The Endogenous Money Hypothesis – Empirical Evidence from the United States (1959-2008)

Paul D. Mueller*

Joshua Wojnilower**

Abstract

Standard economic textbooks portray the money supply as exogenous. Most of these use a money multiplier framework to demonstrate the causal role of the monetary base in determining commercial bank lending and overall economic activity. In contrast, endogenous money theories attribute the determination of commercial bank lending and overall economic activity to the demand for credit, not the supply of money. In these theories, the demand for credit determines the supply of money, which banks create *ex nihilo*. We use updated Granger-causality tests to analyze quarterly U.S. data from 1959 to 2008 and find evidence that changes in commercial bank lending cause changes in both the monetary base and nominal income. Our results provide further support for the endogenous money views that the money supply has always been endogenous and that credit plays an important role in the money supply process. Endogenous money theories therefore provide a strong foundation for analyzing how credit and monetary policy affect overall economic activity.

Keywords: Endogenous Money, Money Multiplier, Credit, Money Supply, Monetary Base, Federal Reserve System, Granger-Causality

JEL classifications: C32, E40, E51, E58

We gratefully acknowledge comments from Louis-Philippe Rochon, Garrett Jones, Claudia Sahm, Mark A. Sadowski, Lawrence H. White, and a couple anonymous referees. All remaining errors are our own.

*****Department of Economics, The King's College, 56 Broadway, New York, NY 10004.
**Corresponding author: Independent Evaluation Office of the International Monetary Fund, 1900 Pennsylvania Ave NW, Washington, DC, 20431. Email: jwojnilower@gmail.com. Phone: 513-377-1447.

Electronic copy available at: https://ssrn.com/abstract=2355178

The Endogenous Money Hypothesis –

Empirical Evidence for the United States (1959-2008)

1 Introduction

"In the real world, banks extend credit, creating deposits in the process, and look for the reserves later" (Holmes 1969, p. 73). Alan Holmes, a former senior vice president of the New York Federal Reserve Bank, made that statement nearly fifty years ago. Recently Seth Carpenter, an associate director of the Federal Reserve Bank, concluded that "the narrow, textbook money multiplier does not appear to be a useful means of assessing the implications of monetary policy for future money growth or bank lending" (Demiralp and Carpenter 2012, p. 74). Despite these admissions by Federal Reserve Bank officers, and empirical evidence to the contrary, standard economic textbooks persist in teaching monetary theory using a money multiplier framework and exogenous money supply (see, for example, Abel et al. 2011; Mankiw, 2011; Mishkin 2013).

While this lack of realism may not have affected the accuracy of forecasts from exogenous money theories much when the Fed was maintaining a federal funds rate target by adjusting the supply of reserves, forecasts based on a money multiplier framework have been completely wrong since the implementation of the Federal Reserve's permanent floor framework (for a discussion, see Mueller and Wojnilower 2016). Furthermore, the lack of realism in exogenous money theories has always impaired their ability to provide sound policy advice.[1] In contrast to standard economic textbooks, post-Keynesians contend that the money supply is

[1] It may be possible to accurately forecast future economic behavior on the basis of an observed historical relationship between two variables, regardless of whether or not any causal relationship between the variables exists. However, in attempting to change future economic behavior, one cannot rely on the same observed relationship holding true, which is known as the "Lucas critique." Sound policy advice must therefore be based on the actual behavior of economic agents that exist in the world one intends to change.

Electronic copy available at: https://ssrn.com/abstract=2355178

endogenous, jointly determined by the demand for credit and the demand for money (see, for example, Lavoie 1996; Rochon 1999, Palley 2013).

Exogenous and endogenous money theories have different empirical implications that we should be able to observe using statistical tests. In his seminal book, *Horizontalists and Verticalists*, Moore (1988) provided the first empirical evidence for the endogenous money hypothesis using Granger-causality tests. Since then, a broader literature developed testing similar empirical hypotheses on longer time-series and spanning several different countries (Palley 1994; Howells and Hussein 1998; Nell 2000-2001; Vera 2001; Shanmugam et al. 2003). Although empirical evidence stemming from these analyses supports endogenous money theories, this body of evidence has been insufficient to displace exogenous money theories and the money multiplier framework within standard economic textbooks.

If the endogeneity of money is empirically verifiable, why has this hypothesis remained outside the core of standard economic textbooks? Our paper advances endogenous money theories in several ways. First, to the degree that Bayesian inference provides a reasonable representation of human thinking, individual studies will do little to change strongly held beliefs. Perhaps, the current body of evidence remains too small to affect the standard view significantly. One paper will not fix this problem but it will help. Second, Granger-causality tests may not provide sufficient evidence for or against a given hypothesis. Results from standard Granger-causality tests are sensitive to pre-test outcomes, which often have low power, i.e. a higher probability of committing Type II errors. We use Toda and Yamamoto Granger-causality tests, which are significantly less sensitive to pre-test outcomes. Third, the results of previous studies may be due to small sample bias, as several year periods limited the number of observations. We use a much larger data set than many previous studies (quarterly U.S. data from 1959 to 2008).

Finally, the endogenous money theories are simply inconsistent with the notion of a "barter" economy and the *a priori* assumption that money is neutral, upon which much of modern macroeconomic theory is built. While empirical analysis can neither prove or disprove a theory, it can provide evidence for or against a theory's domain of validity (or its scope conditions). Our paper therefore strengthens the argument that endogenous money theories are, at a minimum, relevant to understanding our monetary system.

Our statistical analysis of quarterly U.S. data from 1959 to 2008 generates results broadly consistent with endogenous money theories and entirely inconsistent with exogenous ones based on the money multiplier framework. We find that Granger-causality runs from commercial bank lending to the monetary base but not vice versa. Moreover, we find evidence that causality runs from commercial bank lending to nominal income, while no relationship exists between nominal income and the monetary base. Overall our results therefore lend further support to endogenous money theories.

The analysis proceeds as follows. Section 2 outlines and contrasts exogenous money theories with endogenous money theories, more specifically with the "revolutionary" view put forth by Rochon (1999).[2] Section 3 develops several specific empirical hypotheses from each set of theories. Section 4 explains the methodology and data used to assess the validity of those hypotheses. Section 5 reports results from our statistical analysis. Section 6 concludes.

2 Exogenous versus Endogenous Monetary Theories

[2] Rochon and Rossi (2013, p. 212), building on Rochon (1999), "explore and answer [the question of] … whether money has always been endogenous, or whether its endogeneity is the result of recent events and, in particular, of the evolution of the monetary and financial system." They label these two opposing post-Keynesian theories the "revolutionary" and "evolutionary" views, respectively. Our use of the term "revolutionary" therefore reflects the view that "money has always been endogenous, irrespective of the historical period or of specific institutional arrangements" (Rochon and Rossi 2013, p. 212).

Within modern macroeconomics, there exist numerous schools of thought on modern monetary systems (e.g. Monetarist, New Keynesian, post-Keynesian, etc.). As one would expect, there are disagreements between schools regarding issues within monetary economics, such as the transmission mechanism(s) of monetary policy. However, there also exists disagreements within schools of thought. Post-Keynesians, for example, argue about the degree to which the money supply is exogenous or endogenous (for an overview, see Lavoie 1996).[3] We highlight this particular disagreement not to rekindle the debate, but rather to propose a different categorization of theories for the purposes of this article. Going forward we focus on differences between those theories that employ an exogenous money supply based on a money multiplier framework versus post-Keynesian theories that employ an endogenous money supply.[4]

2.1 Exogenous Money Theories

Standard economic textbooks discuss the relationship between the monetary base, the broader money supply, and overall economic activity in the following manner. A central bank affects broader levels of the money supply through a money multiplier framework, by exogenously changing the size of a country's monetary base. This money multiplier framework refers to the process by which banks convert reserves into loans, which once spent and redeposited, enables banks to reconvert a *portion* of reserves into loans, thereby "multiplying"

[3] Palley (2013, p. 406) claims that "Twenty-five years [after Moore's book was published], horizontalism has largely morphed into structuralism." Our discussion therefore focuses more closely on the distinction between structuralists and verticalists.

[4] It's important to note that New Keynesian theories represent a middle ground where an endogenous money supply is based on a money multiplier framework. Palley (2013, p. 411) argues this is problematic for two reasons: "First, the mainstream views the money supply as endogenous because of interest rate targeting rather than because of the fundamental nature of the process. Second, credit remains invisible and apparently irrelevant for the money supply process in the neo-Keynesian representation of interest rate targeting regimes." Although our discussion of New Keynesian theories is very limited, our empirical analysis distinguishes these mainstream views from post-Keynesian endogenous money theories. We discuss the relevant implications of our results in the conclusion.

the initial quantity of reserves into a much larger quantity of deposits. This process continues up to a certain limit, determined by either the inverse of the required reserves ratio or a combination of the currency-deposit and reserve-deposit ratios. Portfolio decisions of households and firms therefore determine the actual size of the money multiplier, which is simply the ratio between a given measure of the broad money supply and the monetary base. A central bank can nevertheless target any desired broad money supply by simply adjusting the size of the monetary base. The money supply, in the traditional sense, therefore remains exogenous (Rochon 1999).

Assuming the central bank exogenously controls the money supply, changes in the money supply translate directly into changes in nominal income, i.e. NGDP. If the velocity of money, or demand to hold real cash-balances, remains stable then changes in nominal income will be proportional to changes in the money supply. However, if the velocity of money varies then changes in the money supply will create more or less than proportional changes in nominal income. Either way the direction of causality running from reserves to loans to deposits to nominal income remains intact. Finally, although the central bank's actions may cause short-run variations in real economic growth due to "sticky" prices or financial frictions, in the long-run only the price level ultimately changes (see, for example, Friedman 1968; Bernanke 1983).

To be clear, this money multiplier process has always been a wildly inaccurate descriptive representation of monetary systems. The bank's action of making a loan to firms or households simultaneously creates a corresponding deposit, thereby increasing both the asset and liability side of its balance sheet (see Figure 1). As the bank's reserves are unchanged, it should be clear that the process does not involve converting reserves into loans. In fact, banks do not need reserves in order to make a loan and are prohibited from lending reserves outside of the banking system, i.e. to households and firms. The only manner by which banks can "convert"

reserves into loans is therefore by lending reserves to one another. Yet this action does not change the broader money supply, meaning the money multiplier remains a myth.

Figure 1

Bank's Balance Sheet **before** Making a Loan			
Assets		Liabilities	
Reserves	100	Equity	100

Bank's Balance Sheet **after** Making a Loan			
Assets		Liabilities	
Reserves	100	Equity	100
Loans	+100	Deposits	+100

While one might expect that hypotheses built on unrealistic assumptions would be deemed less significant, Milton Friedman argued that the reverse is, or perhaps should be, true. Friedman (1953, p. 14-15) claimed that:

> Truly important and significant hypotheses will be found to have 'assumptions' that are wildly inaccurate descriptive representations of reality, and, in general, the more significant the theory, the more unrealistic the assumptions (in this sense). … To put this point less paradoxically, the relevant question to ask about the 'assumptions' of a theory is not whether they are descriptively 'realistic,' for they never are, but whether they are sufficiently good approximations for the purpose in hand. And this question can be answered only by seeing whether the theory works, which means whether it yields sufficiently accurate predictions.

Exogenous money theories are therefore "significant" seemingly for their inability to describe reality and their purported ability to accurately predict economic behavior.

2.2 Endogenous Money Theories

In contrast to mainstream schools of thought, post-Keynesians place significant emphasis on the realism of assumptions underlying their theories. The post-Keynesian approach to monetary theory therefore builds upon the historical nature of money and the operational details of monetary systems, including central banking. However, as alluded to above, this does not imply that post-Keynesians agree upon a specific theory of endogenous money. Nor is it true that post-Keynesians are the only school of thought with theories of endogenous money. Circuitists, or circulationists, also employ theories of endogenous money within their sequential analysis. Describing the numerous variations would, however, take us too far afield. Instead, we focus on Rochon's (1999) approach, which provides a more comprehensive foundation for future research than Moore's (1988) approach in *Horizontalists and Verticalists*.[5]

Rochon's approach focuses on the causal role of credit rather than money in overall economic activity within the framework of a monetary circuit. The monetary circuit begins with firms determining their demand for credit. They must obtain loans before beginning production since they "capture the income from consumption (and saving) only after goods have been produced, brought to market and sold" (Rochon 1999, p. 44). Firms base their demand for credit upon several variables, including their production costs and expectations of effective demand (Rochon 1999).

The next step in the monetary circuit is banks' provision of credit to firms. In contrast to exogenous monetary theories where banks are price-takers, Rochon assumes that banks are both price and quantity setters. Banks set their price, i.e. the rate of interest on loans, "as a mark-up

[5] One could argue, as a reviewer appears to, that the structuralist approach outlined by Palley (2013) provides an even more comprehensive foundation for future research. Rochon's approach does, however, incorporate the aspect of the structuralist position most relevant to our empirical analysis. More specifically, Rochon (1999) recognizes that money demand affects the money supply and interest rates, which in turn affects the demand for credit. Rochon's approach is therefore suitable for our purposes.

over the exogenous, central bank rate, with respect to the *robustness* of the creditworthiness of bank borrowers" (Rochon 1999, p. 279).[6] Separately, banks determine the minimum level of creditworthiness at which they are willing to lend (Rochon 1999). With these measures set, banks are then willing and able to meet all creditworthy demand (see, for example, Moore 1988; Lavoie 1996; Wolfson 1996; Rochon 1999).[7]

With the creditworthy demand for and supply of credit established, the actual extension of credit takes place. When making a loan, a bank creates an asset and a liability on its own balance sheet as well as that of the borrower.[8] Hence, the bank's extension of credit creates deposits, or money, *ex nihilo*. As Rochon (1999, p. 62) aptly notes, "In this context, *money* is 'credit-driven and demand-determined,' and does not arise from an existing pool of money. The issue of scarcity does not exist." Firms can now use their "credit-money" to pay workers and the production process begins.

At the end of the monetary circuit, after the production of goods takes place, households decide how to divide their income between consumption and saving. Consumption spending creates income for firms which, in turn, allows for the repayment of loans. On the other hand, saving leads to a secondary decision for households regarding their division of savings between

[6] Lavoie (1996, p. 277) argues that "For post-Keynesian monetary theory to be truly distinct from various neoclassical versions of monetary theory, both the loanable funds approach and the Wicksellian natural rate of interest must be discarded. While neither is sufficient, or probably necessary, this is *most simply* done by claiming that the central bank is in position to set nominal interest rates—and even *real* rates of interest—by adjusting the former to the actual or expected inflation rate (Moore, 1988, p. 265; Ciccone, 1990, p. 455; Pivetti, 1990, p. 460; Smithin, [1994], p. 172)."

[7] The ability of banks to meet all creditworthy demand refers to banks, in aggregate. There are, however, reasons to believe individual banks face financing constraints that limit their supply of credit (for an overview, see Palley 2013).

[8] This depiction of the loan representing an asset and deposits representing a liability is from the perspective of a bank's balance sheet. A borrower's balance sheet would reflect the reverse depiction, where the loan represents a liability and deposits represent an asset.

cash, deposits and other financial instruments, such as securities. This decision reflects the liquidity preference of households and determines, at least in part, the outstanding quantity of money (Rochon 1999). Moreover, the liquidity preference of households determines, at least in part, the split of existing money between various types of bank liabilities, such as savings deposits or certificates of deposit. Firms ultimately capture these household savings either through the sale of securities (equity and debt) or through the refinancing of loans by banks (Rochon 1999). Firms then face similar decisions, in respect to households, regarding their allocation of savings across various financial instruments. The circuit finally closes with the repayment of loans and a new circuit begins with firms, again, expressing their demand for credit. We must note that households' and firms' portfolio decisions, i.e. liquidity preference, will affect "the spectrum of interest rates which will certainly have feedback effects" (Rochon 1999, p. 297). Monetary circuits are therefore not only overlapping in time, but also connected through time by the liquidity preference of households and firms.

This depiction of Rochon's approach briefly refers to the central bank's role in setting an exogenous base rate of interest but, as of yet, fails to distinguish its role in supplying money. The primary role of a central bank "is to guarantee the stability of the financial market" (Rochon 1999, p. 17) by ensuring a well-functioning payments system. A central bank must therefore be willing to supply the quantity of reserves demanded, at its exogenously set price (see, for example, Moore 1988; Rochon 1999; Lavoie 2005). A demand for reserves arises at both the beginning and the end of the monetary circuit. At the beginning of the circuit, a demand for reserves by banks arises from the demand for credit. At the end of the circuit, a demand for

reserves by households arises from the demand for cash, as a part of their savings.[9] The supply of money by central banks, which is similarly demand-determined, is therefore not causal in the determination of credit or income.

Rochon's (1999, p. 63) approach to endogenous money therefore highlights the following five characteristics:

1) reverse causality between money and income, specifying that the causality runs from expected (or desired) income of firms, to the demand for credit, to money and effective income (Robinson, 1956, 1971);

2) reverse causality between reserves, deposits and loans (Pollin, 1991; Holmes, 1969; Lavoie, 1992; Eichner, 1987), where reserves are endogenous and have no causal influence on loans;

3) reverse causality between savings and investment (Kregel, 1973; Davidson, 1972; Shapiro, 1977), thereby implying that firms must finance production before any saving is generated;

4) an exogenous base rate of interest (Lavoie, 1996; Hewitson, 1995; Smithin, 1994; Wray, 1995); the base rate of interest is not determined by any money market mechanism where demand and supply interact;

5) the money supply is "demand-determined and credit-driven" – 'money' is created *ex nihilo*, and is not a result of portfolio decisions. In this sense, 'money' exists in a continuous circular flow, and is a result of the demand for credit allowing firms to fulfill their expenditure plans. The supply of credit is endogenous, based on the decisions of commercial banks. 'Money' is primarily a flow, created by credit, and extinguished through the reimbursement of loans (Eichner, 1987; Lavoie, 1984, 1992; Parguez, 1984, 1987).

3 Empirical Hypotheses

In their seminal work on monetary history, Friedman and Schwartz ([1963] 2008) fail to differentiate between exogeneity in the control and statistical senses (Moore 1979). Friedman and Schwartz ([1963] 2008) correctly define the monetary base as exogenous in the control

[9] Rochon (1999 p. 164) notes that "The former (credit) is Eichner's [1987] 'accommodative' supply of reserves, while the later (money) is his 'defensive' behavior."

sense, since the Federal Reserve is capable of determining the monetary base, irrespective of changes in other economic variables. In statistics, however, "to say a variable is exogenous is to regard it as [statistically] independent of the influence of the variable whose value it seeks to explain" (Moore 1979, p. 55). Claiming that changes in the monetary base are exogenous, in the statistical sense, therefore assumes that those changes are statistically independent of any influence from commercial bank lending, the broader money supply, and nominal income. While not disputing that the Federal Reserve can control the size of the monetary base, endogenous money theories claim that the monetary base is *not* exogenous in the statistical sense of the word. Instead, the monetary base is statistically endogenous to commercial bank lending because such lending affects commercial banks' demand for reserves and, ultimately, the central bank's supply of reserves.

Endogenous money theories focus on the causal role of credit in the creation of credit-money by banks, the supply of reserves, and the determination of overall economic activity. Since granting loans creates corresponding deposits simultaneously, an aggregate expansion of credit simultaneously increases deposits, i.e. the broad money supply.[10] Subsequently, an increase in credit increases the quantity of reserves, i.e. the monetary base, due to banks' increased demand, and the Federal Reserve's "accommodative" supply.[11] Finally, an increase in credit increases nominal income, by allowing economic units to engage in deficit spending.

[10] Previous empirical studies contend that post-Keynesian endogenous money theories are consistent with unidirectional Granger-causality from commercial bank lending to deposits, i.e. the broad money supply. However, as noted above, the liquidity preference of households and firms will affect "the spectrum of interest rates which will certainly have feedback effects (Rochon 1999, p. 297)" on the demand for credit. Post-Keynesian endogenous money theories are therefore more consistent with bidirectional Granger-causality between commercial bank lending and the broad money supply.

[11] This assumes the stock quantity of reserves is not in excess of the aggregate quantity demanded by banks, an assumption that became unrepresentative of the Federal Reserve's operating framework with the switch to a "floor system" in November 2008 (see Lavoie 2010). Under current conditions, with an excess supply of reserves, a net expansion of credit may not lead to an increase in banks' demand for

According to endogenous money theories, a reciprocal relationship also exists between the broad money supply and the monetary base due to households' and firms' liquidity preference.[12] However, this relationship is not causal since a third variable, households' and firms' portfolio preferences, is causing the changes to occur simultaneously. It is, therefore, clear that "What drives the system is credit, not money" (Rochon 1999, p. 53).

Table 1 displays empirical hypotheses generated by these two sets of monetary theories.

[Table 1 here]

4 Empirical Methodology and Data

The methodology and data utilized in this article differ, in some important respects, from that employed by other authors within this field of research. These differences are necessary because of the types of questions this article seeks to answer and to avoid concerns with traditional Granger-causality tests. Economists commonly employ Granger-causality tests to support theoretical assumptions regarding causal relationships between variables. To determine whether Granger-causality exists between two variables, such as the money supply and nominal income, we estimate the following VAR model:

$$Y_t = \beta_0 + \sum_{i=1}^{r} \beta_{1i} Y_{t-i} + \sum_{i=1}^{s} \beta_{2i} X_{t-i} + \mu_t$$

Testing H_0: $\beta_{2i} = 0$, against H_A: $Not\ H_0$, we can determine whether or not to reject the null hypothesis that X does not Granger-cause Y. If a relationship exists, these tests infer the direction of causality based on whether lagged values of the independent variable X improve the

reserves, and hence the central bank's supply of reserves. The previous, unidirectional relationship from credit (Loans) to reserves (MB) therefore likely ceases to exist.

[12] The current operating framework of the Federal Reserve, which involves an excess supply of reserves, may, in this case, also preclude a bidirectional relationship between the broad money supply and monetary base.

regression's predictive power of the dependent variable Y's current value when lagged values of the dependent variable are also included. We must stress that Granger-causality tests do not prove actual causality but merely provide evidence for a causal relationship between two variables based on the temporal ordering of changes in those variables. Furthermore, Granger-causality tests fail to account for the impact of expectations and suffer from omitted variable bias, both of which we discuss in more detail in Section 5.

Traditional Granger-causality tests (Granger 1969) employ asymptotic theory, which is only defensible for stationary variables. Incorporating nonstationary variables, which are quite common within macroeconomic data typically requires using the first differences of variables. However, unit root tests that determine the stationarity of a variable have relatively low power. Hence, a higher probability of Type II errors exists. Due to this uncertainty, traditional Granger-causality tests may produce spurious results.

Addressing this limitation of traditional methods, Toda and Yamamoto (1995) developed a new methodology of Granger-causality tests whose advantages are well-documented (see, for example, Giles 1997; Mavrotas and Kelly 2001; Giles et al. 2002). This method uses levels rather than first differences of all variables. Furthermore, it appends extra lags of all variables but excludes these extra lagged values in determining Granger-causality. The maximum order of integration within a given regression, for a single variable, determines the number of extra lags. Accordingly, we employ the Toda and Yamamoto (1995) method of Granger-causality tests and add one or two extra lags of each variable to the equations.[13]

[13] Table A, in the Appendix, provides the results of unit root tests used to determine the maximum order of integration for each variable. Unit root tests were unable to determine a maximum order of integration for NGDP, hence we add two extra lags, of each variable, to each equation that includes NGDP. To check the robustness of our results, Table B, in the Appendix, provides results for the same regressions in Table 3 and 4 but assuming the maximum order of integration for NGDP is only one. These results do not significantly alter our conclusions.

We use an array of variables to measure the monetary base, the money supply, commercial bank lending, and nominal income in our analysis. Table 2 lists the term, abbreviation(s), and definition of each variable.[14] Data for all variables is from the St. Louis Federal Reserve's economic database.[15] All variables are seasonally adjusted and available at monthly intervals, except for nominal GDP. We therefore converted all variables to a quarterly series using the average of monthly data. We also transformed all dollar values to log-levels. The selected sample period stretches from January 1959 to September 2008. This period begins with the earliest available money supply data and ends with the Federal Reserve's transition to a "floor system." Some exogenous money theories claim that a floor system, due to the payment of interest on reserves, may invalidate previously predicted relationships between the monetary base and other variables, such as the money supply and NGDP (see, for example, Cochrane 2014).[16] These theories therefore imply that were a central bank, in this case the Federal Reserve, to cease paying interest on reserves, the previous relationships would reassert themselves through massive increases in commercial bank lending and nominal income. Endogenous money theories, on the other hand, claim that although a floor system alters the relationship between commercial bank lending and the monetary base, it does not alter the fact that "What drives the

[14] The M2 Money Supply variable includes retail money-market funds, which are generally associated with non-bank financial institutions. Since both exogenous and endogenous monetary theories technically refer only to banks, we created a variable M2x that excludes retail money-market funds from the M2 Money Supply. To check the robustness of our results, Table C, in the Appendix, provides results for the same regressions in Table 3 and 4 but using M2x instead of M2. These results do not significantly alter our conclusions.

[15] The following is a link to the Federal Reserve's economic database (FRED): http://research.stlouisfed.org/

[16] We must note that whether or not a central bank pays interest on reserves does not alter the fact that the money multiplier process is not an accurate description of the money supply process or the relationship between the monetary authority and banking system. Our focus is, however, on whether exogenous monetary theories with a money multiplier or endogenous monetary theories provide more accurate predictions of economic behavior.

system is credit, not money" (Rochon 1999, p. 53). Hence, the decision to cease payment of interest on reserves would be largely inconsequential to commercial bank lending and nominal income. Our selected end date therefore serves two purposes. First, to avoid biasing our results against exogenous money theories. Second, to establish more definitively whether or not the monetary base was statistically endogenous to commercial bank lending in the U.S post-war era. In doing so, we aim to shed light on whether ending the payment of interest on reserves would validate forecasts of exogenous money theories that quantitative easing (QE) leads to increases in bank lending and nominal income.[17] Finally, we test all regressions at lags of 1, 2, and 4 quarters.

[Table 2 here]

5 Empirical Results

The main value of this paper is presenting evidence for the causal role of credit and endogenous nature of money using longer time-series and better econometric techniques than previous studies have done. We test the empirical hypotheses in Table 1 using Toda and Yamamoto Granger-causality analysis. Our results strongly support the claim that the monetary base is statistically endogenous to commercial bank lending and that credit, not money, drives the system. Table 3 displays results examining the primary hypotheses of exogenous money theories.

[Table 3 here]

[17] As Rochon and Rossi (2013, p. 211) note, "QE is ultimately based on the idea that money is exogenous and on the money multiplier framework: if the central bank somehow increases the liquidity of banks, the latter would in turn increase their lending and get the economy growing again. Yet, from a post-Keynesian perspective, the 'failure' of QE should have been anticipated all along: banks do not lend simply because they have increased liquidity."

Exogenous money theories assume that, ceteris paribus, changes in the monetary base unidirectionally affect commercial bank lending (Loans), the broad money supply (M1, M2), and nominal income (NGDP). Table 3 displays that, contrary to the first assumption, unidirectional Granger-causality exists from commercial bank lending to the monetary base. We should note, however, that the impact of forward-looking expectations on current actions may prevent a clear interpretation of Granger-causality tests. For example, changes in expectations of future earnings or cash flows presumably cause changes in current stock prices. To the degree those expectations are accurate, Granger-causality tests may display unidirectional Granger-causality from changes in current stock prices to changes in realized future earnings or cash flows. Needless to say, such results would contradict many existing theories in finance. In those instances, where expectations play an important role, it is therefore more appropriate to interpret results from Granger-causality tests in reverse. Hence, while a straightforward interpretation of the above results is appropriate for exogenous money theories that rely on actual changes in the monetary base (see, for example, Meltzer 1995), a reverse interpretation may be more appropriate for exogenous money theories that rely on expected changes in the monetary base (see, for example, Sumner 2015). Theories that rely on expected changes in the monetary base must, however, preclude the existence of a money multiplier since the extension of credit takes place before the creation of reserves. These theories therefore implicitly accept that the monetary base is statistically endogenous to commercial bank lending, regardless of whether or not they maintain that modern monetary systems act “as if” a money multiplier exists.

Table 3 also displays unidirectional Granger-causality from the broader money supply to the monetary base. Once again it is possible to argue for the reverse interpretation based on expected changes in the monetary base. This, however, still precludes the existence of a money

multiplier since money is being created prior to the creation of reserves. A more plausible interpretation is that the central bank adjusts the size of the monetary base in response to the demand for credit and demand for money, which is consistent with endogenous money theories.

Lastly, Table 3 displays that no Granger-causality relationship exists between the monetary base and nominal income. We therefore find no evidence that either actual or expected changes in the monetary base cause changes in nominal income. Overall these results demonstrate that exogenous money theories, apart from including unrealistic assumptions, lack the ability to accurately predict economic behavior.

Table 4 displays results examining the primary hypotheses put forth by endogenous money theories.

[Table 4 here]

The central claim of Rochon's approach to endogenous money is that credit, not money, is the causal factor in overall economic activity. Table 4, once again, displays unidirectional Granger-causality from commercial bank lending to the monetary base. This finding supports the view of a central bank whose primary role "is to guarantee the stability of the financial market (Rochon 1999, p. 17)" by ensuring a well-functioning payments system. Hence, these results suggest the Federal Reserve did, in fact, supply the quantity of reserves demanded, at its exogenously set price.

Table 4 also displays unidirectional Granger-causality between commercial bank lending and the broader money supply measures. The direction of causality is, however, reversed between the two measures, running from commercial bank lending to M1 and from M2 to commercial bank lending. While it is clearly true from an accounting perspective that loans create deposits, at the end of the monetary circuit both the quantity of deposits and their division

among different types, e.g. checking and savings, are determined by firms' and households' preferences. These preferences, as previously noted, affect the demand for loans in the ensuing period. Over the course of numerous periods, which is what our analysis reflects, causality therefore runs in both directions. Accordingly, we suggest the following interpretation of these results. Changes in the quantity of commercial bank lending generally cause changes in the quantity of transactions balances, i.e. cash and checking deposits, since the demand for credit "allows firms to fulfill their expenditure plans" (Rochon 1999, p. 63). Meanwhile, changes in the quantity of savings balances generally cause changes in the quantity of commercial bank lending because firms' and households' decision to save more or less alters the expected income of firms, which affects their demand for credit.

Lastly, Table 4 displays unidirectional Granger-causality from nominal income to commercial bank lending. Expectations, in this instance, do affect our interpretation of the results because the first major characteristic of Rochon's (1999, p.63) approach "specif[ies] that the causality runs from expected (or desired) income of firms, to the demand for credit, to money and effective income (Robinson, 1956, 1971)." Since changes in expected income alter the demand for credit, it is appropriate to interpret any Granger-causality between commercial bank lending and nominal income in reverse. These particular results therefore provide evidence that the demand for credit, which determines the quantity of commercial bank lending, causes changes in effective, i.e. nominal, income.

In sum, our results provide strong evidence that the monetary base is statistically endogenous to commercial bank lending and, hence, the money multiplier framework is a myth that lacks predictive content. Moreover, our results are broadly consistent with the hypotheses of Rochon's approach to endogenous money, while entirely inconsistent with the hypotheses of

exogenous money theories in standard textbooks. Overall our results therefore demonstrate that endogenous money theories entail both more realistic assumptions and an ability to more accurately predict economic behavior. Further support therefore exists regarding an endogenous money supply and credit's causal role in overall economic activity.

6 Conclusion

The number of central bank officials openly acknowledging the lack of realism in the money multiplier framework continues to grow (see, for example, McLeay et al. 2014; Jakab and Kumhof 2015). There is, however, no sign of impending change within standard economic textbooks. Moreover, it remains unclear whether accepting that the money supply has always been fully endogenous would lead to acceptance of other non-standard views within endogenous money theories. Our results, nevertheless, provide evidence that the actual direction of causality in modern monetary systems "runs from expected (or desired) income of firms, to the demand for credit, to money and effective income (Robinson, 1956, 1971)," as highlighted in Rochon's approach to endogneous money. Most significantly, our results demonstrate unidirectional Granger-causality from commercial bank lending to the monetary base. The monetary base is therefore statistically endogenous to commercial bank lending, which means the money multiplier lacks both realism and the ability to accurately predict economic behavior. Our results also demonstrate that causality runs from commercial bank lending to nominal income, while no relationship exists between nominal income and the monetary base.

These results hold important implications for monetary theory and policy. For theory, it is clear that the money multiplier not only lacks realism, but also the ability to accurately predict economic behavior. While this is particularly damning for exogenous money theories, it also raises issues for New Keynesian theories. Our results provide evidence that the money supply is

endogenous regardless of interest rate targeting, as our period of analysis begins well before the Federal Reserve's interest rate targeting regime. Economic textbooks should therefore replace discussions of the money multiplier framework with a more realistic, accounting-based discussion of the money supply process and the nexus between central banks and the financial system. For policy, this is further evidence that the domain of validity for exogenous money theories based upon a money multiplier framework does not include modern monetary systems.[18] We should therefore not expect expansions of the monetary base, whether temporary or permanent, including interest or not, to have any direct effect on bank lending or nominal income.[19] Our results also demonstrate that credit, which is largely absent from New Keynesian theories, plays a significant role in the money supply process and determination of nominal income. Hence, Palley (2013, p.423) appears correct that "In a modern endogenous money system the [monetary collar on the economy] is … restricted to self-imposed restraints on lending derived from banks' assessment of credit-worthiness plus financing constraints on financial firms." As such, "the challenge [for policymakers] is to manage the monetary collar, ensuring it is neither too tight nor too loose" (Palley 2013, p. 423).

Our overall conclusion is that the demand for credit, rather than the demand for or supply of money, is the primary driver of overall economic activity in monetary systems. Moreover, our results lend support to Lavoie's (1996, p. 6) claim that "Circuit theory…constitutes the proper foundations to a non-orthodox monetary theory, which itself must be part of a larger non-orthodox research programme encompassing effective demand as well as value theory."

[18] There is little, if any, evidence that the domain of validity for a money multiplier framework includes any place and time in history. Longer time-series may, however, be helpful in providing evidence for the post-Keynesian "revolutionary" view that money has always been endogenous.

[19] Expansions of the monetary base may, however, indirectly affect bank lending and nominal income by altering the spectrum of interest rates.

Endogenous money theories therefore provide the “proper foundations” for further empirical research to demonstrate that “What drives the system is credit, not money” (Rochon 1999, p. 53).

References

Abel, A.B., B. Bernanke, and D. Croushore (2011), *Macroeconomics*, 7th ed., Boston: Addison-Wesley.

Adrian, T. and H. Shin (2008), 'Financial Intermediaries, Financial Stability, and Monetary Policy,' Federal Reserve Bank of New York Staff Reports, No. 346, September 2008.

Barnett, W.A. (1982), 'The Optimal Level of Monetary Aggregation,' *Journal of Money, Credit and Banking*, 14 (4), 687-710.

Barnett, W.A. and M. Chauvet (2011), 'How Better Monetary Statistics Could Have Signaled the Financial Crisis,' *Journal of Econometrics*, 161 (1), 6-23.

Barnett, W.A. (2012), *Getting It Wrong: How Faulty Monetary Statistics Undermine the Fed, the Financial System, and the Economy*, Cambridge: The MIT Press.

Belongia, M.T. (1996), 'Measurement Matters: Recent Results from Monetary Economics Reexamined,' *Journal of Political Economy*, 104 (5), 1065-1083.

Bernanke, B.S. (1983), 'Nonmonetary Effects of the Financial Crisis in the Propagation of the Great Depression,' *American Economic Review*, 73 (3), 257-276.

Carpenter, S. and S. Demiralp (2012), 'Money, Reserves, and the Transmission of Monetary Policy: Does the Money Multiplier Exist?' *Journal of Macroeconomics*, 34 (1), 59-75.

Ciccone, R. (1990), 'Comment on Pivetti,' In K. Bharadwaj and B. Schefold (eds), *Essays on Piero Sraffa: Critical Perspectives on the Revival of Political Economy*, London: Unwin Hyman.

Cochrane, J.H. (2014), 'Monetary Policy with Interest on Reserves,' *Journal of Economic Dynamics and Control*, 49, 74-108.

Davidson, P. (1972), *Money and the Real World*, New York: John Wiley.

Eichner, A. (1987), *The Macrodynamics of Advanced Market Economies*, Armonk: M.E. Sharpe.

Friedman. M. (1953), 'The Methodology of Positive Economics,' In *Essays in Positive Economics*, Chicago: The University of Chicago Press.

Friedman, M. and A.J. Schwartz [1963] (2008), *A Monetary History of the United States, 1867-1960*, Princeton: Princeton University Press.

Friedman, M. (1968), 'The Role of Monetary Policy,' *American Economic Review*, 58 (1), 1-17.

Fullwiler, S.T. (2006), 'Setting Interest Rates in the Modern Money Era,' *Journal of Post Keynesian Economics*, 28 (3), 496-525.

Giles, D.E. (1997), 'Causality between the Measured and Underground Economies in New Zealand,' *Applied Economics Letters*, 4, 63-67.

Giles, D.E., L.M. Tedds, and G. Werkneh (2002), 'The Canadian Underground and Measured Economies: Granger Causality Results,' *Applied Economics*, 34 (18), 2347-2352.

Granger, C.W.J. (1969), 'Investigating Causal Relationship by Econometric Models and Cross Special Methods,' *Econometrica*, 37 (3), 425-435.

Hewitson, G. (1995), 'Post-Keynesian Monetary Theory: Some Issues,' *Journal of Economic Surveys*, 9 (3), 285-310.

Holmes, A.R. (1969), 'Operational Constraints on the Stabilization of Money Supply Growth,' *Controlling Monetary Aggregates*, 65-77.

Howells, P. and K. Hussein (1998), 'The Endogeneity of Money: Evidence from the G7,' *Scottish Journal of Political Economy*, 45 (3), 329-340.

Jakab, Z. and M. Kumhof (2015), 'Banks are not Intermediaries of Loanable Funds - And Why This Matters,' Bank of England Working Paper Series, No. 529, May 2015.

Kregel, J. (1973), *The Reconstruction of Political Economy: An Introduction to Post-Keynesian Theory*, London: Macmillan.

Lavoie, M. (1984), 'Un modèle post–keynésien d'économie monétaire fondé sur la théorie du circuit',' É*conomies et Sociétés*, 18 (2), 233–258.

Lavoie, M. (1992), *Foundations of Post-Keynesian Economic Analysis*, Aldershot: Edward Elgar.

Lavoie, M. (1996), 'Horizontalism, Structuralism, Liquidity Preference and the Principle of Increasing Risk,' *Scottish Journal of Political Economy*, 43 (3), 275-300.

Lavoie, M. (2003), 'A Primer on Endogenous Credit-Money', In L.P. Rochon and S. Rossi (eds), *Modern Theories of Money*, Cheltenham: Edward Elgar, pp. 506-543.

Lavoie, M. (2005), 'Monetary Base Endogeneity and the New Procedures of the Asset-based Canadian and American Monetary Systems,' *Journal of Post Keynesian Economics*, 27 (4), 689-709.

Lavoie, M. (2010), 'Changes in Central Bank Procedures during the Subprime Crisis and Their Repercussions on Monetary Theory,' *International Journal of Political Economy*, 39 (3), 3-23.

Mankiw N.G. (2011), *Principles of Economics*, 6th ed., Mason: South-Western Cengage Learning.

Mavrotas, G. and R. Kelly (2001), 'Old Wine in New Bottles: Testing Causality between Savings and Growth,' *The Manchester School*, 69 (1), 97-105.

McLeay, M., A. Radia, and R. Thomas (2014), 'Money Creation in the Modern Economy,' *Bank of England Quarterly Bulletin*, Q1, 14-27.

Mehrling, P., Z. Pozsar, J. Sweeney, and D.H. Neilson (2013), 'Bagehot was a Shadow Banker: Shadow Banking, Central Banking, and the Future of Global Finance,' Available at SSRN: http://ssrn.com/abstract=2232016.

Meltzer, A.H. (1995), 'Monetary, Credit and (Other) Transmission Processes: A Monetarist Perspective,' *Journal of Economic Perspectives*, 9 (4), 49-72.

Mishkin, F.S. (2013), *The Economics of Money, Banking, and Financial Markets*, 10th ed., Boston: Pearson.

Moore, B.J. (1979), 'The Endogenous Money Stock,' *Journal of Post Keynesian Economics*, 2 (1), 49-70.

Moore, B.J. (1988), *Horizontalists and Verticalists: The Macroeconomics of Credit Money*, New York: Cambridge University Press.

Mueller, P.D. and J. Wojnilower (2016), 'The Federal Reserve's Floor System: Immediate Gain for Remote Pain?,' *The Journal of Private Enterprise*, 31 (2), 15-40.

Nell, K.S. (2000-2001), 'The Endogenous/Exogenous Nature of South Africa's Money Supply under Direct and Indirect Monetary Control Measures,' *Journal of Post Keynesian Economics*, 23 (2), 313-329.

Palley, T.I. (1994), 'Competing Views of the Money Supply Process: Theory and Evidence,' *Metroeconomica*, 45 (1), 67-88.

Palley, T.I. (2013), 'Horizontalists, verticalists, and structuralists: the theory of endogenous money reassessed,' *Review of Keynesian Economics*, 1 (4), 406-424.

Parguez, A. (1984), 'La dynamique de la monnaie, *Économies et Sociétés, Monnaie et Production*, 2, 83–118.

Parguez, A. (1987), 'La crise dans le circuit, ou l'intégration de la finance et de la production, *Économies Appliquée*, 40 (4), 755–770.

Pivetti, M. (1990), 'On the Monetary Explanation of Distribution,' In K. Bharadwaj and B. Schefold (eds), *Essays on Piero Sraffa: Critical Perspectives on the Revival of Political Economy*, London: Unwin Hyman.

Pollin, R. (1991), 'Two Theories of Money Supply Endogeneity: Some Empirical Evidence,' *Journal of Post Keynesian Economics*, 13 (3), 366-395.

Robinson, J. (1956), *The Accumulation of Capital*, London: Macmillan.

Robinson, J. (1971), *Economic Heresies: Some Old Fashioned Questions in Economic Theory*, New York: Basic Books.

Rochon, L.P. (1999), *Credit, Money and Production: An Alternative Post-Keynesian Approach*, Cheltenham: Edward Elgar.

Rochon, L.P. and Rossi, S. (2013), 'Endogneous money: the evolutionary versus revolutionary views,' *Review of Keynesian Economics*, 1 (2), 210-229.

Shanmugam, B., M. Nair, and O.W. Li (2003), 'The Endogenous Money Hypothesis: Empirical Evidence from Malaysia (1985-2000),' *Journal of Post Keynesian Economics*, 25 (4), 599-611.

Shapiro, N. (1977), 'The Revolutionary Character of Post-Keynesian Economics,' *Journal of Economic Issues*, 11 (3), 541-560.

Smithin, J. (1994), *Controversies in Monetary Economics: Ideas, Issues, and Policy*, Aldershot: Edward Elgar.

Sumner, S. (2015), 'Nominal GDP Futures Targeting,' *Journal of Financial Stability*, 17, 65-75.

Toda, H.Y. and T. Yamamoto (1995), 'Statistical Inference in Vector Autoregressions with Possibly Integrated Processes,' *Journal of Econometrics*, 66, 225-250.

Vera, A.P. (2001), 'The Endogenous Money Hypothesis: Some Evidence from Spain (1987-1998),' *Journal of Post Keynesian Economics*, 23 (3), 509-526.

Wolfson, M.H. (1996), 'A Post Keynesian Theory of Credit Rationing,' *Journal of Post Keynesian Economics*, 18 (3), 443-470.

Wray, L.R. (1995), 'Keynesian Monetary Theory: Liquidity Preference or Black Box Horizontalism?' *Journal of Economic Issues*, 29 (1), 273-282.

Table 1: Empirical Hypotheses

Endogenous Money Theories	Exogenous Money Theories
Loans → MB Loans ← → M1, M2 Loans → NGDP	MB → Loans MB → M1, M2 MB → NGDP
→ Denotes unidirectional Granger-causality from left to right. ← → Denotes bidirectional Granger-causality.	

Table 2: Terms, Definitions, and Abbreviations

Term	Abbreviation(s)	Definition
Monetary Base	MB	Borrowed and Non-borrowed Reserves plus Currency
M1 Money Supply	M1	Currency, Traveler's Checks, Demand Deposits, and Other-Checkable-Deposits
M2 Money Supply	M2	M1 plus Savings Deposits, Money-Market Deposit Accounts, Small-Denomination Time Deposits, and Retail Money-Market Funds
Commercial Bank Lending	Loans	Total Loans and Leases in Bank Credit Made by All Commercial Banks
Nominal Gross Domestic Product	NGDP	Nominal Value of Gross Domestic Product in the United States

Table 3: Exogenous Money Theories

Toda and Yamamoto Granger-causality tests

	1 Quarter	2 Quarters	4 Quarters
MB → Loans	.46194	.70751	2.0302
Loans → MB	10.624***	9.9999**	14.904***
MB → M1	.37582	.52795	2.6197
M1 → MB	4.4007**	8.4197**	9.947**
MB → M2	1.9794	.86436	11.179**
M2 → MB	4.7095**	4.8502*	4.3601
MB → NGDP	.69223	3.1558	4.8778
NGDP → MB	.12441	1.1344	2.5841

Chi-squared values are listed. → Denotes unidirectional Granger-causality from left to right. Null hypothesis: X does not Granger-cause Y. Regressions assume the maximum order of integrations for NGDP is 2.
*** Significant at the 1% level ** Significant at the 5% level * Significant at the 10% level

Table 4: Endogenous Money Theories

Toda and Yamamoto Granger-causality tests

	1 Quarter	2 Quarters	4 Quarters
Loans → MB	10.624***	9.9999**	14.904***
MB → Loans	.46194	.70751	2.0302
Loans → M1	12.183***	12.667***	11.941**
M1 → Loans	.09854	.94749	2.255
Loans → M2	1.3552	1.6138	2.9875
M2 → Loans	2.491	7.1026**	9.2091*
Loans → NGDP	1.2881	1.7745	2.6554
NGDP → Loans	4.8633**	8.0682**	9.6048**

Chi-squared values are listed. → Denotes unidirectional Granger-causality from left to right. Null hypothesis: X does not Granger-cause Y. Regressions assume the maximum order of integrations for NGDP is 2.

*** Significant at the 1% level ** Significant at the 5% level * Significant at the 10% level

Appendix

Table A: Unit Root Tests

DFGLS Unit Root Test Statistics

Variable	Test Statistic	Result
MB	0.177	
D MB	-1.481	
D2 MB	-7.464***	I(2)
M1	0.825	
D M1	-2.958***	I(1)
M2	0.174	
D M2	-1.872*	I(1)
M2x	0.760	
D M2x	-3.357***	I(1)
Loans	1.211	
D Loans	-2.782***	I(1)
NGDP	-0.554	
D NGDP	-1.233	
D2 NGDP	-0.290	

D prefix denotes the first differences of variables. D2 prefix denotes the second differences of variables. I(1) denotes variable integrated to the first order. I(2) denotes variable integrated to the second order.
Optimal lag is chosen according to Ng-Perron Sequential t statistics.
Null hypothesis: variable is not stationary.
*** Significant at the 1% level ** Significant at the 5% level * Significant at the 10% level

Table B: Exogenous and Endogenous Money Theories (Alternate Lags)

Toda and Yamamoto Granger-causality tests

	1 Quarter	2 Quarters	4 Quarters
MB → NGDP	2.8628*	5.1037*	8.0705*
NGDP → MB	.42357	2.0394	2.8649
Loans → NGDP	.92467	1.3902	4.0585
NGDP → Loans	7.4651***	9.8733***	9.4937*

Chi-squared values are listed. → Denotes unidirectional Granger-causality from left to right. Null hypothesis: X does not Granger-cause Y. Regressions assume the maximum order of integrations for NGDP is 1.
*** Significant at the 1% level ** Significant at the 5% level * Significant at the 10% level

Table C: Exogenous and Endogenous Money Theories (Alternate M2)

Toda and Yamamoto Granger-causality tests

	1 Quarter	2 Quarters	4 Quarters
MB → M2x	1.2642	.44294	4.4783
M2x → MB	8.0091***	8.2471**	7.9481*
Loans → M2x	3.6566*	4.427	6.9286
M2x → Loans	3.0137*	9.5898***	12.399**

Chi-squared values are listed. → Denotes unidirectional Granger-causality from left to right. Null hypothesis: X does not Granger-cause Y. M2x refers to the M2 money supply excluding retail money-markets fund component. Regressions assume the maximum order of integrations for NGDP is 2.

*** Significant at the 1% level ** Significant at the 5% level * Significant at the 10% level