides, although the volume of investment is important, but it is not the only significant factor that determines the growth rate. This may explain the fact that countries with almost the same amount of investment have growth rates that differ many times [7].

In addition, the same factors can have a different effect on each of the three key indicators differently, creating a unique combination of them, which in turn affects each of these indicators separately. That is why correct explanation and forecast of both growth and employment rates and inflation rates require not only consideration of the set of factors affecting them, but also assessment of the relationship between growth rates, unemployment and inflation. That is, only specialized economic models describing each of these final macroeconomic indicators separately are not sufficient for simultaneous control over the final indicators of macroeconomic dynamics. It is necessary to have a rather general model, which connects all three main macroeconomic indicators and with which the relevant specialized models, explaining the dynamics of each of them separately should be consistent.

The situation is further complicated by the fact that any economic model is based on certain assumptions that distort reality. And the more such assumptions the model contains (for example, assumptions of perfect competition, flexible or inflexible prices and wages, constant character of other market conditions, etc.), the lesser is its practical use and less effective will be a regulatory policy based on such a model.

Another important prerequisite for effective regulatory policy is the ability to quick (preferably monthly) and prompt (preferably with an up to three months' advance) assessment of the current economic situation and ability to provide feedback between the regulator's actions and their impact on the economy. Numerous assumptions that distort reality largely limit the adequacy of theoretical models and make it virtually impossible to analyze economy in real time. This may explain the conclusions of the authors of [8] that large and complex models have little practical efficiency for timely identification and forecasting of changes in macroeconomic trends, in particular recessions. Instead, simple models and rules (such as the Friedman rule, the Taylor rule, etc.) may be more useful and better than complex large-scale models both for predicting the calendar time of recession start and for prompt adjustment of monetary policy. In addition, they are better understood and more practical in their daily use [9].

However, simple monetary policy rules too have their drawbacks and problems that reduce their practical efficiency. It would be advisable in this context to briefly consider these shortcomings on the examples of the well-known Simons, Friedman and Taylor rules. All the more so as all these rules are somehow based on the well-known equation of the quantitative theory of money:

$$\mathbf{M\ V = P\ Q} \tag{1}$$

where M, V, P, Q are respectively, nominal money supply, money velocity, level of market prices and real output.

The use of this equation has a theoretical potential to control two of the three ultimate goals of monetary policy (price level and real output). However, in practice this is hard to do. And it is all the more difficult to optimize the level of prices and output in response to changes in, for example, money supply.

Analyzing the experience of the Great Depression, H. Simons concludes that the discretionary policy conducted by the Fed increases uncertainty and aggravates business cycles. Therefore, he suggested to introduce certain rules for monetary policy in order to avoid errors of subjective assessment of the economic situation. In the mid-1930s, Simons proposed a rule to target the constant short-run price level (the price-level stabilization rule). In particular, according to his proposal, changes in the amount of money act as an intermediate variable in order to maintain a stable price index for goods. Changes in the amount of money, in turn, are made via changes in the government's financial position, i.e. fiscal deficit is used to raise the amount of money, and fiscal surpluses are used to reduce the amount of money. However, this rule was never formalized, and its adequacy was not confirmed by analysis of empirical data, which was a typical case in the era of discretionary monetary policy, in which Simons lived.

Since the late 1950s, M. Friedman proposed a rule for targeting a constant money supply (the money-growth rule). According to his proposal, the growth of money supply should result from open market operations conducted by the central bank. Unlike Simons, Friedman argued that there should be a clear separation of monetary policy measures from fiscal policy measures. Friedman was the first to statistically confirm his rule and justify inefficiency of discretionary monetary policy and efficiency of policy-making based on formalized rules. In particular, he concluded that an annual 3-5% growth of the monetary aggregate M2 can ensure price stability and it is exactly this aggregate that should be included in equation (1), which at that time was confirmed by him empirically (a little earlier, L. Currie, on whose work Friedman relied in formulating his rule, believed that equation (1) should include aggregate M1).

However, the Great Inflation of 1979-1982 made this rule ineffective, which clearly demonstrated non-universality of this rule (as well as other known rules), and its validity for certain market conditions, unknown to the regulator in advance. The Fed targeted the monetary aggregate M1 until February 1987, while the M2 aggregate was used as an indicator of the financial market. But since 1993, the M2 aggregate no longer served as a reliable indicator of this market [10]. In the late 1970s and early 1980s, the central banks abandoned monetary targeting in favor of interest rate targeting, due to significant volatility in money demand in the 1970s.

Interest rate targeting was introduced in 1993 in the Taylor rule that was new at that time. It indicates how the discount rate should change in response to changes in inflation and economic growth. The original of the Taylor rule looks like [11]:

$$\mathbf{i = \pi + r^* + 0.5(\pi - \pi^*) + 0.5(y),} \qquad (2)$$

where i is the current interest rate of the central bank; r^* - equilibrium ("natural") interest rate of the central bank (a "natural" indicator, which is considered as corresponding to full employment); π is the average inflation rate for this time and for the previous three quarters (according to the GDP deflator); π^* - inflation target; and y = (real GDP - potential GDP) / potential GDP.

Taylor assumed that the weighting factors given by the Fed to deviants in inflation and output were 0.5. Besides, he assumed that the equilibrium real interest rate and inflation target were 2%.

The experience of use of this rule by the US Federal Reserve for previous 60 years showed its different adequacy for different periods of time. On the whole, the rule gave an adequate outline of a certain range of changes in the Fed's interest rate, but it could not be used to "accurately" define the interest rate at any given time.

At the same time, the experience of using the Taylor rule by other developed countries was not so optimistic. This is due to a number of shortcomings inherent in the rule (which will be discussed below), and by the goal of the central bank's monetary policy. For example, EU countries have a single-target mandate, so the ECB often does not change the interest rate if the aggregate output of these countries is too low. Besides, the Taylor rule is difficult to apply for Japan's economy, where the interest rate was close to zero for a long time. A similar situation was observed in the US economy after 2008, which too has a negative effect on the effectiveness of this rule.

However, the Taylor rule also has a number of objective shortcomings reducing the effectiveness of its application and raising questions about the validity of any of its current applications. Most of these shortcomings are inherent in any other known rule of monetary policy. Let us consider the main of these shortcomings, based on [3, 6], as well as on a few other works mentioned after relevant considerations listed below.

1. Uncertainty and ambiguity as to the level of potential GDP and the equilibrium ("natural") interest rate of the central bank (the equilibrium real federal funds rate). Some analysts argue that increased productivity due to computer and other technological advances means incorrect measurement of potential output. In addition, if potential GDP is measured by averaging past GDP data, the measurement result depends on the selected averaging period. Also, fundamentally different results can be obtained using an inflation indicator such as the CPI instead of the GDP deflator. This creates additional ambiguity in determining the equilibrium ("natural") interest rate of the central bank in (2), since the central bank uses CPI to target inflation.

2. The Taylor rule uses quarterly data for regular updating. However, this is too long a period to maintain the discount rate unchanged, especially if a recession begins (when the faster you respond, the better).

3. The empirical coefficients of the Taylor rule constantly change over time, which leads to discrepancies between the current optimal value of the discount rate and its historical values [12].

4. The Taylor rule is too sensitive to initial data that the regulator has at the time of decision and subsequent revisions of this data. Even a planned revision of preliminary data can change recommendations for the regulator, as a rule, to the opposite. Thus, final information about potential and real GDP may appear in a few quarters, and possibly years after the time of decision [9].

5. Since monetary policy (however, like any other policy) "works" with a time lag, it is most efficient when it is based on forecasts. The Taylor rule has no ability to predict future events in economic development. Typically, the rule's key variables, such as the central bank's equilibrium ("natural") interest rate and potential GDP, are in practice obtained when observing past macroeconomic changes. This leads to the forced assumption that the future will be similar to the past. However, in economics, history is not an unmistakable guide to the future. Therefore, in practice, Taylor rule is combined with a model (e.g., a neo-Keynesian one) to predict the key macroeconomic indicators used at the rule's "input". However, in this case, the rule's shortcomings are compounded by the model's shortcomings, so the quality of forecasts is a critical factor for the rule's success.

6. The empirical coefficients of the Taylor rule change over time with the change of macroeconomic trend (as in any econometric model), and the regulator does not know in advance about the trend's change before a crisis situation arises. In addition, different scientists obtain different empirical coefficients included in the Taylor rule, even for the same period of time, not to mention their significantly different values for different periods (coefficients can differ more than 10 times) [13].

7. The Taylor rule does not react to changes in the macroeconomic trend. The rule "failed" when the Fed aggressively changed its policy in response to changes in the economic situation (for example, in 1969, 1979, 1987, 1997, 2003, 2006, 2008, 2014, and 2019). The rule also loses its relevance during crises, when central banks apply non-standard monetary policies (e.g. quantitative easing). In particular, the rule does not take into account the fact that monetary policy before economic crises is significantly different from post-crisis policy. That is why there are calls for the rule's modernization. Thus, it is proposed to complement the classic formulation of the Taylor rule with the growth in money, credit, interest rate spreads, and asset price inflation as these variables are signs of changes in the equilibrium interest rate and therefore probably play an important role in setting rates during crises [14].

8. The Taylor rule does not define the way to *optimize* the ultimate macroeconomic goals, in particular, aggregate output and price levels. It is unclear whether it is at all possible to ensure the implementation of the rule, which neither

contains a target path for any monetary aggregate, nor defines the equilibrium price level [15].

9. Theoretically, the Taylor rule could be used to fulfill the Fed's dual mandate. However, the interpretation of output in (2) as a harbinger of future inflationary pressures effectively leads to single-mandate inflation targeting [3].

10. A change in the combination of market conditions requires a change in the empirical coefficients of the Taylor rule. Thus, the original rule (2) provides the same weighting factors for inflation and output growth, which may not always be appropriate. The same factors may work suit well for supply shock conditions, but a higher weight of the output component may be better for demand shock conditions. And the reduction in the threat of inflation in the late 1990s made Taylor propose to reduce the weighting factor for the inflation component and at the same time raise the ratio for the output component in expression (2) to make the rule adequate in the new conditions. However, the use of data available to regulator at the time of decision-making, in real time, produces a big difference in the results of actions performed in accordance with the rule - with lower and higher coefficients for the output component [16].

This study proposes *a new tool* of monetary policy that combines advantages of simple rules and large complex models of macroeconomic dynamics, but does not have the main disadvantages of both simple rules and complex models.

In previous studies, within the proposed new general model of macroeconomic dynamics (hereinafter referred to as CMI-model), we proposed a concept of a *universal* tool for real-time control and forecasting of any economy, under any market conditions. It is the aggregate cumulative market imperfection **(ΔP**) **-** which is defined as difference between the indexes of calculated "natural" or "normal" prices ($\mathbf{P_o}$) and current market prices (**P**), ($\mathbf{\Delta P = P_o - P}$). This figure is the driving force of macroeconomic dynamics and an integral indicator of economic activities [17].

To calculate the "natural" price, exergetic (in addition to monetary ones) measurement units are introduced in order to estimate the production costs of resources. Exergetic costs consist of both the natural component (as opposed to monetary ones) and the production (labor) component (in the same way as the monetary costs of resources). That is, the specific exergetic costs for the *i*th sector, where natural resources are extracted, are:

$$\mathbf{E_i = E_{abs,} + E_{prod}} \qquad (3)$$

where E_{abs} is the natural resource's absolute (natural) value that it has, even in the complete absence of economic activity; and E_{prod} is the cost of production resources per output unit. For the rest of sectors of the economy $E_{abs} = 0$.

The magnitude of the chemical exergy[2] of natural resource E_{abs} characterizes its absolute value, which it has, even while remaining non-extracted. This figure is a kind of natural value constant in the conditions of the planet Earth, which was calculated in thermodynamics for the main types of natural resources [18].

To calculate the specific production costs in the exergy dimension, the well-known V. Leontief's "input-output" model is used, which allows the most complete account of labor and capital flows in the economic system to calculate the vector of exergetic costs.

If we use the input-output matrix to calculate production costs in monetary terms, it is mathematically impossible to define a set of technologies that minimize the specific costs of these resources, because the quadratic matrix of equations to define the production costs, in which the right part is zero, has no unambiguous and single solution. That is, in monetary terms, any technology can be optimal depending on the relative prices for production resources. On the contrary, using the same matrix to define exergetic costs provides the inequality to zero of the equations' right-hand side (which is equal to the value of E_{abs}) for the sectors that extract natural resources. Therefore, in exergetic terms it is possible to obtain an unambiguous and unique solution of the system of equations, i.e. only one set of technologies that minimizes the specific costs of production resources.

Market prices are based on money supply (according to (1)) and specific exergetic costs are based on $\sum E_{abs}$, which is the sum for all extracting sectors. If we multiply the value of E_i from (3) by the product $M/\sum E_{авс}$ (which is the same for all sectors), we can convert exergetic costs into monetary units while maintaining the intersectoral proportions determined by exergetic costs. In this way, the vector of "natural" prices is defined in accordance with the CMI-model of macroeconomic dynamics. Thus, the money supply can be distributed between economic sectors in accordance with the proportions defined both by the specific exergetic costs (non-market mechanism) and by market prices.

The state of the economy *at the moment* when "natural" and market price indices coincide can be considered equivalent to perfect competition. In this state, the cost of production resources in both exergetic and monetary terms are minimal, and economic profit is zero, which, in particular, are quantitative signs of perfect markets. If the market price index is lower (higher) than the "natural" one, then there appear hidden overruns of production resources (compared to the technologically achievable minimum) in the exergetic dimension (ΔE), which "physically" limit the amplitude and duration of both growth and recession. These overruns are proportional to the value $\Delta P = P_o - P$, which characterizes the *degree of market imperfection*.

[2] Chemical exergy is the maximum possible thermodynamic work that can be obtained in the reversible process with the devaluation of a natural resource to the parameters of the "dead" state of the environment, i.e. the state when with the use of physicochemical processes it is impossible to obtain such work from the resource.

The value of money supply, at which the numerical equality of the indexes of "natural" and market prices is possible, is defined as M_{cMi}. At the same time, it is not so much its absolute value that is of fundamental importance, but the growth of M_{cMi}, which approximately equals the business cycle average of *the sum of real GDP increase and inflation*. The value of M_{cMi} directly affects the growth rate of real GDP as determined by the CMI-model. Then the monetary aggregate (M2 – M_{cMi}) produces no effect on the growth rate of real GDP, so it can be considered neutral, while the aggregate (M_{cMi}) can be considered non-neutral.

The initial driving force of macroeconomic dynamics (ΔP = Po - P) in general can be defined as [17]:

$$\pm\Delta \boldsymbol{P} = P_0 - P = \frac{\sum_{i=1}^{n}\left(E_{min_i}X_i\right)}{\sum_{i=1}^{n}\left(P_i^{base}X_i\right)} \times \frac{M_{cMi}}{\sum_{i=1}^{n}\left(E_{abs_y}X_y\right)} - \frac{\sum_{i=1}^{n}\left(P_iX_i\right)}{\sum_{i=1}^{n}\left(P_i^{base}X_i\right)} \qquad (4)$$

where *P, P_o* are respectively market and natural price indices, P_i^{base} - base year price for the *i*th sector; M_{cMi} - the value of neutral money supply; *m* - the number of extracting sectors; $E_{abs,\ y}$ - specific chemical exergy of natural resource (*y)*; X_y - the amount of natural resource extracted in the sector in physical terms; $E_{min,i}$ - specific exergy costs in the *i*th sector; X_i - output of goods or services for the *i*th sector; *n* - the number of sectors to which the economy is aggregated; and P_i is the market price in the *i*th sector.

If **ΔP** > 0, then *economic growth* is observed, if **ΔP** < 0, then there is a recession. Points where **ΔP** = 0 are the turning points of the economic cycle and macro-equilibrium at the same time. Until the value of Δ*P* becomes negative, *the economy is able to absorb external shocks* (or failures of regulators and speculators, etc.) without a recession, only with a slowdown.

Since the value of the cumulative imperfection of the markets is zero (or minimal) at points where Δ***P***→*0*, near these points the growth rate should be maximum (boom) with this combination of market conditions, i.e. the equality of expression (4) to zero is *a condition for maximizing the rates economic growth*. On the contrary, at points where Δ**P**→max, the cumulative imperfection of markets should be maximum, which causes *a change (correction) of the macroeconomic trend*, reversing the economic dynamics towards equilibrium, and towards the minimum value of cumulative market imperfection. Thus, the gap reflected by ΔP is *the driving force of macroeconomic dynamics*.

Unlike the Taylor rule, the definition of the "natural" price level in (4) is not related to the averaging of previous statistics, but is result of a calculation regardless of the level of market prices, and regardless of the current combination of market conditions. According to Taylor, the interpretation of potential output primarily requires data on productivity, labor force participation in the production process and change in full employment [19].

The structure of the economy in the CMI model is taken into account via the indicator of maximum efficiency of the use of production resources (minimum total cost of resources for GDP output), which is defined based on "input-output" tables with maximum possible detail by sector (4). In this way, the model considers the productivity and participation of labor in all sectors of the economy. And the sum of all employed in the sectors characterizes the value of full employment. Therefore, improving production efficiency automatically means changing the value of full employment.

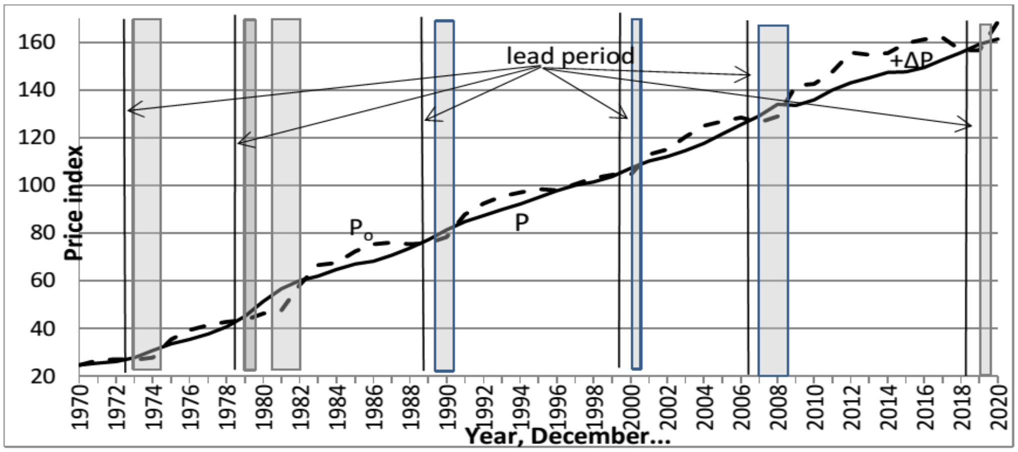
Thus, equation (4) connects all three key macroeconomic indicators: indirectly - the rate of economic growth (via the value of ΔP) and employment (via the sum of the values of unit costs of production by economic sectors) and directly - inflation (according to the price index). That is why it is possible to optimize all three macro indicators at the same time, by targeting only one indicator.

The generality of the CMI-model is a consequence of the *erogeneity* of current market prices, which reflect all known (and even unknown) to market agents' information. Therefore, the CMI-model does not need to accept any assumptions that limit the scope of its use, but is an integral part of the internationally known analogues (other things being equal, flexibility and inflexibility of prices and wages, perfect competition, etc.). Therefore, expression (4) is valid for *any country under any combination of market conditions*.

The main distinguishing feature of the CMI-model is the presence of an *"advance period"*, i.e. the period between the model's signal about the change in macroeconomic trend and the statistical confirmation of this change. The existence of this period is explained by the fact that the CMI model does not predict the GDP value itself (as traditional models do), but the incentives for GDP production, that is, the value of **(ΔP)**. Because there is a time lag in the transmission of incentives and regulatory policies, which almost always exceeds the time lag in statistical output, it becomes possible to predict future events using data about the past, as the "advance period" exceeds both lags.

All the above conclusions are confirmed empirically in *annual* terms on the example of the US economy for the last 50 years (from 1970 to 2021) [17] and of Ukraine's economy (from 1996 to 2017) [20], which *empirically* proves the generality of our model.

Figures 1 and 2 present a graphical confirmation of the adequacy of the CMI model in annual terms for the US and Ukrainian economies, respectively. As shown in Fig. 1, the presence of an "advance period" in the dynamics of the value **(ΔP)** allows identifying crisis phenomena in the economy before the statistics can confirm them. For example, information about the calendar time of the recession emergence in the USA can be obtained almost unambiguously 7-9 months before the stock market crash makes the recession obvious to everyone.



advance period

Fig. 1. Annual indices of market (P) and natural (P_0) prices for the US economy, respectively

Notes: gray columns – *duration of recession*; vertical black line – *signal about recession emergence.*

Source: P_0 – constructed by author, P – statistics (http://www.bea.gov/).

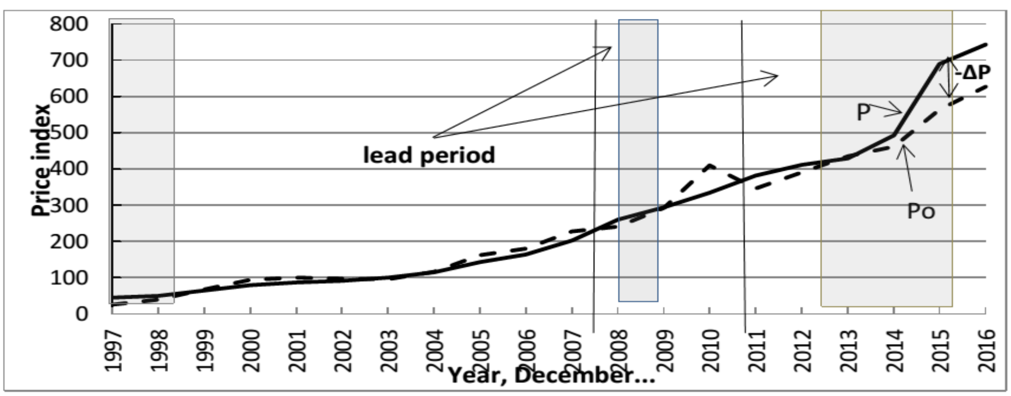


Fig. 2. Annual dynamics of indices of market (P) and natural (P_0) prices for the economy of Ukraine, respectively

Notes: gray columns – *duration of recession*; vertical black line – *signal about recession emergence.*

Source: P_0 – constructed by author [20], P – statistics (http://www.ukrstat.gov.ua).

The dynamics of the calculated value of the monetary aggregate M_{cMi} is presented in Fig. 3 together with that of the known monetary aggregates M1 and M2 for the US economy. According to the CMI model, it is the value of M_{cMi} that influences the real rate of GDP, i.e. money supply M within the range $0 \leq M \leq M_{cMi}$ is not neutral. Instead, the money supply M in the range $M_{cMi} < M < M2$ is neutral, i.e. such that does not affect real GDP. This conclusion is valid for any moment - both for short- and long-term periods.

In [21] it was empirically proved that the growth of the Fed's neutral money supply contributes to the growth of US stock indices rather than raises economic growth, as the growth rate of neutral money supply ($M2 - M_{cMi}$) almost coincides with the growth rate of the Dow Jones Industrial Average and S&P500.

At the same time, according to the CMI model of macroeconomic dynamics, the average growth rates of neutral money supply (M_{cMi}) are practically *equal* to the average annual growth rate of nominal GDP, which, in particular, corresponds to the above mentioned M. Friedman's monetary rule.

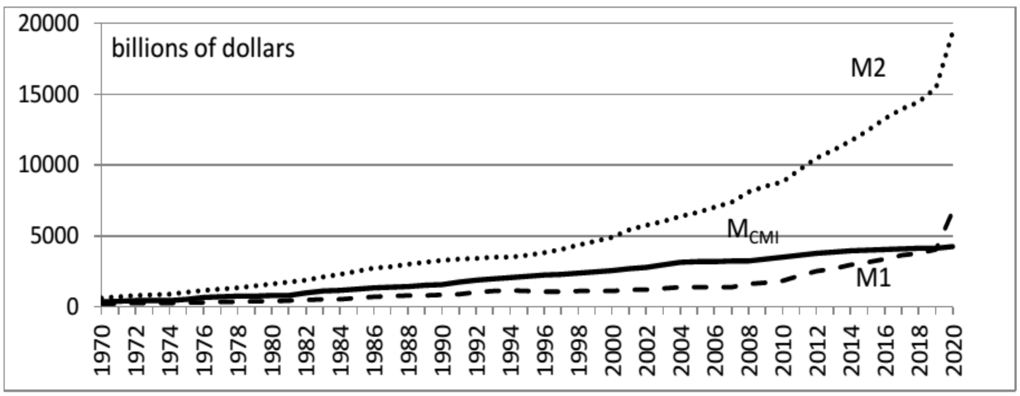


Fig. 3. Annual dynamics of monetary aggregates M1, M2 (The Fed - Money Stock and Debt Measures - H.6 Release) and calculated aggregate M_{cMi} for US economy

Note: the rapid growth of the M1 aggregate from the end of 2020 is due to the revision (expansion) of its components by the US Federal Reserve.

Source: constructed by author.

However, the above mentioned studies and justifications were performed on a 1-year scale, which is unacceptable both for monitoring the value of(ΔP) and for using this value as a tool for regulating monetary policy, as the information that is necessary for the regulator is unavailable for most of the year, while the identification error of the current state of the economy is too large (up to 6 months). Therefore, we modified the method of defining the value of (ΔP) on a 1-month scale and made calculations of this value from December 1999 to the present (over 246 months) for the US economy.

Fig. 4 presents the dynamics of the value $\pm \Delta P = P0 - P$ in *monthly* terms for the US economy. Comparison of Fig. 1 and Fig. 4 clearly shows how much the accuracy and efficiency increase of the use of such a monetary policy instrument as **ΔP** and it also shows the accuracy of forecasting the calendar time of beginning (end) of the last three recessions in the US economy. The introduction of monthly monitoring of the value of (ΔP) would reduce the error in defining the time of recession emergence as much as threefold times compared to the annual monitoring of this value (to 2 months).

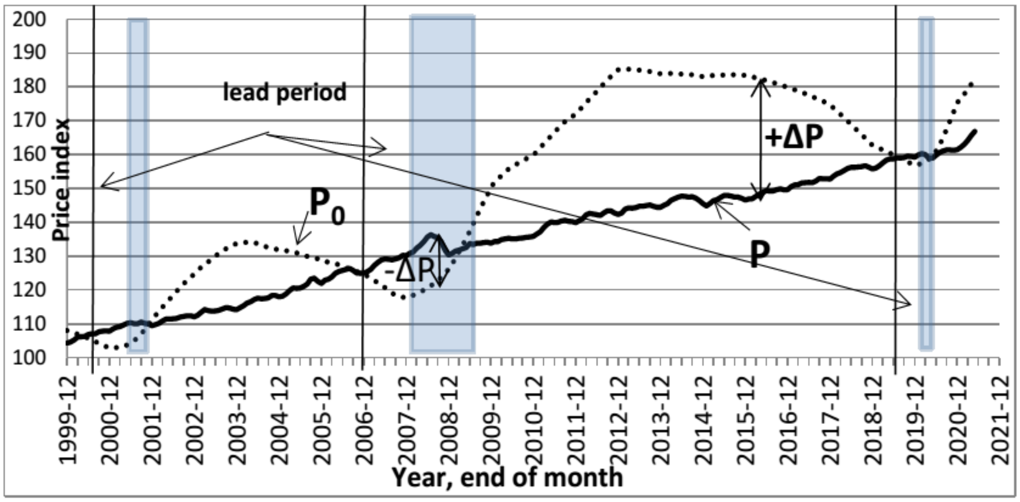


Fig. 4. Monthly dynamics of market indexes of market (P) and natural (P_0) prices in US economy

Notes: gray columns – *duration of recession*; vertical black line – *signal about recession emergence*, vertical dotted line - signal of correction of the macroeconomic trend.

Source: P_0 – constructed by author, P – statistics (http://www.bea.gov/).

Comparing the current value of (ΔP) with its target in real time will allow the regulator to make permanent changes in its policy to keep the national economy within the *optimal* value (ΔP_{opt}=0), which would maximize economic growth and employment at acceptable inflation rate. At the same time, by the magnitude of the difference between (ΔP) and (ΔP_{opt}=0) one can control the efficiency of the regulatory policy itself and adjust it in advance. If due to activity (or lack of activity) of the central bank the current value of ± ΔP goes beyond the optimal range, it is necessary to adjust the monetary policy (using all available tools) so as to return the value of ΔP to this range. If ΔP does not return to the optimal range after adjustment, it is necessary to continue the adjustment using other regulation tools.

As was shown in [22], constant increase in the neutral money supply by the US Federal Reserve (for example, within the monetary policy of "quantitative easing") provides a positive value **(ΔP > 0)** for a longer time, i.e. "extends" the growth phase of the economic cycle, although it does not ensure optimal monetary policy. This, in turn, contributes to the growth of employment even at relatively low (non-optimal) rates of economic growth. In general, employment grows faster at high rates of economic growth and slower at low growth rates.

Thus, the optimal range of values of **(ΔP)** in *annual* terms is [0 ÷ +5] (Fig. 1). The use of this range as a target ensures optimal monetary policy, i.e. maximizes the rate of growth and employment at acceptable inflation rate for a certain combination of market conditions, which has developed at a certain point in real time. At the same time, such targeting would will help stabilize the economy, and reduce the amplitude of fluctuations in the economic cycle. Each of these three macro indicators *is not targeted* separately, i.e. it is not possible to define the optimal value for each of them, as their optimal values constantly change over time together with permanent changes in the current combination of market conditions.

However, if we compare Fig. 1 and Fig. 4, we can see that in *monthly* terms (which is the most relevant for practical application) this range can be almost twice as large. But this issue requires further research, and so does the definition of quarterly and monthly dynamics of the value (ΔP) Ukraine's economy.

Finally, in contrast to Taylor rule (which does not operate with indexes), the difference in price indices (ΔP) is less sensitive to possible errors in statistics and their further refinement, which follows from the very nature of the indexes. Even a significant change in one of the index's components can have little effect on the change in the index itself, because each component has weighting factors (output in kind) that smooth out price fluctuations in individual sectors. In addition, the dynamics of the index's components can be multidirectional. This allows, for example, replacing the GDP price deflator in (4) with the CPI without losing the adequacy of the CMI-model. Fig. 1 shows the deflator, and Fig.4 – the CPI. This makes it possible to monitor the value of ΔP on a monthly basis, because critical data are published on a monthly basis.

Let us list the main *competitive advantages* of the proposed monetary policy tool - aggregate market imperfection (ΔP) - compared to the known rules of monetary policy and models of macroeconomic dynamics:

1) the indicator **(ΔP)** can be used not only as a simple monetary rule, but *simultaneously* as a *target* of monetary policy, the *reaction function* to assess the feedback between the actions of the regulator and the impact of these actions on the current economic situation and a *tool* to *stabilize* cyclical economic dynamics, which creates a *synergistic effect* of the implementation of monetary policy, making it more comprehensive;

2) the author's CMI-model of macroeconomic dynamics, on the basis of which the value **(ΔP)** is estimated, in contrast to the known world analogues, is valid for any combination of market conditions, for any country and at any time in real time. In

particular, it does not require standard assumptions (regarding the flexibility or inflexibility of prices and wages, the perfection of competition, ceteris paribus, etc.), which distort the reality and determine the validity of known models only under these assumptions. Therefore, the *tool* (ΔP) can be used by any regulator in any country;

3) the tool (ΔP) is integral and reflects the final (target) macro indicators. Therefore, its use makes monetary policy more flexible and effective, as it is possible to *simultaneously* use all typical local instruments for regulation, not only monetary policy (interest rates, monetary aggregates, etc.), but also other policies (the fiscal, antitrust, and innovation ones);

4) unlike the known monetary rules that do not take into account changes in the business cycle, the value **(ΔR)** by definition identifies both phases of the business cycle and the point (time) of transition from one phase to another (points of change in macroeconomic trends);

5) the indicator **(ΔP)**, in contrast to the Taylor rule, is insensitive to the accuracy of the initial data that the regulator has at the time of decision-making and to subsequent revisions of these data. According to the planned revision of preliminary data, the recommendation for the regulator acting according to the rule for **(ΔP)** will not change to the opposite (which may be the case if the Taylor rule is followed). In particular, in the indicator **(ΔP),** CPI can be used instead of the GDP deflator (as opposed to the Taylor rule), because the error associated with the difference in the growth rates of both price indexes is insignificant for **(ΔP)**;

6) monitoring of the value (ΔP) can be carried out *monthly* instead of *quarterly* (in contrast to the Taylor rule), which raises the efficiency of monetary policy based on (ΔP);

7) in contrast to the known monetary rules, which lack the ability to predict future events in economic development, the amount ***(ΔP)*** already has an "embedded" CMI-model of macroeconomic dynamics, whose competitive advantage is the presence of *"advance period"* (i.e. the period between the model's signal about the change of macroeconomic trend and the statistical confirmation of this change). This makes it possible to identify changes in the economy before statistics can confirm them. This allows pursuing monetary policy proactively, which can significantly increase its efficiency (even ensure constant and sustainable economic growth);

8) unlike the well-known monetary policy rules, the rule based on (ΔP) ensures the *optimization* of the ultimate macroeconomic objectives by maximizing economic growth and employment with an acceptable inflation for any combination of market conditions at any moment of real time;

9) in contrast to the well-known rules of monetary policy, the rule based on (ΔP) can be used to fulfill the *triple* mandate for any central bank, if the latter has such a mandate.

Conclusions and prospects for further research

The paper offers a new universal and unique monetary policy instrument - the aggregate cumulative market imperfection **(ΔP)**, which combines the advantages of well-known simple monetary policy rules and large complex models of macroeconomic dynamics, but does not have the main disadvantages of the former and the latter.

The universality and uniqueness of our instrument is that the indicator **(ΔP)** can be used *simultaneously* as: a) *a target* of monetary policy; b) a simple *rule* for the daily adjustment of monetary policy (the indicator has essential advantages over well-known global counterparts, such as the rules of Simons, Friedman and Taylor), c) a *reaction function* - the relationship between indicators of economic development and the central bank's response to the change of these indicators, that is, it can be used to assess the feedback between the regulator's actions and the these actions' impact on the current economic situation; d) a tool for stabilizing cyclical economic dynamics, i.e. for reducing the amplitude of business cycle fluctuations, and e) a tool to forecast the calendar time of emergence (end) of recessions and the time of change of macroeconomic trends.

If the government regulation keeps the value of (ΔP) within a given optimal interval (from 0 to +5), or targets only the indicator (ΔP), using all possible tools of monetary and, if necessary, other policies (not only discount rate or money supply), it is possible to control (but not target) all three main macroeconomic indicators: growth, employment and inflation.

Moreover, the *optimality* of these indicators will be *simultaneously* ensured by maximizing economic growth and employment with the desired inflation rate for the current combination of market conditions and for each moment of calendar time, which will also contribute to the stabilizing impact on cyclical economic dynamics. At the same time, each of the three macro indicators is not targeted separately, i.e. it is not possible to define the optimal value for each of them, because their optimal values constantly change over time together with the permanent change in the current combination of market conditions.

Monthly definition and monitoring of the value of **(ΔP)** for Ukraine's economy would make it possible for the national regulator for the first time in world practice to use this indicator as a target to optimize the three main macroeconomic parameters: growth, employment and real-time inflation.

Monitoring the value of **(ΔP)** allows early identification of changes in the macroeconomic trend and choice of both the best regulatory tools and the best time to apply them. All the more so as this indicator in itself predicts the time of onset (end) of recessions, which can be useful for early adjustment of assumptions and coefficients for various models used by the regulator and, especially, for large simulation models that are critically sensitive (in terms of results adequacy) to changes of the macroeconomic trend.

The indicator (ΔP) can serve as a simple rate of economic activities in Ukraine, which connects the macro- and micro-indicators of this activity. This opens the possibility to unite the actions of regulators at the macro and macro levels and assess the efficiency of their implementation within a single universal indicator (ΔP). That is, the monthly monitoring of the value of cumulative market imperfections (ΔP) (both for the economy as a whole and for its sectors (4)), can provide a competitive advantage to the regulator at both national and global levels, because the same indicator (ΔP) can be monitored for various economies.

Besides, monitoring the value of (ΔP) for the US economy would be also useful for the Ukrainian regulator for at least several reasons.

First, since the USA produces and consumes about a quarter of global GDP, then, according to statistics, a recession in the USA always causes recessions in most countries, including Ukraine, but usually with some time lag. At the same time, a recession in the USA initiates a crash on stock markets around the world, which leads to a collapse in commodity prices and, in turn, creates preconditions for recessions in Ukraine. That is why, additional monthly monitoring of the value of (ΔP) in the US economy would allow to define with maximum accuracy the time of collapse in global commodity prices and hence the time of recession in Ukraine's economy. Simultaneously, the time can be defined of the onset of a domestically driven recession in Ukraine (in the absence of a recession in the USA).

Second, such a competitive advantage of the CMI model as the presence of an "advance period", makes it possible to consider any recession in the USA as the best time to maximize business profits. And an opportunity arises for the national regulator to minimize negative consequences of the global financial and economic crisis (or even benefit from it) via early (before the stock market crash) regrouping of resources.

Regulators often begin to actively counter a possible recession after the collapse of global commodity prices, which is usually too late to regroup resources and prevent negative consequences for the economy.

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ОПТИМІЗАЦІЯ МОНЕТАРНОЇ ПОЛІТИКИ ТА СТАБІЛІЗАЦІЯ ЦИКЛІЧНОЇ ЕКОНОМІЧНОЇ ДИНАМІКИ

Показано, що, попри чинний мандат щодо проведення монетарної політики, кінцевою метою останньої (принаймні для центробанків розвинених країн) є контроль над трьома основними макроекономічними показниками: зростанням, зайнятістю та інфляцією. Однак пріоритети реалізації кінцевої мети можуть наштовхнутися на недосконалість макроекономічних моделей та

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правил монетарної політики, тож одночасно контролювати усі три макропоказники не видасться можливим. У статті пропонується новий інструмент для оптимізації макропоказників та стабілізації циклічної економічної динаміки при здійснення монетарної політики – сукупна кумулятивна недосконалість ринків, тобто відхилення індексу поточних ринкових цін від його «природного» рівня, який є предметом нашого розрахунку. Ця величина є рушійною силою макроекономічної динаміки в запропонованій CMI-моделі економічних циклів. Обґрунтовано основні конкурентні переваги цього інструменту монетарної політики порівняно з типовими моделями макроекономічної динаміки та правилами монетарної політики (Саймонса, Фрідмена, Тейлора). Зокрема, запропонований показник є справедливим для будь-якої комбінації ринкових умов, для будь-якої економіки та будь-якого моменту реального часу. Він може використовуватись одночасно як: 1) таргет монетарної політики, 2) «просте правило» для повсякденної корекції монетарної політики, 3) функція реакції (reaction function) для оцінки зворотного зв'язку між діями регулятора та впливом цих дій на поточну економічну ситуацію; 4) інструмент для стабілізації циклічної економічної динаміки; 5) інструмент для прогнозування календарного часу настання (закінчення) рецесій та часу зміни макроекономічних трендів. Якщо за допомогою державного регулювання утримувати величину сукупної кумулятивної недосконалості ринків у заданому оптимальному інтервалі (тобто таргетувати лише один показник), використовуючи весь можливий інструментарій як монетарної, так і, за необхідності, інших видів політики (а не тільки облікову ставку або грошову масу), з'являється можливість оптимізувати всі три основні макроекономічні показники. Оптимальність цих показників означає максимізацію темпів економічного зростання та зайнятості за бажаного рівня інфляції для поточної комбінації ринкових умов та для кожного моменту календарного часу, що також сприятиме стабілізаційному впливу на циклічну економічну динаміку. При цьому кожен із трьох макропоказників окремо не таргетується, тобто точно визначити оптимальне значення для кожного з них кількісно неможливо, оскільки їх оптимальні значення постійно змінюються в часі разом із перманентною зміною поточної комбінації ринкових умов.

***Ключові слова**: монетарна політика, інструменти регулювання, економічне зростання, зайнятість, інфляція, прості правила монетарної політики, стабілізація економіки*