



# Empirical justification of the elementary model of money circulation



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## HIGHLIGHTS

- The set of equation for money circulation in the production system is discussed.
- The contribution to GDP from the money system is defined and discussed.
- The applicability of the model to the money circulation in Russia is confirmed.

## ARTICLE INFO

### Article history:

Received 9 January 2017

Received in revised form 9 September 2017

Available online 6 November 2017

### JEL classification:

E12

E44

E51

### Keywords:

Bank system

Efficiency of bank system

Money circulation

Money system of Russia

Endogenous money

## ABSTRACT

This paper proposes an elementary model describing the money circulation for a system, composed by a production system, the government, a central bank, commercial banks and their customers. A set of equations for the system determines the main features of interaction between the production and the money circulation. It is shown, that the money system can evolve independently of the evolution of production. The model can be applied to any national economy but we will illustrate our claim in the context of the Russian monetary system.

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## 1. Introduction

In the previous article [1], considering a national economic system and following the macroeconomic lines defined by Godley and Lavoie [2], we succeeded in designing a simple model of money circulation that incorporated the government, the central and commercial banks, and many producers and consumers—customers of commercial banks. To catch the main peculiarities of money circulation, we have developed a simple macroeconomic scheme, each actor of which, apart of the central bank, is characterized by its deposit and debt, and the actors are interacting via fluxes of products and money. The model allows us to discuss some features of the relationship between the money and real-production layers of the system, which was the main aim of the previous article [1]. This lays in the context of appeal of some authors [3,4] calling for the development of new tools to study and better understands the relationship between the real economy and GDP.

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The developed model describes money circulation disregarding its mechanisms, resulting eventually from money exchange between separate agents, that was described and investigated in many modern work [5–10]. Physicists suggested several potential solution in the study of the monetary circulation. Wang and Zhang [5] developed agent model to show that the velocity of the money is mainly based on consumers' income and debts. There also exists works using a macro perspective to characterize the evolution of wealth [6,7,10], emphasizing an existing gap between monetary system and productive sphere. In line with these studies, this paper uses a descriptive macro-model to show that the evolution of the monetary system is mainly based on financial fluxes meaning that it can therefore move independently of the evolution of production. We think that some characteristic peculiarities of money circulation could be better understood under a general look at the system, considering the balance relation for each economic actor. This article offers an empirical justification of the circuitist approach of money circulation in a Russian context.

We shall remind the main aim of our research. The economic system takes the form of a productive process likely to generate real wealth for society. This created value is usually estimated through the Gross Domestic Product (GDP), which is the sum of outputs of all production sectors. In line with [1] and earlier work one of the authors [11], it is convenient to assume that the production layer consists of three sectors: the first sector creates basic production equipment, the second one creates non-material intermediate products (consumed by the other two sectors and stored in warehouses and depositories for the future production and non-production consumption) and the third sector creates products for direct consumption by humans. This Keynesian way of structuring the national economy is common in the economic literature, and the conventional expression for GDP takes the following form

$$Y = I + G + C, \quad (1)$$

where  $I$ ,  $G$  and  $C$  are the final outputs of the sectors, that are considered as components of the GDP, estimated (in money units) by value of created commodities: the quantity  $I$  is estimation of the value of investment, distributed over the three sectors; the quantity  $G$  is estimation (in money units) of results of all long-lasting projects (investment in human capital, R&D, infrastructure and so on); we consider this quantity is equal to the government expenditures. For simplicity, it is assumed that the product of the third sector in the amount  $C$  is completely consumed.

The exchange of products between sectors, as we know, is accompanied with circulation of money. Globally then, the finance layer generates the amount of money corresponding to the value created by the productive layer. In this context, there is a correspondence between fluxes of money and fluxes of products. However, one can note that there is no indication of the activity of finance layer in Eq. (1). To introduce money into this frame, we investigated [1] the motion of products and money in the three-sector model, which has allowed us to generalize the expression for the Gross Domestic Product, that will be discussed in Section 2.4. This article aims to confirm the previous results and, in line with the circuitist approach to money [12–16], suggest a potential research by providing in this way a solid base to understand interactions between the real-production and money sides of the economy.

In the next section, we review the balance relations for the actors of the model: the government, a central bank, commercial banks and many customer of the commercial banks. In accordance with the works of Keen [15,16], we will treat debt as a data record rather than a negative money. This specific assumptions is very important since it implies that money used to repay debts goes into a debt account which negates an equivalent sum of debt.<sup>1</sup>

## 2. The actors of the elementary model of money circulation

The production system, which is at the heart of the human society, is considered here to be immersed in the money system [1]. This monetary system is organized and managed by a central bank and commercial banks. The situation is shown schematically in Fig. 1 wherein we use two characteristic quantities: paper money  $M_0$  and the sum of paper money and all deposits in commercial banks  $D$ , that can be written as follows,  $M_2 = M_0 + D$ . This quantity is called the *monetary mass*. Economic actors interact with each other by using money as an exchange means. This money is used for purchasing of resources, both for consumption and for production.

### 2.1. The customer of the commercial banks

In our model, we deal with the aggregated behavior of customers and producers whose deposit and credit are respectively characterized by  $D$  and  $B$ . Customers of commercial banks create a demand for credit money, and they appear to be the major sources of the progress of the economic system. At any time, when the customers need money, they determine whether their own money can be a possible source for expenses or if their situation requires a loan from a commercial bank. The motion of money in the three-sector production system was described in details in a previous paper [1], which determined the balance equation for the aggregate quantities  $D$  (deposits) and  $B$  (debts), recorded as

$$\frac{dD}{dt} = rD - qB + Y - I - C + W_G - T + A_0 - \kappa(D + M_0) + \frac{dB}{dt} \quad (2)$$

<sup>1</sup> A number of authors in the circuitist literature often assume that the repayment of debts destroys money, see Graziani [17] or Keen [15] for further information on that point.

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