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Abstract

The aim of this paper is to assess –on both theoretical and empirical grounds–the two main views regarding the money creation process, namely the endogenous and exogenous money approaches. After analysing the main issues and the related empirical literature, we will apply a VAR and VECM methodology to the United States in the period 1959-2016 to assess the causal relationship between a number of critical variables that are supposed to determine the money supply, i.e., the monetary base, bank deposits and bank loans. The empirical analysis carried out supports several propositions of the endogenous money approach. In particular, it shows that for the United States in the years 1959-2016 (i) bank loans determine bank deposits and (ii) bank deposits in turn determine the monetary base. Our conclusion is that money supply is mainly determined endogenously by the lending activity of commercial banks.

Keywords: Money endogeneity; USA; Money Supply.

JEL classifications: C32, E40, E50, E51, G21.

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1. Introduction

Different views on the money creation process have been present in economic theory since its very beginning. One view considers money as exogenously determined by monetary authorities through changes in the monetary base. Since commercial banks are deemed to extend loans as a multiple of the monetary reserves in order to maximise profits, it is argued that money supply – usually identified with currency and bank deposits – would fully be under the control of monetary authorities, albeit in a close economy. Within this approach, differences arise mainly on the effects of changes in the money supply on prices and economic activity. In the quantitative theory followed by Ricardo and then developed by authors such as Fisher (1911 and 1930), Marshall (1926), Lavington (1921) and Friedman (1956), adjustment of the demand for money to its supply occurs primarily through changes in the price level, at least in the long run. On the contrary, in Keynes (1936), as well as in the neoclassical synthesis of Hicks (1937) and Modigliani (1944), both the velocity of circulation of money and output levels are permitted to vary and the adjustment of the demand for money to its supply passes through changes in the interest rate. Up to recent years, the monetary debate focused precisely on these issues, in particular on the degree of variability of the velocity of circulation and the sensitivity of the demand for money to the interest rates. It was taken for granted that monetary authorities would directly shape the quantity of money.

Another approach, already traceable in Adam Smith (1776: 261; 332-3) and the Banking School (cf. e.g. Tooke, 1844), stresses, on the contrary, the endogenous nature of money. Developed by Wicksell (1898) and Hayek (1930), and suggested at times by Keynes himself (1930; 1937; 1939), this approach rejects the idea that monetary authorities autonomously regulate the money supply and highlights the active role played by commercial banks in the money creation process. It also emphasises the notion of liquidity instead of money, as well as the role of Central Banks as lenders of last resort. This perspective has recently gained increasing consensus in macroeconomics and prominent monetary authorities (cf. ECB, 2011; BoE, 2014) have endorsed it when fixing short-term interest rates. Due to New-Keynesian models (cf. Gali, 2015; Woodford, 2003), it has become the workhorse of Central Bank models and is shared by different streams of thought (cf. for example Kaldor, 1982; Moore, 1988; Lavoie, 2014).

The aim of this paper is to discuss these two approaches to the money creation process on both theoretical and empirical grounds by looking at the experience of the United States after the Second World War. In Section 2 we will briefly outline the main points at issue in the debate on the exogenous or endogenous nature of money whereas in Section 3 we will analyse the empirical literature on money multiplier with regard to the United States. We will then go onto empirically test credit transmission causality between three critical variables, namely the monetary base, bank deposits and bank loans. Specifically, by considering seasonally adjusted time series starting from January 1959 and ending in September 2016, we will make use of time series analysis using the VAR (Vector Autoregression Model) methodology and cointegration analysis that allow considerations to be made regarding the short- and long-run causality between these three variables. Section 4 will introduce the empirical analysis, highlighting the main differences in terms of hypotheses, data and methods compared with the current literature and in Section 5 we will discuss the main results. Our conclusion (Section 6) will be that empirical evidence reveals the existence of causality running from bank loans to bank deposits and in turn from deposits to the monetary base. We will also show that, even though in the short-run the monetary base may determine the level of bank deposit, bank deposit never influences the level of bank loans. In other words, an exogenous increase of the monetary base (e.g. quantitative easing programmes) can influence the deposit demand since it rises the amount of liquidity held by commercial banks, but the amount of deposit (e.g. new liquidity created by central banks) does not affect the level of loan granted by commercial banks to borrowers. This strengthens the view that money supply is endogenously determined by the lending activity of commercial banks.

2. Behind the money creation process

The traditional view on the money creation process starts from account identities, namely the definition of money as the sum of currency and bank deposits, and the equality between the monetary base and the sum of currency and bank reserves. As known, it follows that the amount of money M is equal to the monetary base H multiplied by the so-called money multiplier m, in turn equal to:

$$m = \frac{1+cu}{cu+re} \qquad [1]$$

where cu is the ratio of currency to bank deposits and re is the bank reserve ratio.[i] In this perspective, it is argued that the monetary authorities may always autonomously set the monetary base H at a level that is able to achieve a warranted amount of money M and hence the targeted price level and interest rates, with the causal nexus running from H to the bank loans L and bank deposits DB.

More precisely, since the rates of interest on bank deposits and loans may influence the money multiplier by affecting the ratios cu and re, money supply is conceived as a function of the interest rates and the monetary base. Central Banks will set H through open market operations according to their objectives and the forecast of the money multiplier m, and they may influence the latter also by changing reserve requirements. The adjustment of money and credit demands to the available supplies is then assured by changes in the price level P and the interest rates, focusing on one or the other according to the time horizon and the specification of the demand function for money (see among others, Keynes, 1936; Hansen, 1949; Friedman, 1956; Cagan, 1965, Tobin, 1969).

This view on the money creation process has been criticised inseveral respects, often by Central Bankers themselves, in turn reproached for not having controlled the money growth rate (cf. Blinder, 1999). It is thus maintained that the money multiplier relation tends to hide the role of interest rates in the adjustment process of money demand and supply, and that if H is changed in order to compensate for changes incu and re, the monetary base becomes (de facto) endogenous. Moreover, it is stressed that H is also affected by the foreign and Treasury channels and that they are not under the direct control of monetary authorities (cf. Goodhart, 1975, 136, and 1984: 184; Klein, 1970; Kaldor, 1982; Palley, 2002).[ii]

However, in addition to money multiplier instability and the influence on H of channels not controlled directly by Central Banks, money supply endogeneity is also deduced by the lending behaviour of commercial banks and the reaction to it of monetary authorities when acting to stabilise the rate of interest (cf. Goodhart, 1984: 38, 40, 73; Wray, 1992; Godley, 1996).

As Wicksell (1898) observed, in a pure credit system, commercial banks may create money *ex-nihilo* or in other terms ‘out of nothing’ (cf. also Werner, 2005; 2014a; 2014b), that is, without any need fora prior saving act, the gathering of deposits or a predetermined creation of the monetary base. Therefore, credit would find a limit only in the demand for loans. This is so also in a fiat money economy to the extent that the bank system has excess reserves and potential credit is not fully exploited (cf. Wicksell, 1898: 115), or if the monetary authorities accommodate subsequently the reserve requirements of the bank sector.[iii] In these cases, the quantity of money in circulation will primarily depend on the demand for loans, which in turn creates bank deposits. A variation in both the velocity of circulation of money and the supply of loans will in fact be able to meet an increase in the demand for cash and financing arising from higher wages or a higher desire to spend. This may happen without any change in the interest rates if the credit system is sufficiently elastic.[iv]

However, the endogenous nature of money also follows on from other reactions occurring in the presence of demand pressures on financial markets. As stressed by the Radcliffe Report (1959), liquidity shortness or credit ceilings stimulate financial innovations with the development of fringe institutions, second money markets and new financial instruments. Liability management and securitisation are examples of this kind of reaction that Central Banks may influence only indirectly, for instance by regulating interest rates on time deposits and imposing minimum capital adequacy ratios. Moreover, the bank system usually first satisfies the demand for loans at given interest rates and then looks for the required reserve (cf. Holmes, 1969: 73). In these circumstances, Central Banks tend to accommodate commercial banks’ demand for reserves in exchange for other assets in order not to lose control over the interest rates. Finally, Central Banks have difficulty in changing the quantity of money at will. In particular, there is an asymmetry in this respect: while it may be easy to sustain financial intermediation by increasing the monetary base,[v] it is difficult to reduce the quantity of money (cf. Holmes, 1969: 68; Moore, 1988: 15), primarily because economic units possess unutilised lines of credits in advance and money is not immediately quantity-constrained by Central bankers.

Of course, Central bankers may decide to reduce the monetary base, for instance by selling bonds owned by the Central Bank. In this case, however, the non-borrowed reserves fall and there is competition to acquire funds in excess of bank deposits.[vi] This necessarily starts a phase of increasing interest rates and if the Central Banks do not accommodate the bank reserve requirements at the discount window, it may even lead to a liquidity crisis (Palley, 1987; Moore, 1988; Wray, 1989). As stated above, Central Banks face two concomitant challenges, namely to not lose control of interest rates[vii] and to act as a lender of last resort. For both reasons, they tend to accommodate bank reserves at a given interest rate which means that H and M cannot be set independentlyof the targeted interest rate (cf. Goodhart, 1984: 209 and 212) and that the Central Banks's influence on the amount of money depends on the effect that changes in their policy interest rate will have on the structure of interest rates and the sensitivity of both loans and expenditure to these rates.

As also stressed in recent studies by the Bank of England (cf. McLeay *et al.*, 2014: 21; Jakab and Kumhof, 2015), Central Banks therefore normally set the rate of interest rather than the amount of reserves and money supply stems mostly from the lending activity of commercial banks. In this activity, given the rate of interest fixed by the Central Bank, the bank system regulates the interest rates on loans by adding to the former a mark-up that is influenced by the degree of competition in the sector and the interest rates paid on time deposits, and covers, among other things, loan risks and general expenses (cf. Goodhart, 1984; Palley 1987). With these lending rates, the bank system meets the demand for loans according to its liquidity preference and the borrower credibility.[viii]

It is beyond the aims of this paper to analyse the determinants of the demand for loans, albeit specifying that, whether influenced by expected profits for firms and disposable income for households, as well as by the interest rates on other financing instruments, its sensitivity to lending interest rates is uncertain and variable according to the credit typologies.[ix] However, it is worth noting that it is the solvent or creditworthy demand for loans (cf. Wolfson, 1996; Fontana and Setterfield, 2009) that the bank system satisfies, reflecting the requirements and collateral that borrowers need to access credit according to banks' perceived risks.

The casual nexus between the monetary base, bank deposits and credit is thus reverted in the endogenous approach to money creation process. The effective credit supplies Li provided at the given lending interest rates by the bank system determine the amount of bank deposits D and thus the amount of the monetary base H demanded by commercial banks to the Central bank. It corresponds to the reserves R required to guarantee convertibility of deposits in liquid assets, which will be greater the greater the reserve ratio re and which the Central Banks usually accommodate at a certain fixed policy interest rate.

3. The empirical studies on the nexus between loans and bank reserves

Summing up, while the exogenous approach considers money supply as fixed by Central Banks setting the monetary base,[x] the endogenous approach argues that money supply adjusts itself to the demand for it, as stemming especially from the demand for credit met by commercial bank and the financing needs of the Treasury (cf. Kaldor, 1982; Moore, 1979; 1988). It is on these grounds that the empirical literature has discussed the causal links between income, money supply and the monetary base in the two identities

$$M = mH \quad [2]$$

and

$$MV = PY_r \quad [3]$$

where V is the velocity of circulation of money and Y_r the real income.

In this respect, for the United States, several studies have ascribed to changes in H the greatest part of those in the money supply M defined as the sum of currency and bank deposits. According to Friedman and Schwartz (1963; 1982) and Cagan (1965), in the long-run it would account for 90 per cent of money supply changes whereas for Brunner and Metzler (1964) it is 85 per cent. In both cases, the money multiplier is deemed to be on average substantially stable unlike during the cycle (cf. also Burger, 1971; Brunner, 1973; Johannes and Rasche, 1981),[xi]and changes in H and Mwould be nearly proportional, with the coefficient of correlation equal to 0.88 (cf. Cagan; 1965), at least in the period 1879-1919.

As Cagan (1965) himself admits, the correlation is lower, however, in the subsequent decades, when a slight positive relation emerges between money supply and the rate of interest (cf. also Courchene and Kelly, 1971 for the situation in Canada). This would reflect a direct nexus going from the price level to the interest rate and then to money supply because a higher interest rate on bank deposits would reduce public preference for currency and increase time deposits against sight deposits and therefore the money multiplier. It is also admitted that the role of money multiplier relative to high powered money increases during cyclical fluctuations (cf. Cagan, 1965: 261 and 276) or when the pegging of interest rates is abandoned in favour of price stabilisation and result in erratic changes in both the rate of interest and the money supply, as in the years 1979-1983.[xii]

By itself, however, the high correlation between money supply and the monetary base does not give us any suggestion to the causal nexus between these two variables, as Friedman and Schwartz (1963: 686) acknowledged. Moreover, neither the fact that Central Banks have the power to change the money base nor the fact that changes in the money supply anticipate investment and income during the cycle bear money exogeneity. In the former, it ought to be established that the monetary base does not adapt itself to the demand. In the latter, it stems indeed from the financing process of consumption and investments (cf. Tobin, 1970; Davidson and Weintraub, 1973). Rather, the results of Kydland and Prescott (1990) that broad money aggregates led the cycle whereas base money aggregate lags it may be a first indication that the causal nexus goes in the other direction, from credit supply to the monetary base, with the supply of open-market liabilities being perfectly elastic (cf. Bernanke and Geitler, 1995).

In the last twenty-five years, a number of econometric studies have tried to empirically assess the direction of causality between credit supply and the monetary base. Moore (1988: 106-108, 157 and 163) argued that the monetary base is not statistically exogenous and that the Granger method shows that for a given bank lending rate the demand for loans causes the monetary base and money supply (cf. also Feige and McGee, 1977; and Moore and Stuttman, 1982). Similar results emerge for other developed countries when applying VAR and VECM econometric methods (cf. for instance Arestis, 1987; Badarudin et al., 2013; Carpenter and Demiralp, 2012; Foster, 1994; Holtemoller, 2003; Howells and Hussein, 1998; Palacio Vera, 2001). In particular, Howells and Hussein (1998) applied a causality test within a vector error-correction model (VECM) and found some empirical evidence for money supply endogeneity in G-7 countries. Recently, Badarudin *et al.* (2013) found evidence of money endogeneity in G-7 economies by applying both a VECM and a trivariate vector autoregression model (VAR).

In the following sections, we will apply VAR and VECM econometric methods to the United States for the period 1959-2016 considering the time series of the monetary base, bank deposits and bank loans. These techniques will allow us to make considerations regarding the causality between those variables that reveal a nexus running from bank loans to bank deposits and in turn from deposits to the monetary base. As we will see, it confirms the view that money supply is to a great extent endogenously determined by the lending activity of commercial banks.

4. Data and Methodology

4.1. Data

The econometric analysis carried out in this paper is based on time series aggregate monthly data provided by the Federal Reserve Bank of St. Louis (FRED) and concerns US countries. We make use of the total demand for deposits (LDEMDEP), the bank credit granted by US commercial banks (LCREDIT) and the monetary base (LBM)[xiii]. All time series considered are seasonally adjusted and start from January 1959 and end in September 2016. Since all variables assume positive values, they are transformed into a logarithmic form.

4.2. Methodology

We will apply times series models able to take into consideration and solve issues related to endogeneity. In particular, by using VAR and VECM methodology, all variables are estimated endogenously and these models also allow us to detect and estimate causality between LDEMDEP, LBM and LCREDIT. In order to arrange the data accurately, we implement the following steps. First, we select the optimal lag length of our models by minimising the Schwarz (1978) Bayesian Information Criteria (SBC). Second, in order to understand the stationarity (or the order of integration) of considered variables, a standard unit root test is conducted on selected series. More specifically, the Phillips and Perron (1988) test is implemented since it is more powerful than the augmented Dickey-Fuller test (Davidson and MacKinnon, 1993). Third, if the variables are non-stationary, a Johansen test is carried out by means of Johansen multivariate cointegration (Johansen, 1988). Finally, VAR and VECM econometric techniques allow us to estimate short- and long-run causality between the variables of interest.

Results concerning unit root and cointegration tests led us to use alternative econometric methods to test short- and long-run causality. These methodologies have been developed by Granger (1969, 1988), Engle and Granger (1987), Sims *et al.* (1990), Mosconi and Giannini (1992), Toda and Phillips (1993, 1994), Toda and Yamamoto (1995), and Rambaldi and Doran (1996). In particular, if the time series are I(1) but not cointegrated, we can utilise the Granger non-Causality test based on differentiated VAR (Sims *et al.* 1990; Toda and Phillips, 1993). However, in order to apply a VAR model, we have to eliminate the non-stationary stochastic trend by using the first-order differences. Consequently, applying first-order differences between non-cointegrated variables allows us to use the VAR model and then to estimate a Granger non-Causality test. The VAR model applied to non-stationary and non-cointegrated times series is represented in equation [4]:

$$\Delta y_t = \beta_0 + \sum_{i=1}^{n} \beta_{1i}\, \Delta y_{t-i} + \sum_{i=1}^{n} \beta_{2i}\, \Delta x_{t-i} + \varepsilon_t \qquad [4]$$

Equally, if the series are I(1) and cointegrated, a VECM model has to be estimated (Engle and Granger, 1987 and Granger, 1988). The model is specified by equation [5]:

$$\Delta y_t = \beta_0 + \sum_{i=1}^{n} \beta_{1i}\, \Delta y_{t-i} + \sum_{i=1}^{n} \beta_{2i}\, \Delta x_{t-i} + \beta_3 EC_{t-i} + \varepsilon_t \qquad [5]$$

where $y_t$represents the dependent variable, $x_t$is the independent variable, $EC_{t-i}$is the error-correction term and ε_t is the error term.

Since in the VECM model all variables are estimated as endogenous variables, the causality can be estimated by choosing alternatively the dependent and the independent variables. Unlike VAR models, the VECM allows us to assess both short-run and long-run causality (Engle and Granger, 1987). Short-run causality is tested by using the Wald-test that also shows us the transmission channels. Conversely, long-run causality is tested by analysing the error-correction coefficient (β_3 in equation 2). If such coefficient is negative and also statistically significant, we can claim that a long-run causality moving from x_t to y_t exists.

Moreover, Toda and Yamamoto (1995) suggest estimating a VAR model even if the series are integrated or cointegrated. As maintained by Toda and Yamamoto (1995, p. 245): "we can apply the usual lag selection procedure […] to a possibly integrated or cointegrated VAR. Having chosen a lag length k, we then estimate a $(k + d_{max})$th-order VAR where d_{max} is the maximal order of integration that we suspect may occur in the process." In other words, we increase artificially the optimal VAR lag length k by the maximal order of integration (d_{max})[xiv] and we arrange the VAR model in levels (regardless of the order of integration) without convert series into first differences. If all series are I(1), d_{max} is equal to 1 and we have to estimate the levels VAR with one extra lag for each variable in each equation. Practically, we have to increase the lag, introducing in the VAR the extra lagged variables as an exogenous component of the model. As suggested by Toda and Yamamoto (1995) methodology, the VAR (k, d_{max}) can be represented by the equation [6]:

$$\begin{bmatrix} y_t \\ x_t \end{bmatrix} = \beta_0 + \sum_{i=1}^{k} \left(\beta_i \begin{bmatrix} y_{t-i} \\ x_{t-i} \end{bmatrix} \right) + \sum_{j=k+1}^{k+1+d_{max}} \left(\beta_j \begin{bmatrix} y_{t-j} \\ x_{t-j} \end{bmatrix} \right) + \begin{bmatrix} \varepsilon_{y,t} \\ \varepsilon_{x,t} \end{bmatrix} \qquad [6]$$

In equation [6], $\beta_0$is a vector representing the intercept, $\beta_i$is the matrix of the coefficient of the delayed variables by the optimal lag length k, β_j is the matrix of extra lagged variables and vector ε represents white noise. The granger non-Causality test in VAR methodology applied to the equation [6] is based on the following null hypothesis:

$$H_0: \beta_{i1} = \beta_{i2} = . . . = \beta_{ik} = 0$$

where β_{ik}represents the coefficients of the first summation in equation [6], that is, the coefficients of the optimal lag length variables. When β is equal to zero, there is no short-run causality running from the independent to the dependent variable.

In this paper, variables used within VAR and VECM model are: the demand for bank deposits (LDEMDEP), the monetary base (LBM) and the bank credit (LCREDIT). These models allow us to investigate both short- and long-run causality and to guarantee the stability and robustness of our findings by introducing suitable dummy variables.

4.3. Dummy variables and Chow test

In order to further check the stability of our findings and robustness of our model, we will introduce appropriate dummy variables that allow us to take into consideration external shock in the management of US monetary policy. In order to do so, we first carry out a theoretical and historical analysis of Fed monetary policy decisions. Second, we further assess the statistical significance of the breakpoints considered noteworthy, by testing such hypothetical changes using the Chow breakpoint test within the VAR model.

During the Eighties, the Fed, in order to control the high inflation rate, changed its operating procedures: from the interest rate setting to monetary aggregate targeting (Mishkin, 2000). Indeed, in that period, the Fed implemented monetary policy aimed at controlling the amount of non-borrowed reserves and other monetary aggregates (i.e., M1 and M2) leaving the interest rate determination to interplay between the supply of and demand for money. This specific monetary policy was launched by Paul Volcker in October 1979 when he announced a tight control over money supply. Although during those years, the control over monetary aggregates became gradually less tight (for example, in February 1987, the Fed dismissed the monetary target over M1), it permanently ended in July 1993. Due to the high interest rates, volatility occurred especially between 1979 and 1983 and the Fed, under the chair of Alan Greenspan, ceased to implement any monetary policy based on the monetary aggregate targeting (Mishkin, 1995) and restarted setting directly the interest rate over monetary reserves.[xv]

Moreover, since the intensification of the US financial crisis in 2007 and the fall in the US GDP in the fall of 2008, the Fed launched an unconventional monetary policy (i.e. quantitative easing programmes) in order to support financial market conditions and limit the economic slowdown (Engen *et al.*, 2015). Starting from September 2008, the Fed rapidly expanded its balance sheet by purchasing several types of asset such as mortgage-backed securities and Treasury securities (Hetzel, 2009). The Fed lent a huge amount of liquidity to the financial institutions by means of the discount window and increased its balance sheet that "went from about $800 billion before September 15, 2008, to more than $2,000 trillion at year-end 2008." (Hetzel, 2009, p. 217) The implementation of such unconventional monetary policies increased US monetary base (see Figure 1) with the aim of increasing the liquidity in the overall economic system and promoting the decline of money market rates (Bernanke, 2009).

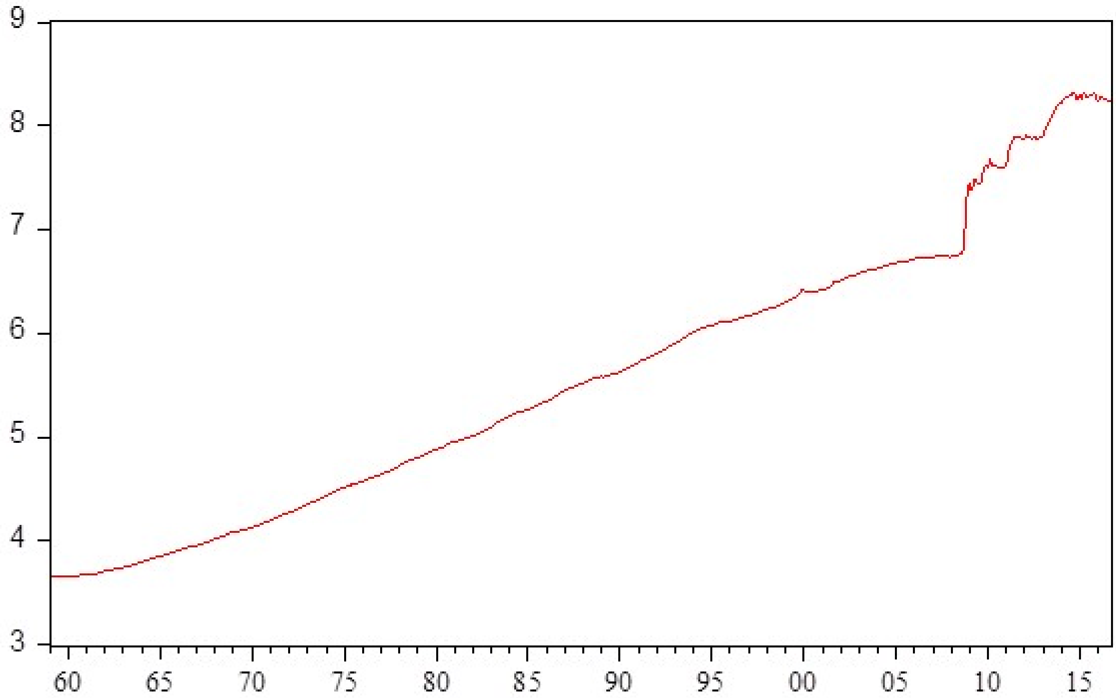

Figure 1. US Monetary Base (FRED dataset, from January 1959 to September 2016)

Due to the theoretical and historical analysis of Fed monetary policy decisions discussed above, by using the Chow breakpoint test, we assess if October 1979 and September 2008 represent exogenous shifts in the conduct of monetary policy. The Chow test is based on the null hypothesis of "No breaks at specified breakpoints". If the p-value associated with the considered breakpoints is less than 10%, we reject the null hypothesis and affirm that a dummy variable can be introduced in that specific period.

As presented in Table 1, the selected breakpoints – October 1979 and September 2008 – are statistically significant since p-values are less than 1% or at most 5%. Such results allow us to reject the null hypothesis and introduce suitable dummy variables for the specified breakpoints.

Table 1
Chow Breakpoint test

Variables	1979M10		
	F-statistic	Log likelihood ratio	Wald Statistic
LMB-LCREDIT-LDEMDEP	1.951038**	34.03732***	33.16765**
Variables	2008M09		
	F-statistic	Log likelihood ratio	Wald Statistic
LMB-LCREDIT-LDEMDEP	20.25245***	290.9213***	344.2917***

* $p<0.10$ ** $p<0.05$, *** $p<0.01$; $\mathbf{H_0}$: No breaks at specified breakpoints

The reasoning and results presented above seem appropriate to introduce dummy variables to suggest that – in some limited periods – the monetary base could be exogenously targeted. In particular, during high inflation eras, financial instability periods and prolonged recessions, the Fed has undertaken unconventional monetary policy measures with the aim of exogenously setting the monetary base and then the money supply. For these reasons, the change in the conduct of US monetary policy during the Eighties and the Fed autonomous increase in the monetary base after the spread of the US financial turmoil in 2008 will be taken into account in the VAR and VECM estimations via the introduction of two dummy variables. The first starts in October 1979 and ends in July 1993 and the second starts in September 2008 and ends in September 2016.[xvi]

5. Findings and discussion

The presentation of findings will be divided into two sub-sections. In the first, we focus on the discussion of results related to the estimation of the baseline VAR and VECM model concerning the relationship between the bank credit, the bank deposits and the monetary base. In the second, we discuss the existing relationship between the considered previous variables by introducing suitable dummy variables to the VAR and VECM model. The latter analysis allows us to understand the effects of both the change in the conduct of the monetary policy during the Eighties and the monetary policy instruments implemented by the Fed after the outbreak of the US financial and economic crisis. The second estimation will also help us determine the stability and robustness of our findings. Moreover, in both sub-sections, we will discuss both the times series properties and the results of specific causality tests.

5.1. Monetary base, bank deposits and bank loans (the baseline model)

Results for the monetary base, bank deposits and bank loans estimated in the baseline model are presented and discussed in this sub-section. The first results involve the properties of the selected time series. The optimum lag length is five and is estimated by minimising the Schwarz Bayesian Information Criteria (SBC). Furthermore, the Phillips-Perron (PP) test results suggest that all considered variables are not stationary at levels, but that they become stationary at the first differences.[xvii] Since all variables treated are not stationary at level, but become stationary at the first differences, we perform the Johansen Cointegration Test in order to understand whether a cointegrating equation exists between all three variables. In short, we are testing if a stationary linear trend occurs between the non-stationary variables.

The Johansen Cointegration Test indicates the existence of one cointegrating equation between LBM, LDEMDEP and LCREDIT in the US. Precisely, as shown in Table 2, the p-value corresponding to the Trace and to the Eigenvalue is less than 5% (Trace of 35.05559) and 1% (Eigenvalue of 26.03019) respectively, suggesting that LBM, LDEMDEP and LCREDIT are cointegrated.[xviii]

Table 2
Johansen Cointegration test

Variables	Trace	Eigenvalue	Lag
LMB – LCREDIT – LDEMDEP	35.05559**	26.03019***	5

* $p<0.10$, ** $p<0.05$, *** $p<0.01$; Trace represents the Trace Test statistics and Eigenvalue is the Maximal Eigenvalue Test statistics.

Due to the existence of a cointegrated equation, we can argue that there is a long-run relationship between LBM, LDEMDEP and LCREDIT. We can therefore estimate a VECM model that allows us to determine both short- and long-run causality between the considered variables. Long-run causality is detected through the coefficient of the error-correction term (β_3 in equation 2). If the coefficient is negative and also statistically significant, we can conclude that the causality runs from the independent to the dependent variable. As shown by the first column in Table 3, we will test if the independent variables jointly determine the dependent variable. Alternatively, short-run causality is estimated through the Wald test that also allows us to estimate the transmission channels.

The VECM long-run results are summarised in Table 3. In order to understand causality, we need the value of the coefficient $\beta_3$and the respective significance. As seen in Table 3, the causality – in the long-run – runs from LCREDIT and LDEMDEP to LBM since there is only one $\beta_3$that is negative and also statistically significant. Sinceβ_3 – equal to -0.005466 – is significant at the 0,01 probability level, we reject the null hypothesis maintaining that the parameter is different from zero and conclude that a statistically significant long-run causality running from LCREDIT and LDEMDEP to LBM exists. On the contrary, β_3 – equal to -0.001118 (see Table 3) – is negative but not statistically significant when we test the long-run causality running from LBM and LDEMDEP to LCREDIT. We can therefore conclude that there is no long-run causality running from LBM and LDEMDEP to LCREDIT.

Table 3
Results of Error-Correction Models (Long-run Causality Test)

Long-run coefficients			t-Statistic	Lag	Long-run	
INDEPENDENT V.	DEPENDENT V.	β_3			CONCLUSION	
LCREDIT & LDEMDEP	LBM	-0.005466***	[-2.50547]	5	LCREDIT & LDEMDEP ➡	LBM
LBM & LDEMDEP	LCREDIT	-0.001118	[-1.48493]	5		

* p<0.10, ** p<0.05, *** p<0.01; H_0: no long-run causality; INDEPENDENT V. represents the independent variable column; DEPENDENT V. represents the dependent variable column. The arrows show the causality direction: single arrows represent one way causality and double arrows represent bidirectional causality.

Table 4
Results of Error-Correction Models (Short-run Causality: Wald Test)

Short-run coefficients			Lag	Short-run		
INDEPENDENT V.	DEPENDENT V.	χ^2 test		CONCLUSION		
LCREDIT	LDEMDEP	10.91368*	5	LCREDIT	➡	LDEMDEP
LDEMDEP	LCREDIT	8.639373	5			
LDEMDEP	LBM	32.80177***	5	LDEMDEP	⬌	LBM
LBM	LDEMDEP	79.73530***	5			
LCREDIT	LBM	35.89287***	5	LCREDIT	➡	LBM
LBM	LCREDIT	6.409055	5			

* p<0.10, ** p<0.05, *** p<0.01. H_0: no short-run causality; INDEPENDENT V. represents the independent variable column; DEPENDENT V. represents the dependent variable column. The arrows show the causality direction: single arrows represent one way causality and double arrows represent bidirectional causality.

In Table 4, we show the VECM short-run causality results. By means of the Wald test, short-run causality is explained by the joint significance of the lagged independent variables. The Wald test is based on the null hypothesis according to which the coefficients of lagged variables are equal to zero, that is, there is no short-run causality. If the probability (p-value) related to the coefficients of the exogenous variables is less than 5% (at most less than 10%), we reject the null hypothesis and claim the existence of short-run causality. The results of the Wald test, represented in Table 4, show that LCREDIT causes in the short-run both LDEMDEP (significant at 10%) and LBM (significant at 1%). A bidirectional causality is estimated between LDEMDEP and LBM (significant at 1%).The Wald test allows us to estimate a feasible credit transmission channel that could be summarised as follow: the loans provided by commercial banks determine the level of bank deposits and in turn bank deposits influence the monetary base. Nevertheless, we have also found that bank loans directly affect the level of the monetary base and the base money is able to determine the level of bank deposit in the short-run.

Finally, we also apply Toda and Yamamoto (1995) methodology and we estimate the Granger non-Causality test in order to confirm and strengthen the VECM short-run results. The Granger non-Causality test applied to a trivariate VAR further validates the existing relationship between LBM, LDEMDEP and LCREDIT.[xix] As shown in Table 5, the Granger non-Causality test applied in the trivariate VAR model shows that bank credit influences both the demand for bank deposit (significant at 10%) and the monetary base (significant at 1%).Moreover, bidirectional causality is estimated between the demand for bank deposit and the monetary base (significant at 1%).Finally, neither bank deposits nor the monetary base determine bank loans. The Granger non-Causality test, estimated with Toda and Yamamoto (1995) methodology, confirms the Wald tests results found through the baseline VECM model (cf. Table 4).

Table 5
Results of the Trivariate VAR (Short-run Causality: Granger non-Causality Test)

Short-run coefficients			Lag	Short-run
INDEPENDENT V.	DEPENDENT V.	χ^2 test		CONCLUSION
LCREDIT	LDEMDEP	10.98461*	5	LCREDIT → LDEMDEP
LDEMDEP	LCREDIT	8.503751	5	
LDEMDEP	LBM	32.95138***	5	LDEMDEP ↔ LBM
LBM	LDEMDEP	80.07952***	5	
LCREDIT	LBM	33.31823***	5	LCREDIT → LBM
LBM	LCREDIT	5.898382	5	

* p<0.10, ** p<0.05, *** p<0.01; H_0: the independent does not Granger cause the dependent variable; INDEPENDENT V. represents the independent variable column; DEPENDENT V. represents the dependent variable column. The arrows show the causality direction: single arrows represent one way causality and double arrows represent bidirectional causality.

The long- and short-run causality results, estimated by means of VECM methodology applied in US, support the Endogenous money view since the monetary base is an endogenous variable in the long-run, being determined by bank loans and bank deposits. Also VECM short-run results, along with their interpretation of the credit transmission channel, support the endogenous money theory since bank loans determine the level of bank deposits which in turn influence the level of the monetary base. In addition, the Granger non-Causality test applied to a trivariate VAR confirms results found through the Wald test estimated in the VECM model. Finally, even though we have shown that in the short-run the monetary base can determine the level of bank deposit, we can also assert that the bank deposit never influences the level of bank loans. In other words, an exogenous increase of the monetary base (e.g. quantitative easing programmes) can influence the deposit demand since it increases the amount of liquidity held by commercial banks. However, this amount of deposit (e.g. new liquidity created by central banks) does not affect the level of loan granted by commercial banks to borrowers. Consequently, such a result could be explained by the important role played by the creditworthy demand for loans. In particular, according to the endogenous money view, in order to enter the money in the real economy, the demand for loans has to increase (firms and households) instead of the supply of funds (i.e. the monetary base and bank deposits). In other words, if during a period of economic slump the central bank wants to increase the amount of money entering the real economy, our results suggest that credit demand has to be stimulated rather than the supply of funds.

5.2. Monetary base, bank loans and bank deposits (with dummy variables)

In order to assess the stability and the robustness of empirical results estimated in paragraph 4.1, as well as the effect of Walker strict control over the money supply and the effect of unconventional monetary policies implemented by the Fed (e.g. quantitative easing programmes) after the outbreak of the US financial and economic crisis. In order to do so, we first estimate a new cointegrated equation by implementing the Johansen Cointegration Test and by adding the two dummy variables (see Sub-section 3.3) as an exogenous component of the test. Second, we estimate the causal relationship between LBM, LDEMDEP and LCREDIT by means of a VAR and VECM model and introduce the two considered dummy variables.

The Johansen Cointegration Test indicates the existence of one cointegrating equation between LBM, LDEMDEP and LCREDIT in the US. In particular, as shown in Table 6, the value of the Trace and the Eigenvalue allows us to maintain that a long-run relationship between LBM, LDEMDEP and LCREDIT exists. The Trace and the Eigenvalue being equal to 107.1979 (significant at 1%) and to 95.83045(significant at 1%) respectively, suggests that LBM, LDEMDEP and LCREDIT are cointegrated (see also footnote x*viii*). We can therefore assert that the introduction of dummy variables does not change the existing long-run relationship between the monetary base, bank deposits and bank loans.

Table 6
Johansen Cointegration test with dummy variables

Variables	Trace	Eigenvalue	Lag
LMB – LCREDIT – LDEMDEP	107.1979 ***	95.83045 ***	5

* p<0.10, ** p<0.05, *** p<0.01; Trace represents the Trace Test statistics and Eigenvalue is the Maximal Eigenvalue Test statistics.

The VECM long-run results are shown in Table 7. The long-run causality is detected by the sign of the coefficient β_3 and the respective significance. As seen in Table 7, the long-run causality runs from LCREDIT and LDEMDEP to LBM since there is only one $\beta_3$that is negative and also statistically significant. Since$\beta_3$is equal to -0.038969 and significant at the 0,01 probability level when we test the long-run causality running from LCREDIT and LDEMDEP to LBM, we reject the null hypothesis of not long-run causality. Since the parameter is statistically different from zero, we can conclude that a significant long-run relationship running from LCREDIT and LDEMDEP to LBM exists. On the contrary, β_3 – equal to -0.001395 – is not significant when we test the long-run causality running from LDEMDEP and LBM to LCREDIT. Consequently, we accept the null hypothesis arguing that there is no long-run causality running from LBM and LDEMDEP to LCREDIT. The findings, concerning the long-run causality estimated by means of VECM model with dummy variable, confirm the empirical result of the baseline model (cf. Table 3).

Table 7
Results of Error-Correction Models with dummy variables (Long-run Causality Test)

Long-run coefficients			t-Statistic	Lag	Long-run
INDEPENDENT V.	DEPENDENT V.	β_3			CONCLUSION
LCREDIT & LDEMDEP	LBM	-0.038969***	[-9.81204]	5	LCREDIT & LDEMDEP ➡ LBM
LBM & LDEMDEP	LCREDIT	-0.001395	[-0.95459]	5	

* p<0.10, ** p<0.05, *** p<0.01; H_0: no long-run causality; INDEPENDENT V. represents the independent variable column; DEPENDENT V. represents the of the dependent variable column. The arrows show the causality direction: single arrows represent one way causality and double arrows represent bidirectional causality.

Table 8
Results of Error-Correction Models with dummy variables (Short-run Causality: Wald Test)

Short-run coefficients			Lag	Short-run
INDEPENDENT V.	DEPENDENT V.	χ^2 test		CONCLUSION
LCREDIT	LDEMDEP	10.85151*	5	LCREDIT ➡ LDEMDEP
LDEMDEP	LCREDIT	8.459165	5	
LDEMDEP	LBM	27.54782***	5	LDEMDEP ⬌ LBM
LBM	LDEMDEP	67.68745***	5	
LCREDIT	LBM	34.07941***	5	LCREDIT ➡ LBM
LBM	LCREDIT	6.074407	5	

* p<0.10, ** p<0.05, *** p<0.01. H_0: no short-run causality; INDEPENDENT V. represents the independent variable column; DEPENDENT V. represents the dependent variable column. The arrows show the causality direction: single arrow represents one way causality and double arrows represent bidirectional causality.

In Table 8, we point out the VECM short-run results estimated by means of the Wald test. The results of Wald test show that LCREDIT causes in the short-run both LDEMDEP (significant at 10%) and LBM (significant at 1%). A bidirectional short-run causality is also estimated between LDEMDEP and LBM (significant at 1%).The results estimated by means of the Wald test within the VECM model with the dummy variables confirm results of the baseline model (cf. Table 4).

Finally, we apply Toda and Yamamoto (1995) methodology and Granger non-Causality test in order to confirm and further strengthen the short-run VECM and VAR results. The Granger non-Causality test applied to a trivariate VAR validates the existing relationship between LCREDIT, LDEMDEP and LBM estimated in paragraph 4.1. As pointed out in Table 9, results of the causality estimation show that bank credit influences both the demand for bank deposit (significant at 10%) and the monetary base (significant at 1%). Furthermore, a bidirectional causality is also confirmed between the demand for bank deposit and the monetary base (both significant at 1%). Finally, neither bank deposits nor the monetary base influence the amount of bank loans granted by commercial banks to borrowers. The Granger non-Causality test, estimated with Toda and Yamamoto (1995) methodology in the trivariate VAR within dummy variables, confirms the short-run causality estimated in the baseline trivariate VAR (cf. Table 5).

Table 9
Results of the Trivariate VAR with dummy variables (Short-run Causality: Granger non-Causality Test)

Short-run coefficients			Lag	Short-run
INDEPENDENT V.	DEPENDENT V.	χ^2 test		CONCLUSION
LCREDIT	LDEMDEP	10.17444*	5	LCREDIT → LDEMDEP
LDEMDEP	LCREDIT	8.541842	5	
LDEMDEP	LBM	27.58556***	5	LDEMDEP ↔ LBM
LBM	LDEMDEP	71.51983***	5	
LCREDIT	LBM	29.31383***	5	LCREDIT → LBM
LBM	LCREDIT	5.333263	5	

* p<0.10, ** p<0.05, *** p<0.01; H_0: the independent does not Granger cause the dependent variable; INDEPENDENT V. represents the independent variable column; DEPENDENT V. represents the dependent variable column; The arrows show the causality direction: single arrows represent one way causality and double arrows represent bidirectional causality.

Finally, even after the introduction of dummy variables, both the VECM model and the trivariate VAR confirm all findings of the baseline VECM and the trivariate VAR model both in the short and the long-run (see paragraph 4.1.). Consequently, these results allow us to assert that the model estimated is robust and stable and allow us to affirm that empirical evidence confirms the endogenous money view.

6. Concluding remarks

The notion according to which in the economic system the quantity of money is set by exogenous and autonomous decisions of the central bank – as usually affirmed by the exogenous money theory – has for a long time symbolised a milestone in the monetary economic literature. Recently, the endogenous money theory has gained momentum in the international debate by proposing an alternative view in order to explain the money creation process in modern economies. In this paper, we have tested the abovementioned theories in the US for the 1959-2016 period in order to answer the following research question: is the money supply exogenously set by the Fed, or is it endogenously determined by the lending activity of commercial banks?

The analysis carried out in this paper shows us that in the United States the money creation process is mainly driven by commercial banks and their lending activities geared towards firms and households. In particular, the quantity of money in circulation is a residual of the money supply process since the monetary base is driven by the demand for and supply of loans. Furthermore, the VAR and VECM model implemented with dummy variables confirm that an exogenous increase of the monetary base such as that dictated in recent years by unconventional Fed monetary policies are unable to channel the liquidity into the real economy. Although we have found short-run causality moving from the monetary base to the bank deposit, we can in fact also assert that the volume of loans provided by commercial banks is not influenced by the quantity of bank deposit and the monetary base. In other words, exogenous monetary policies based on control of the supply of money – such as quantitative easing–can positively affect only the amount of liquidity held by commercial banks and the demand for loans still matters when stimulating the entrance of liquidity into the real economy.

Appendix A.

Total Demand Deposits: https://fred.stlouisfed.org/series/DEMDEPSL?cid=25 (LDEMDEP)

Bank Credit at All Commercial Banks: https://fred.stlouisfed.org/series/LOANINV (LCREDIT)

Monetary Base: https://fred.stlouisfed.org/series/AMBSL (LBM)

Appendix B.

We attach in these two subparagraphs the results of the unit root test (Phillips-Perron) and the optimal lag selection. In the following subparagraphs, we show the results for the monetary base, bank credit and total demand deposits.

B.1. Monetary base (LBM), bank loans (LCREDIT) and bank deposits (LDEMDEP)

B.1.1. Unit root test (Phillips-Perron):

H_0: variable at level has a unit root.

Phillips-Perron Test						
Variables	Intercept		Trend & Intercept		None	
	Adj. t-statistic	P-value	Adj. t-statistic	P-value	Adj. t-statistic	P-value
LBM	1.555922	0.9995	-1.701162	0.7500	6.734733	1.0000
LDEMDEP	1.764828	0.9997	0.205956	0.9981	3.908362	1.0000
LCREDIT	-2.236812	0.1935	0.062755	0.9969	11.98098	1.0000

B.1.2. Unit root test (Phillips-Perron):

H_0: variable at first difference has a unit root.

Phillips-Perron Test						
Variables	Intercept		Trend & Intercept		None	
	Adj. t-statistic	P-value	Adj. t-statistic	P-value	Adj. t-statistic	P-value
LBM	-13.49965	0.000	-13.46336	0.000	-13.52851	0.000
LDEMDEP	-26.25175	0.000	-26.20647	0.000	-26.91278	0.000
LCREDIT	-21.74815	0.000	-21.45662	0.000	-14.36765	0.000

B.1.2. We conduct the optimal lag length by minimising the Schwarz Bayesian Information Criteria (SBC)

N° of Lags	LBM-LDEMDEP-LCREDIT
0	3.224527
1	-18.31855
2	-18.69361
3	-18.67503
4	-18.70759
5	-18.71257*
6	-18.65027
7	-18.58801
8	-18.54915

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[i] As specified by Jordon (1969), the formula of the money multiplier m is indeed more complex, namely $(1 + cu)/[re(1 + t + g) + cu]$, when also taking into account bank reserves on time deposits t and US government deposits g that are not included in the definition of $M1$. This would be relevant if the Central Bank were to forecast m in order to get a targeted amount of M, since t is strongly influenced by the rate of interest and bank competition.

[ii] Monetary liabilities of public sector change with changes in public sector deficit, operations on marketable debt, transactions in non-marketable debt, funds to pay offs on maturing debt and external flows.

[iii] Cf. also Wicksell ([1901] 1935: 24, 42-44 and 142-3) when he maintains that even in a gold money economy money supply may adapt to its demand when there are other means of payment besides gold and discusses the validity of the quantity theory of money.

[iv] Cf. Hayek (1930), who stresses that the bank sector may satisfy an increase in the demand for credit without an increase in the interest rate, obtaining liquidity by lowering the ratio of reserves to bank deposits and selling assets. It is only when Central Bank increases the discount rate and does not accommodate the fall in bank reserves that there is an increase in interest rates. Cf. also Moore (1989) who specifies that credit money is demand determined and there is therefore no need for a change in the interest rate to adjust money demand to the supply.

[v] When not offsetting a previous credit expansion, an increase in the monetary base usually leads to the purchase of securities and the lowering of their interest rates, raising both the liabilities and assets of the banking system. However, unlike what has been stated by Brunner and Meltzer (1964), commercial banks may also hold excess reserves especially during a deep crisis when reserve opportunity cost may be zero or even negative, or when the borrowing cost at the discount window is not linear and increasing (cf. Palley, 1987).

[vi] Notice that deposits are destroyed every time the banking system (included the Central Banks) sells assets to households, firms or the Government sector.

[vii] If Central Bank does not offer non-borrowed reserves at a certain interest rate and there is an increasing demand for reserves in the interbank market or at the discount window, the interest rates tend to rise. Central Banks usually pursue these actions in the case of innovations in their monetary policy (cf. Lavoie, 2014).

[viii] The amount of loans is often changed by changing the criteria for belonging and identifying risk categories rather than the interest rates. A point at issue is, however, if a greater supply of loans requires a higher lending interest rate due to an increasing risk and worsening of the liquidity position of the banking system (cf. Pollin, 1991; Wray, 1990, 1995; Fontana, 2009, Minsky, 1982; Rousseaux, 1989). However, as Lavoie (2014) pointed out, except in the case of non-performing loans, the bank net interest revenues will bring the ratio of loans to own funds back to the previous level after an increase in loans. Moreover, a rise in the ratio of loans to bank deposits does not necessarily occur. Therefore, at least on a macroeconomic level, credit supply for a certain category of risk may be infinitely elastic.

[ix] For an analysis in this direction, see Deleidi (2017). Note also that borrowing units may not use loans for final expenditure as the recent phenomenon in Europe of credit supply without investment shows us.

[x] Since changes in the interest rates will influence the ratios R/D and CU/D, money supply function is deemed to be, however, an increasing function of the interest rate (cf. Burger, 1971).

[xi] Cagan and Friedman maintain that Fed system would not substantially alter the operation of gold standard, with the amount of gold shaping money supply and this supply determining the price level. During the cycle, however, while H increases due to the inflow of gold and Fed open market operations, *cu* and *re* rise due respectively to the conversion of deposits to currency and the lowering of the amount of loans.

[xii] When the money multiplier is considered predictable and the warranted amount of money supply achievable (cf. Balbach, 1981; Bomhoff, 1977; Hafer, Hein, Kook, 1983; Johannes and Rasche, 1987), the loss of control on monetary aggregates is ascribed to erroneous estimates of the money multiplier and to Fed behaviour adding variability to real income and prices (cf. e.g. Metzler, 1982: 635). The unpredictability of money multiplier relates, however, to the management itself of the monetary base leading to variability of the interest rates (cf. Burns, 1974; and Moore, 1979). Note also that the elasticity of money supply to the interest rate is different for different monetary aggregates if it refers to short or long-term interest rates and for quarterly or annual data (cf. also Laffer and Miles: 1977).

[xiii] For more details on time series used, see Appendix A.

[xiv] For instance, let us assume that the maximum order of integration for the group of time-series is d_{max}. If there are two time series and one is I(1) and the other is I(2), then $d_{max} = 2$. If one is I(0) and the other is I(1), then $d_{max} = 1$.

[xv] In this case, following the Taylor rule, Fed explicitly sets a target interest rate. Note that also between 1973 and 1979 Fed specified a monetary growth target but it was never fulfilled in order to stabilise the interest rates (cf. Balbach, 1981).

[xvi] Of course, as stated in Section 2, it depends on a variety of circumstances, and primarily on the sensitiveness of aggregate demand to changes in the interest rates and to what extent Fed's autonomous setting of the monetary base will affect money supply. In the period of time we have taken into account, these two monetary episodes tends, however, to disturb the direction of causality between the monetary base and money supply.

[xvii] Critical tests such as the unit root test and the optimal lag selection are included in Appendix B of the paper.

[xviii] If the Trace and the Maximum Eigenvalue are greater than the critical values and therefore significant, we reject the null hypothesis of no cointegrating equation.

[xix]Unlike the VECM methodology, VAR methodology incorporates only short-run information. Consequently, the Granger non-Causality test applied in a VAR only allows as to study short-run relationships.