



Money creation and circulation in a credit economy



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HIGHLIGHTS

- An agent-based model is developed to study money creation and circulation.
- The money multiplier is determined by not only borrowing but also repayment.
- The velocity of money depends on both money-related and debt-related factors.

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ABSTRACT

This paper presents a multi-agent model describing the main mechanisms of money creation and money circulation in a credit economy. Our special attention is paid to the role of debt in the two processes. With the agent-based modeling approach, macro phenomena are well founded in micro-based causalities. A hypothetical economy composed of a banking system and multiple traders is proposed. Instead of being a pure financial intermediary, the banking system is viewed as the center of money creation and an accelerator of money circulation. Agents finance their expenditures not only by their own savings but also through bank loans. Through mathematical calculations and numerical simulation, we identify the determinants of money multiplier and those of velocity of money. In contrast to the traditional money creation model, the money multiplier is determined not only by the behavior of borrowing but also by the behavior of repayment as well. The velocity of money is found to be influenced by both money-related factors such as the expenditure habits of agents with respect to their income and wealth and debt-related factors such as borrowing and repayment behaviors of debtors and the reserve requirements faced by banks.

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1. Introduction

The issue of how debt affects the economy has been mentioned for a long time but was not attractive to mainstream economists until the recent crisis. Except for a few attempts [1–4] to introduce debt into their models, mainstream macroeconomists have a longstanding habit of ignoring debt [5] and have spent tremendous effort in proving the legitimacy of continuing this tradition [6]. In contrast to these theorists, however, empiricists found that debt, instead of being something that could be ignored, is actually the driving force behind the ups and downs in the economy [7–12]. Because of the inability of current macroeconomics to predict and explain the current crisis, there is growing appeal for it to be revolutionized so that it takes the financial sector seriously. It is therefore obvious that debt, which is central to finance, requires a repositioning to match its real significance.

Evidence of the great influence of debt on the economy can be found in all crises, and this time was no exception [7–9]. The Great Depression in the 1930s, for example, was triggered not only by the reduction of the monetary base but also by the

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contraction of credit [1]. The 2008 financial crisis and the 2009 EU debt crisis, once again, revealed the causal link between financial crises and rapid surges in debt [8]. As a matter of fact, there is a strong correlation between the change in debt and the change in macroeconomic activities in both critical and normal times [13,14].

Regarding all periods, opinions are divided between mainstream economists who attribute all fluctuations to real factors and others who think that monetary factors should receive much greater attention. Paul Krugman, one opinion leader and one of the first economists who acknowledged the failure of macroeconomics [15], is the best representative of current mainstream opinion on money and debt. In his recent work, he insisted that the level of debt is not something we should worry about and financial institutions, instead of being the center of credit creation, are merely intermediaries that could be ignored [16]. These arguments stand in stark contrast to those that place strong emphasis on the role of the financial sector [17–19]. Several big names can be listed. Fisher attributed deflation brought on by the crisis to debt liquidation [20]. Minsky proposed the financial instability hypothesis based upon the distinction of three types of borrowers [21]. All of these theories provide various ways to understanding the impacts of debt on the economy.

To study the influence of debt on the economy, one of the most direct and popular ways is to study its impact on aggregate demand [2,22–25]. Steve Keen, in his early work, argued that aggregate demand is the summation of preceding income and change in debt [18]. Afterwards, he changed the expression into the sum of preceding income and the product of the change in debt and the velocity of money [19]. Regardless of which expression is correct, it can be implied that debt influences both money creation and money circulation.

The act of borrowing and lending is the core of money creation. When a commercial bank lends to a borrower, both agents' balance sheets will expand with money (asset to the borrower and liability to the commercial bank¹) and debt (asset to the commercial bank and liability to the borrower) being simultaneously created. In the textbook story of money creation, the quantity of loans commercial banks could possibly grant is constrained by the quantity of base money and reserve requirement. Models of this kind, however, are often criticized for being static and deficient in micro foundations. Due to the lack of the concepts of stocks and flows, these models often neglect the time and dynamics of the money creation process. Even if there is time, it is hypothetical logic time rather than realistic historical time. The behaviors that constitute the money creation process are characterized by ratios of stocks such as the ratio of currencies to deposits which considers no time and provides no accounts for how the frequency of borrowing or spending could make a difference on the money aggregate. With everything covered up by ratios of macro variables, important individual behaviors are ignored. One example of this kind is the common omission of the repayment behavior. Economists talk about banks' lending behavior but hardly consider the consequences of loan repayments. Actually, when debtors repay their debt, money already created before will be annihilated [26,27]. Analogous to positrons and negatrons, debt and money are found to arise or disappear simultaneously [28]. It is demonstrated by Siyan Chen et al. [29] through a random exchange model that the repayment behavior makes a difference to the economic equilibrium despite its idealist postulations of random exchange and the simple characterizations of banks.

The creation and destruction of debt also affect the process of money circulation. Since debt is a useful means to get money where it is most needed, from creditors with an excess of it, to borrowers who are short of it, it enables debtors to make consumptions that would have been impossible without the loan. In other words, the creation of debt will bring about more transactions. One way to describe the impacts of debt on the circulation of money is to study its impacts on the velocity of money, which is the frequency at which one unit of money participates in transactions. The velocity of money circulation is a central matter in monetary theories which has attracted much attention for hundreds of years. Although exploration of the velocity can be traced backward to the earlier works in 1660s [30], most of current investigations of velocity is commonly attributed to Irving Fisher's exchange equation, $MV = PY$, where M is the total stock of money, V is the circulation velocity of money, P is the average price level and Y is the total output [31]. From this equation, the velocity of money can be computed as the ratio of transaction volume or aggregate income to money stock. Based on this equation, many theoretical and empirical research works on the velocity have been carried out to examine its determinants [32–41]. However, the Fisher Equation does not look into the intrinsic properties of the velocity. In the microscopic view, the velocity can be measured by the reciprocal of the average holding time of money, which is the time interval between two money transfers [42,43]. Also, it was found that the distribution of wealth and the required reserve ratio [44] would have a critical influence on both the distribution and the velocity of money. However, it remains ambiguous what role debt plays in the process of money circulation.

In this paper, we propose an agent-based model to depict the dynamic process of money creation and money circulation in a credit economy. To simplify the analysis, we employ the textbook assumption of exogenous money where the lending capability of banks is restricted by the money base and the required reserve ratio. Meanwhile, compared to the traditional theories, we make two major extensions. The first extension is to take the repayment behavior into account in the process of money creation. The second is that loans from banks are used to financing expenditures which create money and accelerate money circulation simultaneously. Through computer simulations, we demonstrate macroscopic impacts of individual behaviors and institutional mechanisms, which are specifically embodied in two variables, the money multiplier and the velocity of money. Section 2 presents the existing theories of money creation and money circulation. Section 3 illustrates the model in detail. Theoretical analysis of the model is performed in Section 4, while the simulation results are presented in Section 5. We finish with some conclusions in the last section.

¹ Here we suppose that the loan is given in the form of deposit. If the loan is in the form of currency, then money will be the liability of the central bank.

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