Money creation in the Eurozone:
An empirical assessment of the endogenous and the exogenous money theories

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Abstract

The aim of this paper is to strengthen our understanding of the money creation process in the Eurozone for 1999-2016 period, through an empirical assessment of two main monetary theories, namely the (Post Keynesian) endogenous money theory and the (Monetarist) exogenous money theory. By applying a VAR and VECM methodology, we analyse the causal relationship among monetary reserves (or monetary base), bank deposits and bank loans. Our empirical analysis supports several propositions of the Post Keynesian endogenous money theory since (i) bank loans determine bank deposits, and (ii) bank deposits in turn determine monetary reserves.

Keywords: Endogenous money theory; exogenous money theory; Eurozone, Post Keynesian, Monetarist.

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

1. Introduction

In the economic literature the supply of money has been for a long time analysed and discussed as an exogenous variable. Supporters of the Monetarist exogenous money theory (Brunner and Meltzer 1990) maintain that the central bank autonomously determines the growth rate of the money supply through changes in monetary reserves, also called the monetary base (MB). In this view, commercial banks are allowed to extend loans as a fixed or variable multiple of the monetary reserves supplied by the central bank. As a consequence, the interest rate set by the central bank is seen as a market phenomenon depending on the interplay between the demand for and the supply of money.

Recently, different perspectives on the creation of money have been proposed, and the idea of an endogenous money supply has gained momentum in the international debate (Fontana 2007, Table 1; Werner 2014). At the forefront of this debate, there are supporters of the Post Keynesian endogenous money theory (e.g., Deleidi 2020; Fontana *et al*. 2020; Lavoie 1996, 2014; Marshall and Rochon 2019; Moore 1988; Rochon 1999, 2001, 2016), who maintain that monetary aggregates are endogenously determined by the (effective) demand for bank loans (LOAN). These scholars highlight the active role played by commercial banks in the money creation process: bank loans create bank deposits (DEPOSIT), which in turn then make the monetary reserves of the central bank. This perspective has been recently endorsed by prominent monetary authorities (ECB 2011b), including the Bank of England (BoE) (Jakab and Kumhof 2015; McLeay *et al.* 2014). For instance, in a recent BoE quarterly bulletin, it is argued that:

> "In the modern economy, most money takes the form of bank deposits. But how these bank deposits are created is often misunderstood: the principal way is through commercial banks making loans. Whenever a bank makes a loan, it simultaneously

creates a matching deposit in the borrower's bank account, thereby creating new money." (McLeay *et al.* 2014, p. 1)

The aim of this paper is to improve our understanding of the money creation process in the Eurozone for the 1999-2016 period through an empirical assessment of the two main monetary theories introduced above, namely the Post Keynesian endogenous money theory and the Monetarist exogenous money theory. In order to do this, we will empirically study the relationship among three critical variables, i.e. monetary reserves (also called the monetary base), bank deposits and bank loans. Specifically, if the empirical evidence reveals the existence of causality running from the monetary base to deposits and loans, the Monetarist exogenous money theory (EXMT, for short) would be confirmed. Conversely, if the data highlights the existence of a causality link going from bank loans to bank deposits, and in turn from deposits to the monetary base, then the Post Keynesian endogenous money theory (ENMT, for short) would be supported. We focus on the Eurozone for two main reasons. Firstly, there is currently a lively debate in Europe on the importance of identifying the factors that could stimulate the credit market. Indeed, according to Draghi (2014): 'Credit weakness appears to be contributing to economic weakness in these countries.' Secondly there has been very little analysis of the money creation process in the European monetary union.

In order to estimate the relationship among the abovementioned variables, we make use of time series analysis using the VAR (Vector Autoregression Model) methodology and cointegration analysis. This allows an investigation of the short- and long-run causality among the monetary base, bank deposits and bank loans. The Eurozone monthly monetary statistics used in this paper are from the Statistical Data Warehouse of the European Central Bank (ECB), and cover the period for February 1999 to April 2016.

The paper is structured as follows. In Section 2, we discuss both the EXMT and the ENMT. The theoretical discussion – including a comparison between the horizontalist and structuralist approaches to the Post Keynesian ENMT – is completed by a review of the relevant empirical literature. In Section 3, we introduce our empirical analysis, highlighting what are the main differences in terms of hypotheses, data and methods compared with the current literature. In Section 4, the empirical results of our analysis are presented and discussed. Section 5 concludes.

2. Money Supply Theories: a graphical and analytical representation

In the Post Keynesian endogenous money theory, the quantity of money in circulation is determined by the (effective) demand for loans, which in turn in aggregate is equal to an equal amount of bank deposits (Fontana 2003). Commercial banks act as 'money producers' and not as mere intermediaries between saving and investment decisions. Indeed, commercial banks create money *ex-nihilo*, or in other words "out of nothing" (Werner 2014), without a prior saving act, the gathering of deposits or a prearranged creation of monetary base. In the ENMT, monetary aggregates are an outcome of the demand for loans of borrowers and the supply of loans by commercial banks. After granting bank loans – and as result creating bank deposits – commercial banks demand a certain amount of the monetary base from the central bank, corresponding to the reserves required to guarantee the convertibility of deposits into cash.[1]

[1] For an in-depth discussion of money endogeneity in mainstream theory, see among others Fontana *et al*. (2020).

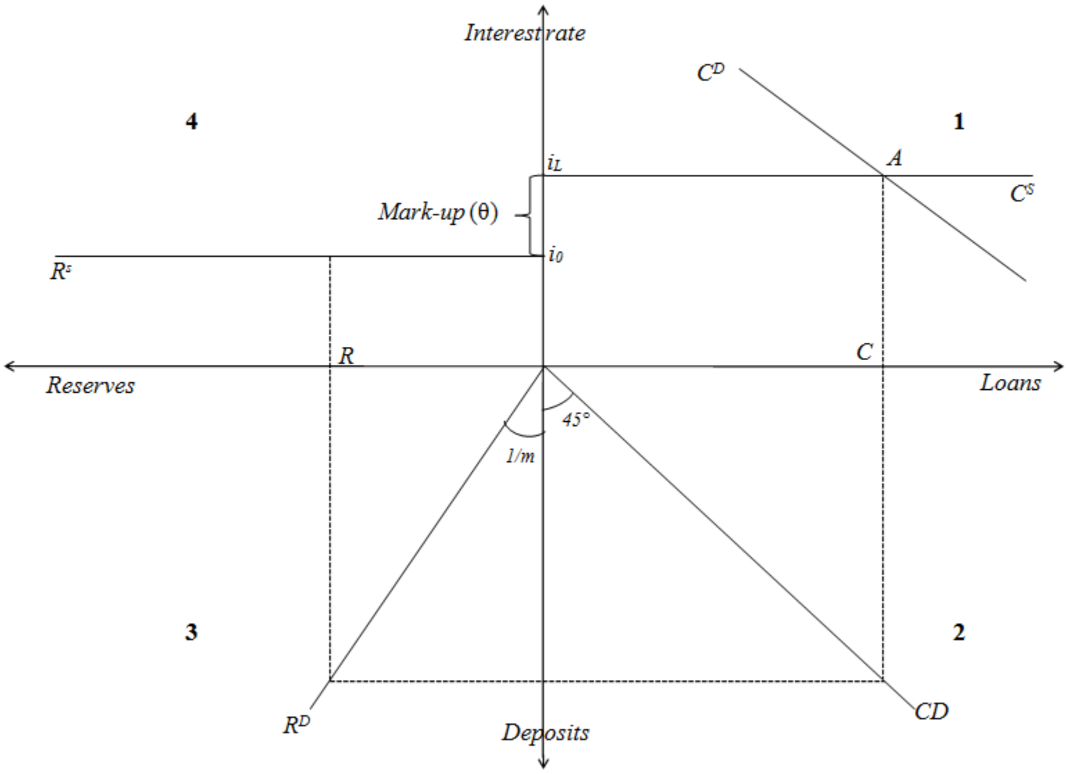

Figure 1: Post Keynesian endogenous money theory (Source: Fontana 2003, 2004 and Authors' elaboration)

The Post Keynesian endogenous money theory is presented by the four quadrants of Figure 1.[2]

I. The central bank sets the short-run interest rate i_0 and commercial banks fix the interest rate on loans i_L by applying a mark-up θ on i_0 (see quadrants 4 and 1):[3]

$$i_L = i_0 + \theta \qquad (1)$$

II. The supply of loans (C^S) is infinitely elastic, and can be represented by the following equation (quadrant 1):

$$i_L = \overline{i_L} \qquad (2)$$

[2] For sake of simplicity, we are assuming the Post Keynesian horizontalist perspective (Moore 1988; Lavoie 1996; Rochon 2001; Deleidi 2020).

[3] The mark-up depends on the level of competition between commercial banks, on the loan duration, and on the liquidity and the insolvency risks (Fontana *et al.* 2017). A longer duration and greater risk increase the mark-up; conversely, greater competition decreases the mark-up.

The effective demand for loans (C^D) is made of the credit demand of enterprises (C^{De}) and the credit demand of households (C^{Dh}) as indicated by equation (3):

$$C^D = C^{De} + C^{Dh} \qquad (3)$$

The credit demand of enterprises (C^{De}) depends positively on the expected demand (Y^{exp}) and negatively on the bank lending policy instruments (X). The latter variable – varying between 0 and 1 – is a proxy for the assessment by banks of the creditworthiness of borrowers or, in a broader sense, for the availability of credit by the banking system (Wolfson 1996; Fontana and Setterfield 2009). When X is equal to 0, the banking system does not credit-constrain borrowers. For all values greater than 0, the banking system credit-constrain some borrowers, with $X = 1$ meaning that credit is completely rationed.[4] Therefore, the credit demand of enterprises (C^{De}) is represented by equation (3.1) below:[5]

$$C^{De} = f(Y^{exp}; X) \qquad (3.1)$$

The credit demand of households (C^{Dh}) depends positively on the disposable income (Di) (Arestis and Eichner 1988), negatively on the interest rate determined by commercial banks (i_L), and negatively on the bank lending policy instruments (X).

[4] The trustworthiness of borrowers can be measured in terms of e.g. collateral disposal. When the banking system increases its demand for collaterals, X tends to 1; when the demand for collaterals decreases, X is closer to 0. As suggested by Deleidi (2020, p. 162, ft. 6) "commercial banks do not merely accommodate all potential loan demands […], but only the effective creditworthy demands […]. Banks are able to select good borrowers […] and ration credit by means of quantitative constraint (such as changing the collateral requirements)."

[5] Following Deleidi (2018), the credit demand of enterprises is assumed to be not affected by the level of the rate of interest.

$$C^{Dh} = f(Di; i_L; X) \qquad (3.2)$$

Changes in the interest rate (i_L) set by commercial banks entail movements on the credit demand curve (C^D). Expected income (Y^{exp}) and bank lending policy instruments (X) act as exogenous variables that lead to movements of the credit demand curve (C^D). Quadrant 1 shows the equilibrium point A, which represents the situation where the demand curve for loans (C^D) of enterprises and households intersects with the supply curve for loans (C^S). Such equilibrium determines the quantity of loans (C) provided by commercial banks to borrowers.

III. Quadrant 2 shows the 45°-degree line, where the overall level of credit (i.e. bank loans) provided to borrowers (C) creates an equivalent overall level of deposits (D).[6]

$$C \equiv D \qquad (4)$$

IV. The quantity of reserves (or monetary base) provided at a given interest rate (i_0) by the central bank depends on the level of deposits (quadrant 2) and on – as it was defined by Lavoie (1984, p. 778) – the *Credit Divisor*, which is represented in quadrant 3 by the reserve ratio $1/m$.[7] The *Credit Divisor* is influenced by the central bank, and it shows the level of compulsory and/or voluntary reserves R that commercial banks hold in order to guarantee the convertibility of deposits into cash. As suggested in Fontana and Venturino (2003), the relationship between deposits (D) and monetary reserves (R) is given by the following equation:

[6] Following Palley (1994, 1996) and Fontana (2004), we assume that households hold assets – such as deposits – in a fixed proportion to loans.

[7] To make the reader become more familiar with endogenous money theory definitions, it is worth it to stress that credit divisor in the endogenous money theory represents the equivalent concept of the money multiplier in the exogenous money theory.

$$R = \frac{1}{m} D \qquad (5)$$

V. The quantity of reserves (R) is determined by the Credit Divisor $1/m$, the deposits D and the supply of reserve (R^S) at a given interest rate. The supply of reserves (R^S) is infinitely elastic and can be represented by the following equation:

$$i_0 = \overline{i_0} \qquad (6)$$

Equations (1) – (6) presented above allow us to discuss the fundamental differences between the ENMT and the EXMT. In the Post Keynesian endogenous money theory, the monetary base (or monetary reserves) is the residual of the lending activity of commercial banks. Moreover, the interest rates i_0 and i_L are exogenous variables, since they are determined by the autonomous decisions of the central bank and commercial banks in the reserve and credit markets, respectively.[8]

Within the Post Keynesian ENMT, a lively debate between the Horizontalist and Structuralist perspectives exists. For the sake of simplicity, this paper adopts an Horizontalists perspective. The debate between Horizontalists and Structuralists focuses on several controversial arguments related to the credit and monetary reverses markets, interest rates determination, the willingness of the central and commercial banks to grant the volume of reserves and loans demanded by borrowers, as well as the role played by financial markets and the behaviour of the economic agents in their portfolio adjustments (Fontana 2004). Supporters

[8] A thorough review of the theoretical literature related to the endogenous money theory is provided in Deleidi (2020), Fontana (2003, 2004, 2009), Graziani (2003), Lavoie (1984, 1996, 2014), Minsky (1975, 1982), Moore (1988), and Wray (1990, 1992). Additionally, for an in-depth review of the Post Keynesian money theory within an open economy framework, see among others Lavoie (2001, 2014), Rochon and Vernengo (2001) and Vera (2014).

of the horizontalist perspective (see among others, Moore 1988; Lavoie 1996; Rochon 2001; Deleidi 2020) consider the interest rate as an exogenous variable, namely independent from the volume of loans demanded. Consequently, the supply of loans is regarded as a horizontal line, as interest rates are not affected by changes in the demand for loans. By contrast, the structuralist perspective regards the interest rate as endogenously determined by the interaction between supply of and demand for loans. According to structuralists, the supply of loans is viewed as an upward sloping curve in the interest – banks loans space, and changes in the demand for loans positively influence the level of interest rates. Structuralists explain this effect on interest rates through two main theoretical pillars: (i) "the principle of increasing risk" (Kalecki 1937); and (ii) the Keynesian "liquidity preference theory" embedded in the supply of loans through the endogenous money–liquidity preference model (Wray 1992; Dow 1996).[9]

According to the Monetarist exogenous money theory (Friedman 1969; Samuelson and Nordhaus 1995; Krugman and Obstfeld 2000; Cecchetti and Schoenholtz 2015), the supply of loans is an exogenous variable influenced by the central bank. By setting the monetary base (also called monetary reserves), the central bank influences through the money multiplier the quantity of banks deposits, and hence the amount of loans supplied by commercial banks. The interplay between the supply of and the demand for the monetary base determines the short-run nominal interest rate. As a consequence, in the EXMT the interest rates i_L and i_0 are seen as a market phenomenon endogenously determined in the credit market and the reserves market by the interaction of the supply of, and the demand for, loans and monetary reserves, respectively.[10]

In the last twenty-five years, a number of econometric studies have tried to empirically assess if the supply of loans is created endogenously by the interaction between banks,

[9] For an in-depth review of the debate between these two approaches, see among others Lavoie (1996), Palley (1996), Rochon (2001), Fontana (2003, 2004) and Deleidi (2019, 2020).
[10] For an in-depth empirical and theoretical review of the EXMT, see among others Deleidi and Levrero (2019).

entrepreneurs and households. There is now significant empirical evidence showing that the (effective) demand for loans determines the monetary base, and that the central bank has a weak power over the lending activities of commercial banks. For instance, Arestis (1987), Foster (1992, 1994), Howells and Hussein (1998), Moore (1989) and Palacio Vera (2001) reach these conclusions in their analyses of the monetary transmission mechanism in different developed countries, whereas Badarudin *et al.* (2009), Nell (2000), Shanmugam *et al.* (2003) and Vymyatnina (2006) reach similar conclusions in the case of developing countries.

Howells and Hussein (1998) apply a causality test within a vector error-correction model (VECM) and find empirical evidence for the endogeneity of the money supply process in G-7 countries. Similarly, using a VECM on German data, Holtemöller (2003) finds out that monetary aggregates are determined endogenously in the loans and the reserves markets, respectively. Also, Cifter and Ozun (2007) find empirical evidence of money supply endogeneity in a VECM analysis of the monetary transmission mechanism in Turkey. Recently, Badarudin *et al.* (2013) find evidence of money endogeneity in G-7 economies by applying both a VECM and a trivariate vector autoregression model (VAR). Similarly, by using a VECM for the US economy and taking into consideration several monetary aggregates, Deleidi and Levrero (2019) support the money supply endogeneity hypothesis. Finally, by making use of panel cointegration techniques, Liu and Kool (2018) show the existence of a long-run relationship between bank loans and monetary aggregates in the euro area.

3. Data and Methods

3.1. Data

The econometric analysis is conducted on the euro area as a whole, using aggregate monthly data provided by the European Central Bank's (ECB) Statistical Data Warehouse. We make use of the outstanding amount of Bank credit (LOAN), Deposits (DEPOSIT) and

Monetary base (MB). [11] Additionally, we make use of data on the Balance of Payments (BoP) in order to control our estimates for open economy issues, namely the effect that transactions among intra and extra euro area countries could exert on Eurozone monetary aggregates. The time series considered start from February 1999 and end in April 2016. The period considered is dictated by data availability. DEPOSIT, MB and LOAN are transformed into a logarithmic form and plotted in Figure 2. As variables are not seasonally adjusted, an ARIMA X-11 procedure is carried out to remove seasonality.

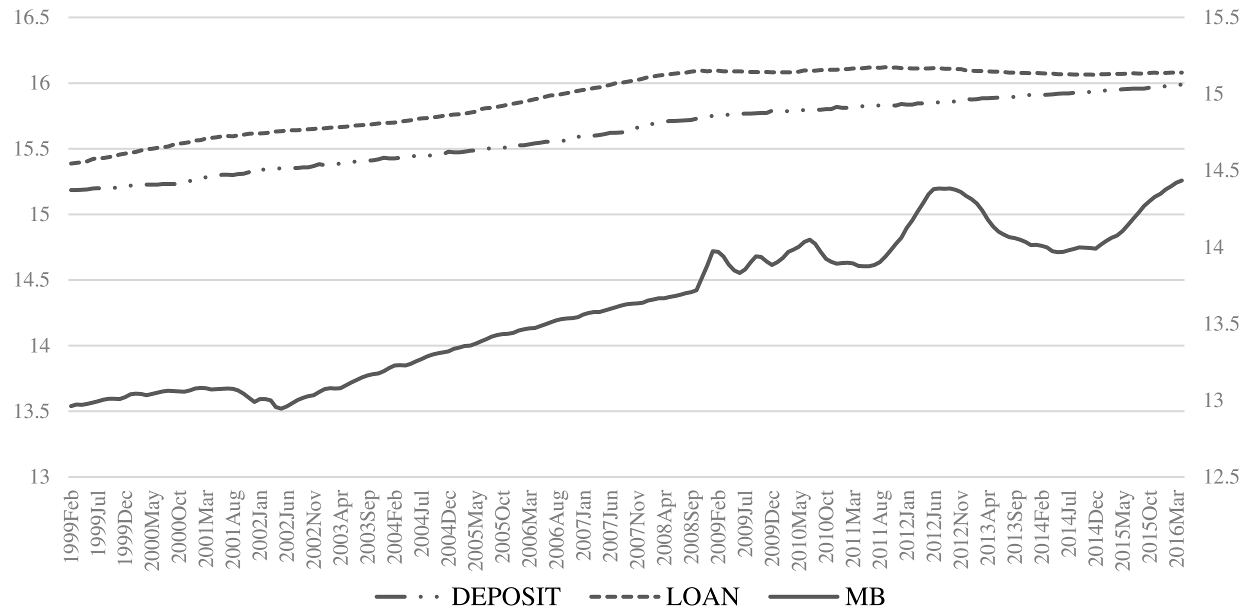

Figure 2: DEPOSIT and LOAN are measured on left axis; MB is measured on the right axis. All variables are displayed in logarithm form.

3.2. Methodology

In this paper we apply the econometric methodology proposed by Howells and Hussein (1998), Holtemöller (2003), Cifter and Ozun (2007), Badarudin *et al.* (2013), and by Deleidi and Levrero (2019). Furthermore, we introduce some methodological innovations concerning the estimation of structural breaks and the cointegration test. Specifically, we make use of VAR

[11] The variable LOAN is built as the sum of the outstanding amount of bank loans provided to enterprises and to households. The variable DEPOSIT is built as the sum of the outstanding amount of bank deposits provided to enterprises and to households.

and VECM models and the Granger non-Causality test in order to investigate causality among the investigated variables. These tests are performed on all variables presented in Section 3.1. Firstly, in order to arrange the data accurately, we conduct the optimal lag length of the VAR by minimising the Akaike Information Criterion (AIC) (Akaike 1974). Secondly, a standard unit root test is carried out to understand the order of integration of the variables. For this purpose, the Phillips and Perron (1988) test is performed since it is more powerful than the augmented Dickey-Fuller test (Davidson and MacKinnon 1993). Thirdly, if the variables are I(1) or non-stationary, a Johansen test is conducted by means of the Johansen multivariate cointegration (Johansen 1988). Finally, Bai-Perron (1998, 2003) test and Chow Breakpoint test are carried out to look for possible exogenous structural changes and check the stability of the model.

3.2.1. Causality

Causality tests aim to determine whether a causal relationship between two or more time series exists. Several results related to unit root and cointegration tests led us to consider using alternative econometric methods to test Granger causality - i.e., VAR and VECM models. These methods have been proposed by 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).

If the time series are I(1) but not cointegrated, Sims *et al.* (1990) and Toda and Phillips (1993) show that causality tests based on differentiated VAR are also valid. As stressed by Toda and Phillips, “causality test in difference VAR’s are likely to have higher power in finite samples.” (1993, p. 1377) However, in order to apply a VAR model, we have to eliminate the non-stationary trend using the first-order differences. Applying the first-order differences in a non-cointegrated system allows to use the VAR model and then to perform a Granger non-

Causality test. The VAR model applied to not stationary and not cointegrated times series is represented in (7):

$$\Delta y_t = \beta_0 + \sum_{i=1}^{n} \beta_{1i}\, \Delta y_{t-i} + \sum_{i=1}^{n} \beta_{2i}\, \Delta x_{t-i} + \varepsilon_t \tag{7}$$

Conversely, if the series are I(1) and cointegrated, a VECM model has to be used (Granger 1988). The model is specified in (8):

$$\Delta y_t = \beta_0 + \sum_{i=1}^{n} \beta_{1i}\, \Delta y_{t-i} + \sum_{i=1}^{n} \beta_{2i}\, \Delta x_{t-i} + \beta_3\, EC_{t-1} + \varepsilon_t \tag{8}$$

where y_t represents the dependent variable, x_t is the independent variable, EC_{t-1} is the error-correction term and ε_t is the error term. Unlike VAR models, the VECM methodology allows us to test both short-run and long-run causality (Engle and Granger 1987). Short-run causality is tested using the Wald-test. Conversely, long-run causality is tested by studying the error-correction coefficient (β_3 in equation 8). If the coefficient is both negative and statistically different from zero, we can conclude that there exists long-run causality running from the independent to the dependent variable.[12]

However, Toda and Yamamoto (1995) suggest estimating a VAR model even if the series are integrated or cointegrated. They propose a procedure that requires the determination of the optimal lag length of the model to impose restrictions on the parameters of VAR model without pre-testing for a unit root and a cointegrating ranking. The authors argue that this procedure is

[12] These tests allow to check Granger causality and in particular if past values are able to predict the current values of variables under investigation. Additionally, this can be interpreted as causality (in Granger sense) only if there is a suitable theory that explains a clear causal relationship between variables included in empirical models.

more suitable than using a VECM, "since the non-causality hypothesis in ECM's involves nonlinear restrictions on parameter matrices, and therefore Wald test for Granger causality may suffer from size distortions due to rank deficiency that cannot be excluded under the null hypothesis." (Toda and Yamamoto 1995, p. 227) As stressed in Toda and Yamamoto, "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 maximal order of integration that we suspect might occur in the process." (ibid. 1995, p. 245)

In other words, we increase the optimal VAR lag length k by the maximal order of integration (d_{max})[13] and we arrange the VAR model in levels (regardless of the order of integration) without convert series into first differences. Basically, if the time series is composed by three variables (e.g., monetary base, deposits and loans, plus the constant term), the maximal order of integration is one (I(1)) and the optimal VAR lag length is four ($k = 4$), we have to estimate the levels VAR with one extra lag for each variable in each equation ($d_{max} = 1$). Practically, we have to increase the lag, introducing in the VAR the extra lagged variables as an exogenous component of the model: we estimate a trivariate VAR (k, d_{max}) using an original test designed to produce the best parameter estimates. The trivariate VAR (k, d_{max}) – estimated among bank loans, bank deposits and the monetary base – can be represented by the following equation:

$$\begin{bmatrix} MB_t \\ LOAN_t \\ DEPOSIT_t \end{bmatrix} = \beta_0 + \sum_{i=1}^{k} \left(\beta_i \begin{bmatrix} MB_{t-i} \\ LOAN_{t-i} \\ DEPOSIT_{t-i} \end{bmatrix} \right) + \sum_{j=k+1}^{k+1+d_{max}} \left(\beta_j \begin{bmatrix} MB_{t-j} \\ LOAN_{t-j} \\ DEPOSIT_{t-j} \end{bmatrix} \right) + \begin{bmatrix} \varepsilon_{MB,t} \\ \varepsilon_{LOAN,t} \\ \varepsilon_{DEPOSIT,t} \end{bmatrix} \qquad (9)$$

[13] 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 $d_{max} = 1$.

In equation (9), β_0 is a vector (3X1) representing the intercept, β_i is the matrix (3X3) of the coefficient of the delayed variables by the optimal lag length k and β_j is the matrix (3X3) of extra lagged variables, and the vector ε represents the white noise.

The Granger causality test in VAR methodology applied to the equation (9) is based on the following null hypothesis:

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

where β_{ik} represent the coefficients of the first sum in equation (9), that is, the coefficients of the optimal lag length variables. When β is equal to zero, there is no causality running from the independent to the dependent variable.

Causality will be tested between bank loans, bank deposits and the monetary base, applying both VAR and VECM methodology. These models allow us to investigate both short- and long-run causality and to check the robustness of our findings.

3.2.2. Bai-Perron test and Chow breakpoint test

In order to control for internal and external shocks within the Eurozone, we introduce dummy variables to verify the statistical stability of the parameters of the model, and the presence of possible exogenous structural changes.

Since the intensification of the financial crisis, which started in 2007 in the US and the spread in 2008 in Europe, and the burst of European sovereign debt crisis in the last months of 2009, the ECB has introduced a number of non-standard policy measures in the Eurozone. Those measures are mainly based on the purchasing of financial assets and on the increase of the duration of the loans provided to the banking system. The implementation of this unconventional monetary policy – termed by ECB as ‘outright operations’ – represents an autonomous decision of the ECB aiming to increase the liquidity in the economic system by expanding the monetary base. As these instruments do not represent the ordinary operating methods of European monetary policy, but at the same time change the level of the monetary base (MB), it seems appropriate to introduce a dummy variable to suggest that – in some limited periods – the monetary base could not depend exclusively on the variables considered in our model (bank deposits and loans). Especially, during financial instability periods or prolonged recessions, the ECB undertakes non-standard monetary policy measures (more or less effective in solving issues that ECB intends to pursue) in order to increase the liquidity into the economic system.

In order to identify the structural breaks, we proceed as follows. First, we investigate the possible existence of breakpoints in the series considered through the Bai-Perron test, based on appropriate econometric techniques developed by Bai (1997) and Bai and Perron (1998, 2003). Secondly, by means of the Chow breakpoint test, we assess the statistical significance of the breakpoints found with the Bai-Perron method within the VAR model. Moreover, in order to justify the breakpoints found through the Bai-Perron methods, we integrate the research with a theoretical and historical analysis of ECB policy decisions.

As a first step, we apply a Bai-Perron L+1 vs. L sequentially test determined breaks method to look for multiple breakpoints on BM, DEPOSIT and LOAN series.[14] As illustrated in Table 1, the Bai-Perron test allows us to reject the null hypothesis of 0,1,2,3 in favour of the alternative hypothesis of 1,2,3,4, as the scaled f-statistics is greater than the critical values. The series are therefore divided by four breakpoints: February 2002, June 2005, November 2008 and January 2012.

[14] Bai and Perron proposed a test for L versus L+1 breaks, explaining that "The test amounts to the application of (L+1) tests of the null hypothesis of no structural change versus the alternative hypothesis of a single change. The test is applied to each segment containing the observations T_{i-1} to T_i (i =1, …, L+1). We conclude a rejection in favour of a model with (L+1) breaks if the overall minimal value of the sum of squared residuals (over all segments where an additional break is included) is sufficiently smaller than the sum of squared residuals from the L breaks model." (Bai and Perron 2003, p. 14)

Bai-Perron tests of L+1 vs. L sequentially determined breaks				
Sequential F-statistic determined breaks and repartition data				
Break Test	Scaled F-statistic	Critical Value**	n°	Repartition
0 vs. 1 *	294.2314	13.98	1	2002M02
1 vs. 2 *	250.7445	15.72	2	2005M06
2 vs. 3 *	54.75259	16.83	3	2008M11
3 vs. 4 *	53.49110	17.61	4	2012M01
4 vs. 5	0.000000	18.14		

Table 1: Multiple Breakpoint test on Monetary Base (MB) * Significant at the 0.05 level; ** Bai-Perron critical values (Econometric Journal 2003)

As a second step, results presented in Table 1 will be further tested through the Chow Breakpoint test within the VAR model. In Table 2, Chow Test shows that not all results found with the Bai-Perron test are significant – namely breaks found in February 2002 and June 2005. As a consequence, we accept the null hypothesis affirming the absence of breaks at the specified breakpoint. Conversely, breaks found in November 2008 and January 2012 are statistically significant, which leads us to reject the null hypothesis and to consider plausible to introduce particular dummy variables in correspondence of the last two specified breakpoints.

Variables	**2002M02**		**2005M06**	
	F-statistic	*Log likelihood ratio*	*F-statistic*	*Log likelihood ratio*
MB LOAN DEPOSIT	0.891725	6.592462	0.662417	4.917346
Variables	**2008M11**		**2012M01**	
	F-statistic	*Log likelihood ratio*	*F-statistic*	*Log likelihood ratio*
MB LOAN DEPOSIT	3.419009***	24.20091***	3.959375***	27.77728***

Table 2: Chow Breakpoint test (* p<0.10 ** p<0.05, *** p<0.01; **H_0**: No breaks at specified breakpoints)

In order to provide a stronger justification to the introduction of a dummy at November 2008 and January 2012, we analyse ECB monetary policy decisions that followed the burst of European financial turmoil since the last quarter of 2008. As a consequence of the intensification of the financial crisis in September 2008, the ECB has introduced a number of non-standard monetary policy measures with the aim of boosting the euro area credit market and to control interest rates. For instance, starting from 30th October 2008, the Governing Council of the ECB has made effective the decision to extend the list of eligible collaterals for Eurosystem refinancing operations, as well as the decision to enhance the provision of supplementary liquidity by introducing three- to six-months long term refinancing operations (ECB, 2008a). Furthermore, in June 2009 the ECB launched the first Covered Bond Purchase Programme (CBPP1) for a total value of sixty billion Euro with the aim to fund banks that had been particularly affected by the financial crisis (ECB 2008b; Beirne *et al.* 2011; Cour-Thimann and Winkler 2012).

Moreover, in November 2011, the ECB (ECB 2011a) launched the second Covered Bond Purchase Programme (CBPP2) for a total of forty billion Euro. In December 2011, the Long Term Refinancing Operations (LTROs) were introduced for a value of five hundred billions Euro.[15] Differently from more conventional policies and the first type of long term refinancing operations, LTROs provided extra liquidity to the financial system within a deadline of three years. As declared by the ECB, the objectives of these programs were to contribute to: (i) promote the ongoing decline in money market term rates; (ii) ease funding conditions for credit institutions and enterprises, by encouraging credit institutions to maintain and expand their lending to clients (Darracq-Paries and De Santis 2015);[16] and (iii) improve market liquidity in important segments of the private debt securities market (Beirne *et al.* 2011). Furthermore, in January 2012, the ECB cut the reserve coefficient on deposits with maturity of up to 2 years from 2% to 1%, causing a nominal cutting in the level of bank reserves and then in the level of the monetary base.

Finally, since 2008 until the present day, in addition to the Covered Bond Purchase Programmes (CBPP1, CBPP2 and CBPP3), the European monetary authority has launched a number of others unconventional programs as the Securities Markets Programme (SMP), the Fine-Tuning Operations (FTOs) and the expanded asset purchase programme (APP), with the

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[15] Please see the following link: https://www.ecb.europa.eu/press/pr/date/2011/html/pr111208_1.en.html

[16] It is plausible to argue that at times the ECB encourages the increase of bank loans (both to finance expenditure for both consumption and investments) in order to foster the economic growth (Bijsterbosch and Falagiarda 2015; Hristov *et al.* 2012).

purpose of buying financial assets (from both private and public sector) both on primary and secondary markets and of increasing the liquidity in the economic system.

The spread of the European financial turmoil, the external ECB monetary quantity shocks and the cut in the reserve coefficient will all be taken into account in the VAR and VECM estimations via the introduction of two dummy variables in accordance with the two the specified dates. The first period starts in November 2008 and ends in December 2011, while the second period starts in January 2012 and ends in April 2016.

4. Findings and discussion

In order to make a clear presentation of the findings, we are going to discuss them by splitting them into two subsections. First, we discuss the relationship between bank loans, bank deposits and the monetary base. Secondly, we focus on the existing relationship between the considered variables introducing suitable dummy variables. The latter analysis allows us to understand whether monetary policy instruments implemented by the ECB after the financial crisis have fostered the credit dynamics in the euro area. It will also help determining the stability and the robustness of our model. Finally, in order to provide additional robustness checks, we augment both the models with and without dummy variables with the euro area Balance of Payments (BoP) variables. This allows us to furtherly check the stability of our models for feasible open economy effects on Eurozone monetary aggregates produced by changes in the transactions among intra and extra euro area countries. Findings of these analyses are reported and discussed in Appendix A.

4.1. Monetary base, bank deposits and bank loans (without dummy variable)

Results on the monetary base, bank deposits and bank loans are presented and discussed in this sub-section. The first results concern the time series properties. The Akaike Information

Criteria (AIC) recommends that the optimum lag length is seven (see Appendix B). Moreover, the Phillips-Perron (PP) test results suggest that all variables are not stationary at levels, but they become stationary at the first differences (see Appendix C).[17] Since all considered variables are I(1), the next step is to perform the Johansen Cointegration Test in order to understand whether a cointegrating equation among all three variables exists. In other words, we are testing if a stationary linear combination occurs between the non-stationary variables.

The Johansen Cointegration Test indicates the existence of one cointegrating equation between MB, DEPOSIT and LOAN in the Eurozone. Specifically, as shown in Table 3, the p-value corresponding to the Trace and to the Eigenvalue are less than 1% and 5% respectively, suggesting that MB, LOAN and DEPOSIT are cointegrated.[18]

Variables	Trace	Eigenvalue
MB-LOAN-DEPOSIT: Lag 7		
None	42.45336***	26.19597**
At most 1	16.31739	12.39549
At most 2	3.921898	3.921898

Table 3: Johansen Cointegration test (* p<0.10, ** p<0.05, *** p<0.01; Trace represents the Trace Test statistics and Eigenvalue is the Maximal Eigenvalue Test statistics)

Thanks to the existence of the error correction vector, we can conclude that there is also a long-run association between MB, DEPOSIT and LOAN. As a consequence of the Johansen Cointegration Test results, we estimate a VECM model that allows us to determine short- and long-run relationships between the variables of interest. Long-run causality is detected through the coefficient of the error-correction term (β_3 in equation 8). If the coefficient is both negative and statistically different from zero, we can conclude that the causality runs from the independent to the dependent variable. As shown by the first column in the Table 4, we will

[17] We have also carried out the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) unit toot test which confirms that all variables are not stationary at levels, but they become stationary at the first differences. Findings are available upon request.

[18] 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.

test if the independent variables jointly influence the dependent variable. On the other hand, short-run causality is detected by the means of the Wald test.

The VECM long-run results are summarized in Table 4. As shown in Table 4, the long-run causality runs from LOAN and DEPOSIT to MB. Being the β_3 – equal to -0,032816 – significant at the 0,01 probability level, we reject the null hypothesis arguing that the parameter is different from zero and conclude that a statistically significant relationship running from LOAN and DEPOSIT to MB exists. On the contrary, β_3 – equal to -0,000626 – is negative but not significant when we test the long-run causality from MB and DEPOSIT to LOAN. Consequently, we accept the null hypothesis arguing that there is no long-run causality running from MB and DEPOSIT to LOAN. When we look at the effect of MB and LOAN on DEPOSIT, the estimated β_3 is significant at the 0,01 probability level and equal to 0.010390. As the coefficient is found to be positive, no long-run causality from MB and LOAN to DEPOSIT exists.

Long-run coefficients			t-Statistic	Lag	Long-run
INDEPENDENT V.	*DEPENDENT V.*	β_3			*CONCLUSION*
LOAN & DEPOSIT	MB	-0.032816	[-3.138880]***	7	
MB & LOAN	DEPOSIT	0.010390	[3.56439]***	7	LOAN & DEPOSIT ➡ MB
MB & DEPOSIT	LOAN	-0.000626	[-0.611553]	7	

Table 4: Results of Error-Correction Models (Long-run Causality Test); * p<0.10, ** p<0.05, *** p<0.01; H_0: no long-run causality; INDEPENDENT V. represents the column of the independent variable; DEPENDENT V. represents the column of the dependent variable. The arrows show the causality direction: single arrows represent one way causality and double arrows represent bidirectional causality.

In Table 5, we show the VECM short-run results by using the Wald test. The Wald test is performed on the null hypothesis according to which the coefficients of the exogenous variables are equal to zero. If the 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 confirm the existence of short-run causality. The Wald test shows that LOAN causes DEPOSIT, DEPOSIT causes MB and LOAN determines MB. The Wald test allows us to show that the volume of loans provided by commercial banks influences the level of bank deposits and in turn bank deposits determine the monetary base. However, we have also found that bank loans directly affect the level of the monetary base. The long- and short-run causality results, estimated by means of VECM methodology applied to Eurozone countries, support the endogenous money theory and confirm that exogenous changes in the monetary base are inconsequential in affecting both the volume of loans and bank deposits.

Short-run coefficients			Lag	Short-run		
INDEPENDENT V.	*DEPENDENT V.*	χ^2 test		*CONCLUSION*		
LOAN	DEPOSIT	60.91634***	7	LOAN	➡	DEPOSIT
DEPOSIT	LOAN	11.57590	7			
DEPOSIT	MB	41.14427***	7	DEPOSIT	➡	MB
MB	DEPOSIT	3.942127	7			
LOAN	MB	16.50585**	7	LOAN	➡	MB
MB	LOAN	8.154957	7			

Table 5: Results of Error-Correction Models (Short-run Causality: Wald Test; * p<0.10, ** p<0.05, *** p<0.01. H_0: no short-run causality; INDEPENDENT V. represents the column of independent variable; DEPENDENT V. represents the column of dependent variable. The arrows show the causality direction: single arrow represents one way direction and double arrow represents bidirectional causality.)

Finally, as anticipated in subsection 3.2.1, we apply Toda and Yamamoto (1995) methodology and Granger non-Causality test in order to uphold and to strengthen the VECM results. As the maximal order of integration of our variables is one, we introduce in the VAR model at levels variables with one extra lag. The Granger non-Causality test applied to a trivariate VAR further validates the existing relationship between MB, LOAN and DEPOSIT.[19] As shown in Table 6, the Granger non-Causality test applied in the VAR model shows that both bank deposits and loans determine the monetary base. Moreover, bank loans influence bank deposits. Finally, the monetary base does not determine bank deposits and loans and deposits do not influence bank loans. Toda and Yamamoto (1995) methodology confirms the Wald tests results estimate by means of VECM methodology (cf. Table 5).

[19] 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.

Short-run coefficients			Lag	Short-run		
INDEPENDENT V.	*DEPENDENT V.*	χ^2 test		*CONCLUSION*		
LOAN	DEPOSIT	51.95332***	7	LOAN	➡	DEPOSIT
DEPOSIT	LOAN	11.10725	7			
DEPOSIT	MB	33.82365***	7	DEPOSIT	➡	MB
MB	DEPOSIT	2.190114	7			
LOAN	MB	15.74154**	7	LOAN	➡	MB
MB	LOAN	7.866351	7			

Table 6: Results of the Trivariate VAR (Short-run Causality: Granger non-Causality Test; * $p<0.10$, ** $p<0.05$, *** $p<0.01$; H_0: the independent does not Granger cause the dependent variable; INDEPENDENT V. represents the column of the independent variable; DEPENDENT V. represents the column of the dependent variable; The arrows show the causality direction: single arrow represents one way direction and double arrow represents bidirectional causality.)

The results presented in this section support the Post Keynesian endogenous money theory 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 support the Post Keynesian 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 in a trivariate VAR reinforces results found through the Wald test estimated in the VECM model.

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

In order to assess the stability and the robustness of the empirical results estimated in paragraph 4.1, as well as to consider the effect of financial crisis and of monetary policy instruments implemented by the ECB from the last quarter of 2008, we estimate the causal relationship among BM, DEPOSIT and LOAN by means of VAR and VECM model introducing the dummy variables shown in paragraph 3.2.2.

The VECM long-run results are summarized in Table 7. As shown in Table 7, the long-run causality runs from LOAN and DEPOSIT to MB, since there is only one β_3 significant. Being the β_3 equal to -0,392996 and significant, we reject the null hypothesis concluding that a statistically significant relationship running from LOAN and DEPOSIT to MB exists. On the contrary, the β_3 – equal to 0,005873 – is both positive and not significant when we test the long-run causality running from MB and DEPOSIT to LOAN. Consequently, we accept the null hypothesis of no long-run causality from MB and DEPOSIT to LOAN. Similarly, there is not long-run causality moving from MB and LOAN to DEPOSIT as the estimated coefficient β_3 is negative equal to -0.009451 and not significant.

Long-run coefficients			t-Statistic	Lag	Long-run
INDEPENDENT V.	*DEPENDENT V.*	β_3			*CONCLUSION*
LOAN & DEPOSIT	MB	-0.392996	[-9.92844]***	7	LOAN & DEPOSIT ➡ MB
MB & LOAN	DEPOSIT	-0.009451	[-0.46518]	7	
MB & DEPOSIT	LOAN	0.005873	[1.15784]	7	

Table 7: Results of Error-Correction Models with dummy variables (Long-run Causality Test; * p<0.10, ** p<0.05, *** p<0.01; H_0: no long-run causality; INDEPENDENT V. represents the column of the independent variable; DEPENDENT V. represents the column of the dependent variable. The arrows show the causality direction: single arrows represent one way causality and double arrows represent bidirectional causality.)

In Table 8, we show the VECM short-run results. The Wald test shows that LOAN causes DEPOSIT and MB, and DEPOSIT determines MB. We do not find any causal relationship neither going from MB to DEPOSIT and LOAN, nor from DEPOSIT to LOAN.

Short-run coefficients			Lag	Short-run
INDEPENDENT V.	*DEPENDENT V.*	χ^2 test		*CONCLUSION*
LOAN	DEPOSIT	41.69941***	7	LOAN ➡ DEPOSIT
DEPOSIT	LOAN	11.50748	7	
DEPOSIT	MB	43.04009***	7	DEPOSIT ➡ MB
MB	DEPOSIT	0.806606	7	
LOAN	MB	98.63529***	7	LOAN ➡ MB
MB	LOAN	5.479174	7	

Table 8: Results of Error-Correction Models with dummy variables (Short-run Causality: Wald Test; * p<0.10, ** p<0.05, *** p<0.01. H_0: no short-run causality; INDEPENDENT V. represents the column of independent variable; DEPENDENT V. represents the column of dependent variable. The arrows show the causality direction: single arrow represents one way direction and double arrow represents bidirectional causality.)

Finally, we apply Toda and Yamamoto (1995) methodology and Granger non-Causality test in order to strengthen the VECM results. The Granger non-Causality test applied to a trivariate VAR further validates the existing relationship between MB, LOAN and DEPOSIT estimated in the paragraph 4.1. As shown in Table 9, the Granger non-Causality test applied in the VAR model shows that both bank loans and deposits determine the monetary base.

Moreover, bank loans determine bank deposits. Finally, the monetary base does not influence bank deposits and loans and deposits do not determine bank loans. Toda and Yamamoto (1995) methodology confirms the Wald tests results estimate by means of VECM methodology (cf. Table 8).

Even after the introduction of dummy variables, both the VECM model and the trivariate VAR ascertain the short- and the long-run results of the baseline VECM and trivariate model (please see paragraph 4.1). Also the findings of the VAR and VECM models (with and without dummy variables) augmented by the euro area Balance of Payments reported in Appendix A confirm the same causal relationships. Consequently, these results allow us to assert that the model estimated is robust and stable and that empirical evidence upholds the Post Keynesian endogenous money theory in the Eurozone

Short-run coefficients			Lag	Short-run
INDEPENDENT V.	*DEPENDENT V.*	χ^2 test		*CONCLUSION*
LOAN	DEPOSIT	40.20452***	7	LOAN ➡ DEPOSIT
DEPOSIT	LOAN	11.42626	7	
DEPOSIT	MB	19.30635***	7	DEPOSIT ➡ MB
MB	DEPOSIT	1.807217	7	
LOAN	MB	62.59193***	7	LOAN ➡ MB
MB	LOAN	7.257907	7	

Table 9: Results of the Trivariate VAR with dummy variables (Short-run Causality: Granger non-Causality Test; * $p<0.10$, ** $p<0.05$, *** $p<0.01$; H_0: the independent does not Granger cause the dependent variable; INDEPENDENT V. represents the column of the independent variable; DEPENDENT V. represents the column of the dependent variable; The arrows show the causality direction: single arrow represents one way direction and double arrow represents bidirectional causality.)

5. Concluding remarks

The idea that monetary aggregates are determined exogenously through autonomous decisions of the central bank – as explained by the exogenous money theory – has for a long time represented a benchmark in the economic literature. The Post Keynesian endogenous money theory has proposed an alternative way to discuss the money creation process in modern economies. This theory has gained increasing attention due to the support received by important monetary institutions like the Bank of England (McLeay *et al.* 2014). In this paper, we have tested the above theories in the Eurozone for the 1999-2016 period through the following research question: in the Eurozone, are monetary aggregates determined by the supply of monetary reserves of the ECB, or are they the outcome of the interaction between the demand for and the supply of loans in the credit market?

The paper offers significant and original empirical evidence in order to answer this question. Specifically, we have estimated cointegration and causality using the Johansen test and the Granger causality tests, employed both in VAR and VECM methodology. Our tests have been enhanced by the use of dummy variables taking into considerations both external shocks – such as the financial crisis – and policy changes by ECB as a result of the implementation of unconventional monetary policy strategies.

Our findings support the Post Keynesian endogenous money theory in the Eurozone for the 1999-2016 period. By using a VECM methodology, we have found that in the long-run monetary aggregates depend on both bank deposits and bank loans. In the short-run, the study suggests that bank loans influence the level of bank deposits, which in turn determine the level of the monetary reserves. We have also found a direct influence of bank loans on the monetary base. Moreover, the Granger non-Causality test applied to a trivariate VAR confirms the short-run results estimated by means of the Wald test in the VECM model. Also, in order to check the stability of the models, we have also introduced suitable dummy variables. Econometric results of dummy VECM and trivariate VAR model ascertain the findings of models estimated without dummy variables. These support the Post Keynesian endogenous money theory, and suggest that exogenous changes in the monetary reserves do not influence the volume of loans provided by commercial banks in the euro area. The same short- and long-run causal relationships are confirmed when an open economy model – including the dynamics of the euro area Balance of Payments – is estimated. Our analysis of the money creation process in the Eurozone also supports recent studies at the Bank of England (McLeay *et al.* 2014; Jakab and Kumhof 2015), showing that in modern economies monetary aggregates are endogenously determined in the credit market by the interaction between the supply of and the demand for loans.

References

Akaike, H. 1974. 'A new look at the statistical model identification.' *IEEE Transactions on Automatic Control* 19(6): 716-723.

Arestis, P. 1987. 'The credit segment of a UK post Keynesian model.' *Journal of Post Keynesian Economics* 10(2): 250–269.

Arestis, P., and Eichner, A.S. 1988. 'The post-Keynesian and institutionalist theory of money and credit.' *Journal of Economic Issues* 22(4): 1003–1021.

Badarudin, Z.E., Khalid, A.M., and Ariff, M. 2009. 'Money supply behaviour in emerging economies: a comparative analysis.' *Journal of the Asia Pacific economy* 14(4): 331–350.

Badarudin, Z.E., Ariff, M., and Khalid, A.M. 2013. 'Post-Keynesian money endogeneity evidence in G-7 economies.' *Journal of International Money and Finance* 33: 146–162.

Bai, J. 1997. 'Estimating multiple breaks one at a time.' *Econometric theory* 13(3): 315–352.

Bai, J., and Perron, P. 1998. 'Estimating and testing linear models with multiple structural changes.' *Econometrica* 66(1): 47–78.

Bai, J., and Perron, P. 2003. 'Computation and analysis of multiple structural change models.' *Journal of applied econometrics* 18(1): 1-22.

Beirne, J., Dalitz, L., Ejsing, J., Grothe, M., Manganelli, S., Monar, F., Sahel, B., Susec, M., Tapking, J., and Vong, T. 2011. 'The impact of the Eurosystem's covered bond purchase programme on the primary and secondary markets.' *ECB Occasional Paper* No. 122.

Bijsterbosch, M., and Falagiarda, M. 2015. 'The macroeconomic impact of financial fragmentation in the euro area: Which role for credit supply?' *Journal of International Money and Finance* 54(C): 93–115.

Brunner, K. and Meltzer, A. 1990. 'Money Supply', in Friedman, B. and Hahn, F. (eds.), *Handbook of Monetary Economics*, 357-398, Amsterdam: North Holland.

Cecchetti, S. G., and Schoenholtz, K. L. 2015. *Money, Banking, and Financial Markets*. New York: McGraw-Hill, 4th edn.

Cifter, A., and Ozun, A. 2007. 'The Monetary Transmission Mechanism in the New Economy: Evidence from Turkey (1997-2006).' *South East European Journal of Economics and Business* 2(1): 15–24.

Cour-Thimann, P., and Winkler, B. 2012. 'The ECB's non-standard monetary policy measures: the role of institutional factors and financial structure'. O*xford Review of Economic Policy* 28(4): 765-803.

Darracq-Paries, M., and De Santis, R.A. 2015. 'A non-standard monetary policy shock: The ECB's 3-year LTROs and the shift in credit supply.' *Journal of International Money and Finance* 54(C): 1–34.

Davidson, R., and MacKinnon, J.G. 1993. *Estimation and Inference in Econometrics.* New York: Oxford University Press.

Deleidi, M. 2018. 'Post Keynesian endogenous money theory: A theoretical and empirical investigation of the credit demand schedule.' *Journal of Post Keynesian Economics*, 41(2): 185-209.

Deleidi, M. 2019. 'Horizontalists, Structuralists and the credit market: an empirical assessment of post-Keynesian endogenous money approaches.' *Bulletin of Political Economy*, 13(1): 21-53.

Deleidi, M. 2020. 'Post-Keynesian endogenous money theory: Horizontalists, structuralists and the paradox of illiquidity.' *Metroeconomica* 71(1): 156-175.

Deleidi, M., and Levrero, E.S. 2019. 'The money creation process: A theoretical and empirical analysis for the United States.' *Metroeconomica*, 70(4): 552-586.

Dow, S.C. 1996. 'Horizontalism: A Critique.' *Cambridge Journal of Economics*, 20(4): 497–508.

Draghi, M. (2014). 'Monetary policy in a prolonged period of low inflation.' *ECB Forum on Central Banking, Sintra*, 26 May 2014. https://www.ecb.europa.eu/press/key/date/2014/html/sp140526.en.html.

Engle, R.F., and Granger, C.W. 1987. 'Co-integration and error correction: representation, estimation, and testing.' *Econometrica: journal of the Econometric Society* 55(2): 251–276.

EUROPEAN CENTRAL BANK (ECB). 2008a. '*Monthly Bulletin November 2008*', ISSN 1725-2822.

EUROPEAN CENTRAL BANK (ECB). 2008b. 'Covered Bonds in the EU Financial System', *Monthly Bulletin December 2008*, ISBN 978-92-899-0361-5.

EUROPEAN CENTRAL BANK (ECB). 2011a. 'Decision of the European Central Bank of 3 November 2011 on the implementation of the second covered bond purchase programme.' *Official Journal of the European Union* ECB/2011/17, 2011/744/EU.

EUROPEAN CENTRAL BANK (ECB). 2011b. 'The supply of money – Bank behaviour and the implications for monetary analysis.' *Monthly Bulletin October 2011*, ISSN 1725-2822.

Fontana, G. 2003. 'Post Keynesian approaches to endogenous money: a time framework explanation.' *Review of Political Economy* 15(3): 291–314.

Fontana, G. 2004. 'Rethinking endogenous money: a constructive interpretation of the debate between horizontalists and structuralists.' *Metroeconomica* 55(4): 367–385.

Fontana, G. 2007. 'Why Money Matters: Wicksell, Keynes and the 'New Consensus View' on Monetary Policy.' *Journal of Post Keynesian Economics* 30(1): 43-60

Fontana, G. 2009. *Money, uncertainty and time*. London: Routledge.

Fontana, G., Pacella, A., and Realfonzo, R. 2017. 'Does fiscal policy affect the monetary transmission mechanism? A monetary theory of production (MTP) response to the new consensus macroeconomics (NCM) perspective.' *Metroeconomica* 68(2): 378-395.

Fontana, G., Realfonzo, R., and Passarella, M. V. 2020. 'Monetary economics after the global financial crisis: what has happened to the endogenous money theory?.' *European Journal of Economics and Economic Policies: Intervention*, 1-17 https://doi.org/10.4337/ejeep.2020.0056

Fontana, G., and Setterfield, M. 2009. 'Macroeconomics, Endogenous Money and the Contemporary Financial Crisis.' *International Journal of Pluralism and Economic Education* 1(1-2): 130-147,

Fontana, G., and Venturino, E. 2003. 'Endogenous money: an analytical approach.' *Scottish Journal of Political Economy* 50(4): 398–416.

Foster, J. 1992. 'The determination of Sterling M3, 1963-88: an evolutionary macroeconomic approach.' *The Economic Journal* 102(412): 481–496.

Foster, J. 1994. 'An evolutionary macroeconomic model of Australian dollar M3 determination: 1967–93.' *Applied Economics* 26(11): 1109–1120.

Friedman, M. 1969. '*The optimum quantity of money, and other essays.*' Chicago: Aldine Publishing Company.

Granger, C.W. 1988. 'Some recent development in a concept of causality.' *Journal of econometrics* 39(1-2): 199–211.

Graziani, A. 2003. '*The monetary theory of production.*' Cambridge: Cambridge University Press.

Holtemöller, O. 2003. 'Money Stock, Monetary Base and Bank Behavior in Germany, Geldmenge, Geldbasis und Bankenverhalten in Deutschland.' *Journal of Economics and Statistics* 223(3): 257–278.

Howells, P., and Hussein, K. 1998. 'The endogeneity of money: evidence from the G7.' *Scottish Journal of Political Economy* 45(3): 329–340.

Hristov, N., Hülsewig, O., and Wollmershäuser, T. 2012. 'Loan supply shocks during the financial crisis: Evidence for the Euro area.' *Journal of International Money and Finance* 31(3): 569–592.

Johansen, S. 1988. 'Statistical analysis of cointegration vectors.' *Journal of economic dynamics and control* 12(2): 231–254.

Jakab, Z., and Kumhof, M. 2015. 'Banks are not intermediaries of loanable funds—and why this matters.' *Working Paper No. 529* Bank of England.

Kalecki, M. 1937. 'The principle of increasing risk.' *Economica* 4(16): 440–447.

Krugman, P. R., and Obstfeld, M. 2000. *International Economics, Theory and Policy.* Reading, MA: Addison-Wesley Publishing Company.

Lavoie, M. 1984. 'The endogenous flow of credit and the post Keynesian theory of money.' *Journal of Economic Issues* 18(3): 771–797.

Lavoie, M. 1996. 'Horizontalism, structuralism, liquidity preference and the principle of increasing risk.' *Scottish Journal of Political Economy* 43(3): 275–300.

Lavoie, M. 2001. 'The Reflux Mechanism and the Open Economy.' In Rochon, L. P., Vernengo, M. (eds). *Credit, Interest Rates and the Open Economy: Essays on Horizontalism*. 215 -242. Cheltenham: Edward Elgar Publishing.

Lavoie, M. 2014. '*Post-Keynesian Economics: New Foundations.*' Cheltenham, UK: Edward Elgar Publishing.

Liu, J. and Kool, C.J. 2018. 'Money and credit overhang in the euro area.' *Economic Modelling*, 68(C): 622-633.

Marshall, W.C. and Rochon, L.P. 2019. 'Public banking and Post-Keynesian economic theory.' *International Journal of Political Economy*, 48(1): 60-75.

McLeay, M., Radia, A., and Thomas, R. 2014. 'Money creation in the modern economy.' *Bank of England Quarterly Bulletin Q1*.

Minsky, H. 1975. *John Maynard Keynes.* New York: McGraw Hill Professional.

Minsky, H. 1982. *Can "It" Happen Again?: Essays on Instability and Finance.* Armonk, New York: M.E. Sharpe,

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

Moore, B.J. 1989. 'The endogeneity of credit money.' *Review of Political Economy* 1(1): 65–93.

Mosconi, R., and Giannini, C. 1992. 'Non-causality in cointegrated systems: representation estimation and testing.' *Oxford Bulletin of Economics and Statistics* 54(3): 399-417.

Nell, K.S. 2000. '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. 1996. 'Accommodationism versus structuralism: time for an accommodation.' *Journal of Post Keynesian Economics* 18(4): 585-594.

Palacio-Vera, A. 2001. 'The Endogenous money hypothesis: some evidence from Spain (1987-1998).' *Journal of Post Keynesian Economics* 23(3): 509–526.

Phillips, P.C., and Perron, P. 1988. 'Testing for a unit root in time series regression.' *Biometrika* 75(2): 335–346.

Rambaldi, A., and Doran, H. 1996. 'Testing for Granger Non-Causality in Cointegrated Systems Made Easy.' *Working Paper in Econometrics and Applied Statistics No. 88.* Department of Econometrics, University of New England, NSW, Australia.

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

Rochon, L.P. 2001. 'Horizontalism: Setting the Record Straight.' In Rochon, L. P., and Vernengo, M. (eds). *Credit, Interest Rates and the Open Economy: Essays on Horizontalism*. 31-65. Cheltenham UK: Edward Elgar Publishing.

Rochon, L.P. 2016. 'In pursuit of the holy grail: monetary policy, the natural rate of interest, and quantitative easing.' *Studies in Political Economy* 97(1): 87-94.

Rochon, L. P., and Vernengo, M. 2001. *Credit, Interest Rates and the Open Economy: Essays on Horizontalism.* Cheltenham UK: Edward Elgar Publishing.

Samuelson, P., and Nordhaus, W. 1995. *Economics.* New York: McGraw-Hill.

Shanmugam, B., Nair, M., and Li, O.W. 2003. 'The endogenous money hypothesis: empirical evidence from Malaysia (1985-2000).' *Journal of Post Keynesian Economics* 25(4): 599–611.

Sims, C.A., Stock, J.H., and Watson, M.W. 1990. 'Inference in linear time series models with some unit roots.' *Econometrica: Journal of the Econometric Society* 58(1): 113–144.

Toda, H. Y., and Phillips, P.C.B. 1993. 'Vector autoregressions and causality.' Econometrica 61(3): 1367–1393.

Toda, H. Y., and Phillips, P.C.B. 1994. 'Vector autoregressions and causality: a theoretical overview and simulation study.' *Econometric Reviews* 13(2): 259-285.

Toda, H.Y., and Yamamoto, T. 1995. 'Statistical inference in vector autoregressions with possibly integrated processes.' *Journal of econometrics* 66(1-2): 225–250.

Vera, L. 2014. 'The simple post-Keynesian monetary policy model: an open economy approach.' *Review of Political Economy* 26(4): 526-548.

Vymyatnina, Y. 2006. 'How much control does Bank of Russia have over money supply?' *Research in International Business and Finance* 20(4): 131–144.

Werner, R. A. 2014. ‘Can banks individually create money out of nothing? The theories and the empirical evidence.’ *International Review of Financial Analysis* 36: 1-19.

Wolfson, M.H. 1996. ‘A Post Keynesian theory of credit rationing.’ *Journal of Post Keynesian Economics* 18(3): 443–470.

Wray, L.R. 1990. *Money and Credit in Capitalist Economies: The Endogenous Money Approach*. Aldershot, Hants, England; Brookfield, Vt., USA: Edward Elgar Pub.

Wray, L.R. 1992. ‘Alternative approaches to money and interest rates, Journal of Economic Issues.’ 26(4): 1145–1178.

Appendices

Appendix A

In this appendix, we report the findings of the models considering open economy issues. To do this, we augment all the models presented in Section 4 (VAR and VECM with and without dummy variables) with the euro area Balance of Payments data displayed in Figure A1. Our findings, reported from Tables A1 to A6, are in line to those obtained in Section 4 therefore supporting the Post Keynesian endogenous money theory. Specifically, as shown in Tables A1 and A4 (VECM without and with dummy variables, respectively), long-run causal relationships moving from LOAN and DEPOSIT to MB are estimated and no other long-run relationships have been found significant. When we look at the short-run effects estimate in the VECM without and with dummy variables (Tables A2 and A5, respectively), short-run causal relationships moving from LOAN to DEPOSIT and MB and from DEPOSIT to MB are estimated. Finally, when short-run causality is estimated within the Toda and Yamamoto (1995) procedure (without and with dummy variables, Tables A3 and A6 respectively), short-run causal relationships moving from LOAN to DEPOSIT and MB and from DEPOSIT to MB are found.

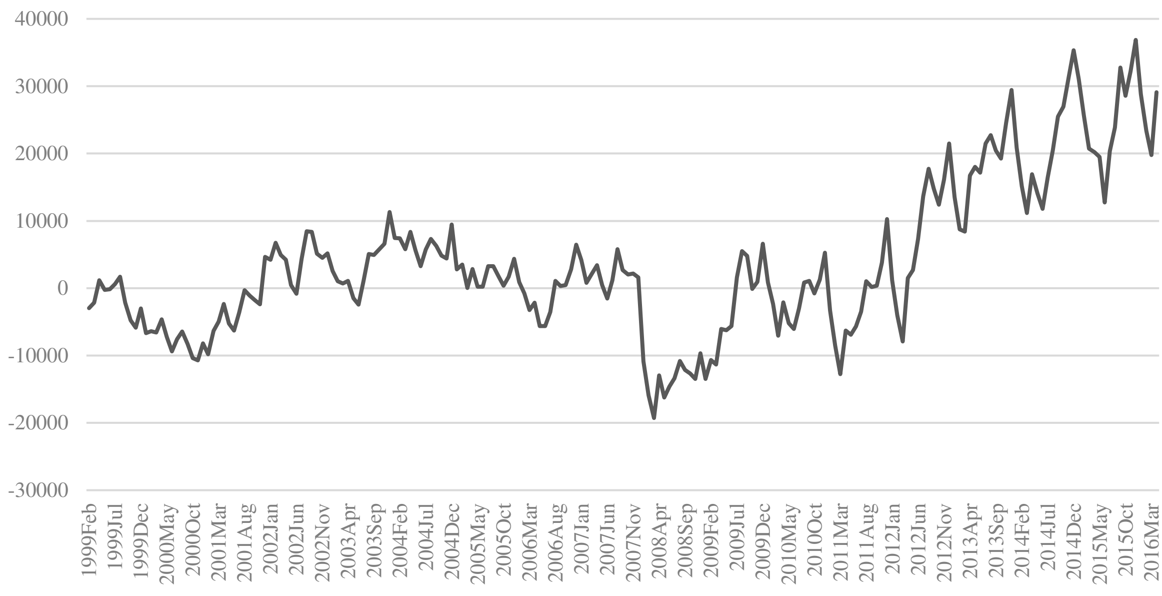

Figure A1: Balance of Payments, Euro area. Millions of Euro

Long-run coefficients			t-Statistic	Lag	Long-run
INDEPENDENT V.	*DEPENDENT V.*	β_3			*CONCLUSION*
LOAN & DEPOSIT	MB	-0.072358	[-3.98155]***	7	
MB & LOAN	DEPOSIT	0.003396	[1.06239]	7	LOAN & DEPOSIT → MB
MB & DEPOSIT	LOAN	-0.001324	[-0.73128]	7	

Table A1: Results of Error-Correction Models with BoP (Long-run Causality Test; * p<0.10, ** p<0.05, *** p<0.01; H_0: no long-run causality; INDEPENDENT V. represents the column of the independent variable; DEPENDENT V. represents the column of the dependent variable. The arrows show the causality direction: single arrows represent one way causality and double arrows represent bidirectional causality.)

Short-run coefficients			Lag	Short-run
INDEPENDENT V.	*DEPENDENT V.*	χ^2 test		*CONCLUSION*
LOAN	DEPOSIT	51.49346***	7	LOAN → DEPOSIT
DEPOSIT	LOAN	11.94998	7	
DEPOSIT	MB	36.10382***	7	DEPOSIT → MB
MB	DEPOSIT	1.548016	7	
LOAN	MB	16.91474**	7	LOAN → MB
MB	LOAN	7.848660	7	

Table A2: Results of Error-Correction Models with BoP (Short-run Causality: Wald Test; * p<0.10, ** p<0.05, *** p<0.01. H_0: no short-run causality; INDEPENDENT V. represents the column of independent variable; DEPENDENT V. represents the column of dependent variable. The arrows show the causality direction: single arrow represents one way direction and double arrow represents bidirectional causality.)

Short-run coefficients			Lag	Short-run
INDEPENDENT V.	*DEPENDENT V.*	χ^2 test		*CONCLUSION*
LOAN	DEPOSIT	60.65639***	7	LOAN → DEPOSIT
DEPOSIT	LOAN	12.91103	7	
DEPOSIT	MB	46.43762***	7	DEPOSIT → MB
MB	DEPOSIT	1.651137	7	
LOAN	MB	15.56873**	7	LOAN → MB
MB	LOAN	7.663441	7	

Table A3: Results of the Trivariate VAR with BoP (Short-run Causality: Granger non-Causality Test; * p<0.10, ** p<0.05, *** p<0.01; H_0: the independent does not Granger cause the dependent variable; INDEPENDENT V. represents the column of the independent variable; DEPENDENT V. represents the column of the dependent variable; The arrows show the causality direction: single arrow represents one way direction and double arrow represents bidirectional causality.)

Long-run coefficients			t-Statistic	Lag	Long-run
INDEPENDENT V.	*DEPENDENT V.*	β_3			*CONCLUSION*
LOAN & DEPOSIT	MB	-0.078998	[-4.08595]***	7	
MB & LOAN	DEPOSIT	0.001927	[0.55844]	7	LOAN & DEPOSIT → MB
MB & DEPOSIT	LOAN	-0.002185	[-1.13122]	7	

Table A4: Results of Error-Correction Models with BoP and dummy variables (Long-run Causality Test; * p<0.10, ** p<0.05, *** p<0.01; H_0: no long-run causality; INDEPENDENT V. represents the column of the independent variable; DEPENDENT V. represents the column of the dependent variable. The arrows show the causality direction: single arrows represent one way causality and double arrows represent bidirectional causality.)

Short-run coefficients			Lag	Short-run
INDEPENDENT V.	*DEPENDENT V.*	χ^2 test		*CONCLUSION*
LOAN	DEPOSIT	61.55053***	7	LOAN ➡ DEPOSIT
DEPOSIT	LOAN	11.08819	7	
DEPOSIT	MB	39.96178***	7	DEPOSIT ➡ MB
MB	DEPOSIT	1.164843	7	
LOAN	MB	15.59381**	7	LOAN ➡ MB
MB	LOAN	7.019743	7	

Table A5: Results of Error-Correction Models with BoP and dummy variables (Short-run Causality: Wald Test; * $p<0.10$, ** $p<0.05$, *** $p<0.01$. H_0: no short-run causality; INDEPENDENT V. represents the column of independent variable; DEPENDENT V. represents the column of dependent variable. The arrows show the causality direction: single arrow represents one way direction and double arrow represents bidirectional causality.)

Short-run coefficients			Lag	Short-run
INDEPENDENT V.	*DEPENDENT V.*	χ^2 test		*CONCLUSION*
LOAN	DEPOSIT	58.74622***	7	LOAN ➡ DEPOSIT
DEPOSIT	LOAN	12.87985	7	
DEPOSIT	MB	45.09760***	7	DEPOSIT ➡ MB
MB	DEPOSIT	1.554717	7	
LOAN	MB	15.65534**	7	LOAN ➡ MB
MB	LOAN	7.384194	7	

Table A6: Results of the Trivariate VAR with BoP and dummy variables (Short-run Causality: Granger non-Causality Test; * $p<0.10$, ** $p<0.05$, *** $p<0.01$; H_0: the independent does not Granger cause the dependent variable; INDEPENDENT V. represents the column of the independent variable; DEPENDENT V. represents the column of the dependent variable; The arrows show the causality direction: single arrow represents one way direction and double arrow represents bidirectional causality.)

Appendix B

N° of Lags	MB-DEPOSIT-LOAN
0	-4,125922
1	-19,84981
2	-20,13462
3	-20,24039
4	-20,30412
5	-20,42959
6	-20,48152
7	-20,56656*
8	-20,52489

Table B.1. Optimal lag length based on the Akaike Information Criteria (AIC)

Appendix C

	Phillips-Perron Test					
Variables	Intercept		Trend & Intercept		None	
	Adj. t-statistic	P-value	Adj. t-statistic	P-value	Adj. t-statistic	P-value
			Level			
MB	-0.221546	0.93	-2.475030	0.34	2.438235	1.00
DEPOSIT	-1.437836	0.56	-0.471110	0.98	10.28803	1.00
LOAN	-2.174442	0.22	0.105902	1.00	4.011986	1.00
BoP	-1.665727	0.45	-2.634704	0.27	-1.353497	0.17
			First difference			
MB	-12.01771	0.00	-12.00861	0.00	-11.72738	0.00
DEPOSIT	-15.96802	0.00	-16.18515	0.00	-13.07182	0.00
LOAN	-9.300874	0.00	-12.34593	0.00	-6.218814	0.00
BoP	-13.37819	0.00	-13.36587	0.00	-13.38879	0.00

Table C.1. Unit root test (Phillips-Perron): $\mathbf{H_0}$: considered variable has a unit root.