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Endogenous money supply, global liquidity and financial transactions: Panel evidence from OECD countries

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Abstract

Research background: Endogenous money creation is an inherent feature of today's economies and widely accepted phenomenon. As the various theories of money rely on the money quantity equation, most empirical research is heading towards the analysis of the two-way relationship between the quantity of money and nominal GDP. In today's world, with the extraordinary development of the financial sector, money is used not only for transactions in the real economy, but increasingly also for purchasing financial assets. This observation was absorbed by Werner in the quantity theory of disaggregated credit.

Purpose of the article: The aim of the paper is to join the debate on endogenous character of money supply by testing a disaggregated equation of money. It assumes that the domestic money supply is positively determined not only by growth in GDP-based transactions but also by growth in non-GDP-based transactions (financial transactions). Additionally, it is assumed that in the age of globalization it can be also positively influenced by the global liquidity.

Methods: Testing of the above-mentioned hypotheses takes place with the use of panel unit roots tests, panel Granger causality test and panel estimations (OLS, models with

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fixed/random effects, GMM). In the study, annual data from 2002 to 2018 for OECD countries were chosen for statistical research.

Findings & value added: The article confirms the hypothesis that real and financial economic activity together with global liquidity positively influence domestic credit and thus money supply. As the amount of money in an economy is driven not only by the real economy but also by the financial economy, prudential regulations that restrict leverage (and thus control the amount of credit) and limit risk-taking during price bubbles periods should be therefore considered. In the research, the reaction of domestic money supply to the changes in US money supply is positive. It confirms the importance of spill-over effect of expansionary policy in major economies to other economies.

Introduction

The debate on exogenous or endogenous character of money supply accelerated in the 70s and 80s of the last century. The old attitude towards money, which was treated as an exogenous product of the central bank's monetary policy, was confronted with the behavior of commercial banks providing credit on demand. To resolve the problem of money supply exogeneity or endogeneity, post-Keynesians pointed to so-called reverse causation. Kaldor (1982) concluded that money supply adapts to its demand through two mechanisms, first, commercial banks increase their reserves to meet new credit demand, and second, central banks become adjusted to this demand. Inability to control the money supply and falling inflation with an increase in money supply in the late 80s caused a departure from monetarist view on exogenous money supply also by central banks. They generally accepted the endogenous nature of money and started controlling short-term interest rate to influence inflation and GDP (see e.g. Woodford, 2004; Lavoie, 2019).

A "new consensus" (Arestis & Sawyer, 2006) appeared to have been reached, but the advent of quantitative easing (QE) policies that became widespread after the financial crisis of 2007–2008 rekindled the debate (see e.g. Sieroń, 2019; Sawyer, 2020; Fontana *et al.*, 2020). As discussed by Lavoie and Fiebiger (2018), the monetarist view is generally that an increase in bank reserves automatically leads to an increase in the broad money, which can lead to higher nominal spending, higher nominal GDP, and higher inflation. Post-Keynesian views, on the other hand, emphasize the endogeneity of money and oppose the monetarist proposition. Without additional demand from businesses and households, increasing reserves will not encourage banks to lend more. However, only the demand for

credit from firms and households is not enough. For the economy to grow, they need to engage in GDP-based transactions, and not those that do not create GDP¹.

The contribution of the paper to this debate is as follows. First, as money is used in general for transactions, the theoretical basis for analysis in the article is their disaggregation into GDP-based and non-GDP transactions in the spirit of Werner (2005). In this approach, increased expenditures both in real and financial sector of economy can stand behind new money creation. Second, although there are various empirical studies that investigate endogeneity of money, however, only limited attention has been paid to test the disaggregated equation of exchange. Additionally, the paper empirically examines the global liquidity contribution to the domestic money creation.

Given the rapid growth of the financial sector, the Werner's innovation is an interesting theoretical proposal concerning the relationship between money creation and the behavior of real and financial economy. As Huber (2020) noted, the aggregate putting-in-one of GDP and non-GDP transactions is misleading. Non-GDP transactions need also financing and thus they impact money demand. From such thinking a research hypothesis follows. It assumes that the domestic money supply is positively determined not only by growth in GDP-based transactions, but also by growth in non-GDP-based transactions. Especially, the paper assumes that there is a two-way causality between non-GDP based transactions and money supply. Additionally, it is assumed that in the age of globalization domestic money supply can be also positively influenced by an external factor, namely by the global liquidity.

Knowledge of the above interdependencies suggests that potential credit creation need not contribute to economic growth at the desired scale, as it can be used for non-GDP based transactions, but also for capital outflows abroad. Werner's model of disaggregated credit may also help explain the puzzle of the limited effectiveness of QE policies after the 2007–2008 financial crisis, including the problem of decoupling between money and nominal GDP after the introduction of QE policy.

¹ In addition to the sale of intermediate goods and used goods, non-GDP transactions mainly include the sale of financial assets (stocks, bonds and other securities), the trading of real estate and commodities as financial instruments, derivatives, foreign exchange and cryptocurrencies.

Panel regression analysis (OLS, models with fixed and/or random effects and GMM) was used to test the hypothesis. OECD countries and the period under investigation which runs from 2002 to 2018 were chosen for statistical research due to data availability.

The paper is organized in six sections. Section 2 presents a brief review of underlying theory and empirical works. Next section provides hypothesis and describes data and empirical methodology to be used in the econometric study. Section 4 presents and discuss findings and section 5 concludes.

Underlying theory (theoretical and empirical work)

Real and financial transactions and money

Various macroeconomic theories rely on the traditional quantity theory relationship (Werner, 2005):

$$M \times V = P \times Y \quad (1)$$

where M stands for money supply, V for velocity of money, PY defines nominal GDP (where Y represents real output and P – the GDP deflator), or its modified version:

$$M' \times V' = P' \times T' \quad (2)$$

defining M' as the quantity of money used for transactions, V' as the transaction velocity of money, $P'T'$ as the total value of transactions in an economy (where P' stands for the price paid for transactions and T' for the number of transactions).

This version of the classical Fisher equation does not match, however, modern conditions. The equation [2] is retained if it considers GDP-related transactions. GDP comprises however only finished goods and services when purchased by their final users. Although intermediate carried-out transactions are reflected indirectly in GDP-based transactions, there is a growing part of economy which is not related to GDP. The distinction between transactions which are related to GDP and which are non-GDP-items where identified already by e.g. Fisher (1911) and Keynes (1930).

According to Fisher, nominal transactions can be split into income and financial transactions. Keynes distinguished, in turn, productive, speculative (in capital goods and commodities) and financial (e.g. in bonds and shares) transactions.

Due to extreme development of the financial market resulting in rapid increase in speculative and investment transactions (resulting in so-called financialization of the economy, see e.g. Davis & Kim, 2015; Tori & Onaran, 2018; Moran & Flaherty, 2022) the weakness of focusing on $P \times Y$ and consequently only on GDP-based transactions can be seen. Given the arguments cited, Werner (2005) disaggregated the equation [2] for GDP-based and non-GDP-related (primarily financial) transactions:

$$M_r \times V_r = P_r \times T_r \quad (3)$$

$$M_f \times V_f = P_f \times T_f \quad (4)$$

as

$$M' \times V' = M_r \times V_r + M_f \times V_f \quad (5)$$

$$P' \times T' = P_r \times T_r + P_f \times T_f \quad (6)$$

the equation [7] must also hold

$$M_r \times V_r + M_f \times V_f = P_r \times T_r + P_f \times T_f \quad (7)$$

defining M_r as money used for transactions that are part of GDP (real transactions), M_f – money which is not used for GDP-based transactions (financial transactions), V_r – ‘real’ velocity of money, V_f – ‘financial’ velocity of money, P_r – the price paid for ‘real’ transactions, P_f – the price paid for ‘financial’ transactions, T_r – the number of ‘real’ transactions, T_f – the number of ‘financial’ transactions.

In dynamic terms, equation [7] takes the following form:

$$\Delta M_r \times V_r + \Delta M_f \times V_f = \Delta(P_r \times T_r) + \Delta(P_f \times T_f) \quad (8)$$

Equation [8] shows that the rise (or fall) in the amount of money which is used for all the transactions in the economy is equal to the rise (or fall) in

the change in the value of GDP-based transactions (the nominal GDP) and to the change in the value of non-GDP-based transactions.

Werner (1997, 2005, 2012) developed his ideas including disaggregated traditional money quantity equation into the quantity theory of credit, which is based on the idea that money is primarily created by commercial banks and credit from banks is used also for transactions not included in GDP. Quantity theory of credit was empirically supported e.g. by Lyonnet and Werner (2012) and Ryan-Collins *et al.* (2016).

Endogeneity of money

The assumption of exogeneity of money supply, which is still often encountered in macroeconomic textbooks, does not suit the modern economic conditions. The exogenous character of money assumes that money supply equals the monetary base times the money multiplier. As such, the money supply can be determined by the central bank that, in turn, can control it. In this view, banks can create new credits when they receive new money for it from the central bank. The interest rate is the result of dynamics of money supply and money demand.

In the real world, the central banks do not directly control the money supply, since the money supply is a function of the financial behavior of the various economic units, especially commercial banks, which play a key role in the process of creating money. Money supply is thus endogenous to the creation of credit. The question of endogeneity of money supply (and credit itself) were the subject of theoretical considerations already by Smith (1776 [2012]), Wicksell (1898), Hayek (1933). However, this approach was much developed in post-Keynesian monetary theory. The endogenous nature of money was recognized already by Keynes himself (1930, 1936), but it was supported and confronted with the monetarist money exogeneity view by e.g. Robinson (1956), Kaldor (1970, 1982), Davidson and Weintraub (1973), Moore (1988), Le Bourva (1992) and Wray (1992). The discussion about the endogenous character of money supply is still present in the current literature. Especially after the onset of the financial crisis of 2007–2008, there has been renewed interest in the limitations of the conventional and especially unconventional monetary policies which are clearly of monetarist origin (Fontana *et al.*, 2020). Academic arguments emphasize that the inability to control money supply is largely due to the endogenous nature of bank lending (Lavoie & Fiebiger, 2018).

The evidence of money supply which is determined within the economic system was provided by numerous papers starting from Kaldor (1982) and Moore (1983). Table 1 contains the selected recent academic empirical research papers in which money endogeneity was tested, pointing at the variables studied, the statistical data and methods engaged and received results.

Asset prices, financial transactions and money supply

The relationship between the money supply and asset prices is well described in economic literature. According to Friedman (1969) the increased money supply influences banking liquidity and thus, in turn, credit creation, which has a positive impact on asset prices. In case of stock prices, this view was supported by e.g. Bernanke and Kuttner (2005), Balatti *et al.* (2017), Hudepohl *et al.* (2021) and in case of property prices by Reisenbichler (2020)².

The relationship between the money supply and asset prices appears, however, to be two-way. This is visible in the process of creating and bursting of the speculative bubble as described in Hyman Minsky' style by the Economic Affairs Department (2012). Asset prices initially rise significantly as a result of credit creation for financial transactions and remain above the fundamental values. Then the speculative bubble bursts and asset prices suddenly fall. Fall in assets process (e.g. property and stock prices) reduce the value of assets held by households and businesses (*the balance sheet channel*). Borrowers lose their creditworthiness and increase their risk of default. The number of bad loans leads to instability of the banking and financial system and worsens bank balance sheets by reducing the value of the banks' assets and equity (*the bank capital channel*), which causes the phenomenon of credit rationing. Banks are then more averse to risk and become more cautious in granting loans, which together with rising market interest rates (*the interest rate channel*) and lower levels of optimism among households and producers limit their demand for consumer goods and services or means of production. The role of monetary policy in the 'bubble' world is also discussed in recent works (see e.g. Dong *et al.*, 2020; Asriyan *et al.*, 2021).

² However, there is also a broad literature that do not support this view, e.g. Gordon and Leeper (2002), Belke *et al.* (2009), Yao *et al.* (2014).

International capital flows and money supply

In global economy, national monetary aggregates could be determined also by international capital flows in direct and indirect way. The international capital inflows are reflected in accumulation of the central bank's foreign reserves (the balance of payments surplus) which, if not sterilized, increase the amount of money in circulation). On the contrary, balance of payments deficit causes an outflow of foreign currency. Domestic money flows into the central bank as payment for foreign currency. Thus, the unsterilized changes in the balance of payments have a direct impact on the money supply (Reinhart & Reinhart, 2008; Ponomarenko, 2019).

However, even with balanced payments, dynamics of domestic credit and thus the money supply may be affected by international capital flows that affect both banks and non-banks funding conditions (Lane & McQuade, 2014). In globalized financial, world domestic banks and non-banks can obtain financing from the international financial system. They can finance their activity in cross-border transactions with foreign entities. In many cases, they are multinational companies linked to the parent companies delivering financing within the same organization (Lane & McQuade, 2014). Allen *et al.* (2011) investigating cross-border financing of European banks indicate the big role of foreign-owned banks in many countries in financial deepening. On the one hand, it broadens access to financing, but on the other hand it contributes to the fact that the credit activity of domestic banks is much influenced by international developments in credit markets.

Capital flows (especially to emerging economies) can inflate (deflate) the domestic money supply also in an indirect way causing domestic bubbles in asset prices and later deflate it when foreign investors withdraw the capital causing bubbles to burst. Asset price inflation (or deflation) activates the mechanism described in point [Asset prices, financial transactions and money supply]. The effects of foreign capital inflows on asset prices were examined by e.g. Kim and Yang (2011) and Baba and Sevil (2020).

Capital flows are driven by both domestic and foreign factors (Tchorek *et al.*, 2017), but it has been widely observed that especially in emerging economies they are often driven more by global liquidity conditions than domestic economic conditions (Gupta, 2016; Ibarra & Tellez-Leon, 2020). Carrera *et al.* (2016) and Rodrigo *et al.* (2018) noticed that in the last years especially the Quantitative Easing (QE) programs, the unconventional

monetary policy in which central banks in major developed economies increased their monetary base³ (and decreased short-term and influenced long-term interest rates) to inject liquidity into their economies, were transmitted to developing countries through interest rates, credit growth and exchange rate channels. Empirical works generally support the idea of positive causality between higher global liquidity and domestic output and money supply although observed with some delay. Granger-causality analysis supporting this view was conducted by Baks and Kramer (1999), Ruffer and Stracca (2006). Similar conclusions were drawn regarding US QE spill-over to developed and developing countries in works by e.g. Baumeister and Benati (2012), Fratcher *et al.* (2013), Gambocorta *et al.* (2014) and Lane and McQuade (2014).

Hypothesis, data and empirical method

Hypothesis

Considerations regarding the factors influencing the money supply should start with the fact that the key part of M is the creation of credit by banks, which affects the number and value of transactions⁴. According to the equation [5], the existence of M' in an economy is driven by the real and also by financial economy. Thus supply of money is a function of profit expectations in both sectors of the economy. The causality goes from the expected income of firms in the real economy and expected profits in the financial economy to the demand of credit which leads to the creation of money⁵. Taking it all into account, the research hypothesis assumes that aside real also financial economic activity positively influences money supply. Thus, the hypothesis concerns the question of endogeneity of mon-

³ QE programs in the US, UK, EU, Japan, Switzerland and Sweden have injected roughly \$12 trillion into the global financial system since the collapse of Lehman Brothers (Rodrigo *et al.*, 2018). Quantitative easing was an important determinant of capital flows and their volatility (Burns *et al.*, 2014).

⁴ Werner (2005, p. 186–190) provides interesting discussion leading to the conclusion that M (traditionally measured by such aggregates as M1, M2 or M3) represents savings potential, that is potential, not effective purchasing power. The amount of money actually used for transactions can only be increased when banks create new credit.

⁵ It is worth highlighting that both demand factors for loans (driven by profit expectations) and supply factors (credit rationing by banks on their own initiative or as a result of state regulation) are responsible for money creation.

ey. As the result the casual relationship between money supply and real and financial economic activity is assumed. A review of the literature shows that domestic credit growth could be determined also by external factors. Therefore, it is also assumed that the global liquidity can also have a positive effect on the money supply.

The research hypothesis and the choice of analyzed variables refer to the broad literature on modern money creation (Rapih, 2021; Hook, 2022) and were divided into two main groups: demand-pull and supply-push factors (table 2). Pull factors are driven by each country's demand for GDP-based and non-GDP-based transactions proxied by financial transactions. Push factors are driven by domestic (credit rationing) or external shocks influencing both money supply.

Broad money represents a wide scope definition of money being the most flexible measure of economy's money supply. However, it contains both exogenous and endogenous factors as M1 is controlled by the central bank itself. It is commercial banks that decide to increase or decrease credits in reaction to changes in macroeconomic conditions making money endogenous. That is why domestic credit to private sector by banks is used in the process of hypothesis testing the dependent variables.

Data

The data set focuses on OECD countries. Annual data from 2012 to 2018 were utilized. These were dictated by the availability of the data for OECD countries. All variables are downloaded from the WDI online database of the World Bank. As WDI does not provide all needed time series for all OECD countries, countries with missing data were excluded for the econometric analysis. Also, because the US money supply (broad money) development was chosen as a proxy for global liquidity the USA was excluded from the examined sample. Table 3 lists the analyzed countries and the sample period.

The research is based on annual data of domestic credit to private sector by banks (DC_{it})⁶. The explanatory variables correspond to components gathered in table 2. Real economic activity is proxied by gross domestic product which is decomposed into real GDP growth (dY_{it}) and inflation measured by GDP deflator (P_{it}). As stock markets booms often accompany assets prices inflation periods which goes together with the increased

⁶This approach was proposed by Werner (1997) using bank credit as a proxy for M.

number of financial transactions, total value of stock traded should reflect the dynamics of such transactions (ST_{it})⁷. The US money supply is, in turn, an approximation of global liquidity ($MUSA_{it}$)⁸. To avoid non-stationarity, all variables in levels (DC_{it} , P_{it} , MUS_{it} , ST_{it}) were transformed into growth rates (dDC_{it} , dP_{it} , $dMUS_{it}$, dST_{it}).

Table 4 contains the definitions of variables used in this paper to test the hypothesis formulated in this paper. Unit root test results for all the variables are provided in Section 4.

Methods

Panel unit roots tests

The research starts with a panel unit root tests to determine the stationarity of variables used in econometric models. The analysis of the panel data set requires a panel unit root test framework which has higher power than unit root tests based on individual time series (Eviews, 2014). Four types of panel units' test were computed: Levin *et al.* (2012), Im *et al.* (2003), Fisher-type tests using Augmented Dickey and Fuller — ADF and Phillips and Perron — PP tests (Maddala & Wu, 1999; Choi, 2001). The null hypothesis in all four tests is that panel data has unit root, so it is nonstationary. By rejecting this hypothesis, we assume stationarity of examined time-series.

Panel Granger causality test

Then Granger (1969) causality test is pursued, which can roughly be described to determine whether one-time series (x) is useful in forecasting another (y). Thus, in the Granger sense, x is a cause of y . It is important to note that the statement “ x Granger causes y ” does not imply that y is the effect or the result of x . Granger causality measures precedence and infor-

⁷ The size of the real economy is described by GDP, but there is no comparable general indicator for the financial sector. The level of financial (non-GDP) transactions in the U.S was proxied e.g. by Palley (1994) by value of transactions on the New York stock exchange and by the sales of existing family houses.

⁸ The US money supply was chosen to illustrate the global liquidity, as US dollar is the world's dominant reserve currency and is dominant in international transactions and financial markets (Bertaut *et al.*, 2021). US monetary policy is also a major driver of the global financial cycle (Rey, 2013).

mation content but does not itself indicate causality in the more common use of the term (Eviews, 2014). The Granger causality concept delivers, however, some hints regarding interpretation of the relationship.

The two-way regressions in a panel data context can be written in general as (Eviews, 2014):

$$y_{it} = \alpha_{0i} + \alpha_{1i} y_{it-1} + \dots + \alpha_{li} y_{it-l} + \beta_{1i} x_{it-1} + \dots + \beta_{li} x_{it-l} + \varepsilon_{it}, \quad (9)$$

$$x_{it} = \alpha_{0i} + x_{it-1} + \dots + \alpha_{li} x_{it-l} + \beta_{1i} y_{it-1} + \dots + \beta_{li} y_{it-l} + \varepsilon_{it}, \quad (10)$$

where t stands for the time period dimensions of the panel, and i denotes the cross-sectional dimensions. In the paper, the stacked causality test was performed which treats the panel data as one large stacked set of data without taking the lagged values of data of one cross-section to the next cross-section⁹.

Panel estimation

Data used for the panel data estimation are cross-sectional data (data of each country) pooled over several time periods. The general form of panel models is written as (Eviews, 2014)¹⁰:

$$Y_{it} = \alpha + X_{it}\beta_{it} + \delta_i + \gamma_t + \varepsilon_{it}, \quad (11)$$

where Y_{it} denotes dependent variable at t periods and i cross-sectional units, X_{it} is a vector of regressors, α stands for the overall constant, δ_i and γ_t represents cross-section effects, and respectively time specific effects, which cannot exist or be of random or fixed character, and ε_{it} are error terms.

Preliminary regression for panel data include the pooled model performed on all available observations as if they were homogeneous cross-sectional data without any individual effect ($\delta_i = 0$ and $\gamma_t = 0$). All observations are treated as coming from a random sample and the simple ordinary least square (OLS) method is applied (1st model).

⁹ Methods on testing the Granger causality using panel data models and their limitations are discussed e.g. in Xiao *et al.* (2022).

¹⁰ Advantages and challenges of panel data analysis are analyzed e.g. in Hsiao (2022).

As heterogeneity of the panel is assumed, cross-section and time specific effects δ_i and γ_t may be included in the OLS panel model using fixed or random effect methods (2nd model). Referring to Kreft and De Leeuw (1998), fixed effects are variable which are constant across individuals in the panel, and random effects vary and are unpredictable. The random-effects estimator forms a compromise between the fixed-effects and pooled models (Clark & Linzer, 2015). The Hausman test (Hausman, 1978) will be computed to choose between fixed and random effects model. The Hausman test checks the correlation between the random effects and regressors in the model. The null hypothesis is that the random effect is preferred and random effects are uncorrelated with explanatory variables.

As shown in the theoretical part of the paper the regressors may be endogenous or predetermined. To avoid biased estimates exogenous instrument variables are included in the regression equation. In addition to the models with fixed or random effects, the dynamic panel generalized method of moments (GMM) model (3rd model) was used (Arellano & Bond, 1991). To remove individual cross-section effects, orthogonal deviations (Arellano & Bover, 1995) were applied. One lag of dependent variable was used as regressor.

Application of OLS, fixed or random effects and GMM models was dictated by robustness checking of the results.

Findings and discussion

Panel unit roots tests

Two types of panel units' root tests were used for checking the stationarity of variables. The results indicate that all variables, after transforming them into growth rates, are stationary. In every test the null hypothesis of non-stationarity was rejected with 1 percent level of significance. Details of PP – Fisher Chi-square panel unit root test (assuming individual unit rate process) results of different variables are given in Table 5¹¹. Probability values of three other unit roots tests assuming both individual (Im, Pesaran and Shin W-stat, ADF – Fisher Chi-square) and common unit roots pro-

¹¹ Fisher-type tests have higher statistical power as N (number of countries) and T (time periods) are comparable (Maddala & Wu, 1999).

cess (Levin, Lin and Chu) gave the same results. The stationarity of variables enables further research.

Panel Granger causality test

Table 6 provides a summary statistics regarding two direction causality between domestic credit and other variables. According to Granger's definition, we can state that the unidirectional causalities is present between changes in real GDP and prices and changes in domestic credit and bidirectional causality exists between changes in financial transactions proxied by total stock traded and changes in domestic credit. The results for the causality between the changes in US money supply (broad money) and changes in domestic credit of pooled OECD countries are blurry and may arise from the fact that there are omitted variables that influence them.

The results provoke some reflection since there is no expected bilateral causality between real GDP, prices and domestic credit. Especially the link between money supply and inflation is well established in the economy. It is based generally on the assumption that by constant real output and other factors not affecting the demand for money, the growth rate of money supply should affect inflation¹². The empirical literature between the money growth and inflation supports the relationship between them and suggest that money is the casual variable for inflation (EBC, 2010). However, some papers indicate that this relationship may not always be present. Friedman and Kuttner (1996) and Estrella and Mishkin (1997) find that based on the post-1980 data money/credit growth do not explain inflation. Also Goodhardt and Hoffmann (2008) and McCallum and Nelson (2010) provide evidence suggesting decreasing money growth effect on inflation in the last decades. The debate over the relationship between the money supply and inflation was again intensified after Japan introduced on a larger scale the expansionary monetary policy (including QE policy) in 2001 and also after the 2007–2008 financial crisis, when monetary authorities in major economies launched similar programmes to stimulate their economies. QE's impact on money supply and inflation was, however, smaller than expected (Gros *et al.*, 2015, Reis, 2016). The recent literature has rated the effect of QE on inflation as moderately positive, but this is largely due to portfolio re-

¹² Just as in famous Milton Friedman (1970, p. 24) sentence "Inflation is always and everywhere a monetary phenomenon in the sense that it is and can be produced only by a more rapid increase in the quantity of money than in output."

balancing, signaling, exchange rates, or reduced uncertainty rather than credit channels (see e.g. Weale & Wieladek, 2016; Cova *et al.*, 2019)¹³.

The relationship between money supply and inflation does not disappear and is still strong. Excess money supply is associated with non-GDP transactions, leading to asset inflation (and creation and expansion of new financial instruments). Low interest rates, which should stimulate bank credit and then investment and other spending in the real economy, lead to increasing demand for assets including those with higher risk and higher expected return (Beckmann *et al.*, 2022).

The results of Granger causality tests show that there is no two-way Granger casual relationship between credit growth and real GDP growth. Macroeconomics textbooks generally emphasize that higher domestic credit supplied by banks should lead to higher aggregate demand and contribute to higher GDP, which in turn endogenously increases financial demand for money. The inability to identify a stable relationship between monetary aggregates and nominal GDP has led to change of operational target of monetary policy. Instead of targeting monetary aggregates, central banks turned to interest rates to target inflation and nominal GDP (Woodford, 2004). As Huber (2020) noticed, until about 1980 bank credit and thus the money supply in industrialized countries grew at about the same rate as nominal GDP. Since then, the growth of non-GDP financing has outpaced nominal GDP growth several times, with money and credit growth pouring into non-GDP transactions. Credit that does not flow into the real economy generally has no direct impact on GDP and consumer and producer inflation.

With these arguments, which are rooted in Werner's quantity theory of credit, we can join the discussion why QE policies were less efficient than expected, meaning that central banks have failed to close the output gap and raise inflation in time (see e.g. Fabo *et al.*, 2021). First, QE must work through bank lending channels if it means expanding bank credit supply. No significant impact of QE policies on bank lending, however, was found (Butt *et al.*, 2015; Giansante *et al.*, 2019). Second, QE was deployed to help the real economy, but the new money was directed on a large scale towards non-GDP transactions (Huber, 2020).

¹³ However, the combination of high inflation and large central bank balance sheets after 2021 has given the relationship between money supply and inflation a resurgence in importance (Senner & Surbek, 2022).

Panel estimations

The hypothesis on positive relationship between global liquidity, real and financial economic activity and money supply [12] was tested by panel regression models.

$$dDC_{it} = f(\overbrace{dY_{it}}^+, \overbrace{dP_{it}}^+, \overbrace{dMUS_{it}}^+, \overbrace{dST_{it}}^+) \quad (12)$$

Table 8 depicts the outcomes of panel regressions model¹⁴: (1) panel OLS, (2) panel OLS with cross-section fixed effects, (3) panel EGLS with period random effects, (4) panel ELGS with fixed cross-section and random period effects and (5) panel GMM. Pooled OLS was chosen for preliminary examination, next, models with random or fixed effects were chosen according to the results of Hausmann' test (Table 8) and panel GMM to deal with endogeneity of variables crowns the study.

All the regression showed that both real GDP growth and inflation are positively related to the domestic credit. This is consistent with theoretical arguments supporting endogenous character of money supply resulting from real (GDP-based) economic activity and the results of Granger causality tests. The statistics presented in Table 8 show that nominal GDP growth (with two components: real GDP change and inflation) had positive impact on domestic credit and thus on money supply. This supports the idea that the expansion of domestic credit operates through demand channel. This relationship is rooted in post-Keynesian monetary theory and supported by recent empirical literature (see Table 1).

The positive impact of financial transactions on the demand and supply of domestic credit is also observed in all the regressions¹⁵. This finding goes along well with the quantity theory of credit: the rise in asset prices may reflect the fact that the newly created money is being used for non-GDP transactions without effecting nominal GDP. Financial bank credit creation is, however, unsustainable (Werner, 2013). It can be fixed in the Minsky

¹⁴ R-squared of about 30% indicates that the variables analyzed can only partially explain the growth of domestic credit. Despite the large amount of unexplained variation, important conclusions can still be drawn about the relationship between the dependent and independent variables.

¹⁵ Analyzing the results presented, it should be borne in mind that financial assets involve far more instruments and markets than just traded stocks. Derivatives, mutual funds, real estate assets, debt securities and other instruments resulting from financial innovations create a vast array of products for financial transactions that were excluded from the calculations.

model of endogenous fragile financial markets (Minsky, 1986) or positive feedback theory of financial crises (Shiller, 2016). A positive change in monetary policy can not only increase the aggregate demand, but also increase optimism among investors. Due to expectations, their investments pushes asset prices to higher levels. Demand for debt rises also together with new financial innovations, which in turn endogenously creates new money. However, the fragility of markets causes that at a certain point of time euphoria/greed is replaced by panic/fear influencing money supply. A problem often raised in empirical studies on the impact of monetary policy on stock prices is the endogeneity between monetary aggregates and stock market behavior (see Rigobon & Sack, 2003). It should be borne in mind that the demand for non-GDP money depends not only on the returns of financial assets, but also on the degree of liquidity of various financial instruments and the total wealth¹⁶.

With too much non-GDP credit, asset inflation, over-investment and over-indebtedness, bubbles and financial crises recur more frequently and more severely than before. The overshoot dynamics of non-GDP finances could negatively impact growth. Financial bubbles and credit are discussed in recent literature by Miao and Wang (2018) and Martin and Ventura (2018), and in the context of QE stimulation by Balatti (2016) and Hudepohl *et al.* (2021).

As shown in Table 7, there is the significance of another variable effecting domestic credit, which is the US money supply, which was chosen as a proxy for global liquidity. This implies that higher global liquidity encourages investors to invest internationally, suggesting some supply-push money creation as the result of international capital flows. International spillovers of the monetary policies, especially when implemented by a large country are discussed by Chen *et al.* (2016) and Haldane *et al.* (2016). International money transmission takes indirect form, which is not by direct central bank's injection of money into the economy, but by endogenous character of money.

Based on the US QE, Bernanke (2017) argues that it comprises the influence of one country's expansionary policy on both home and foreign output through exchange, interest rate and uncertainty channels and on cross-border capital flows, as described in point [2.4]. An increase in the US money supply should depreciate the US dollar as relative interest rates fall

¹⁶ Asset prices are a good proxy for wealth. On wealth and price effects on economic activity see Altissimo *et al.* (2005).

(Haldane *et al.*, 2016). Adjusting the trade balance increases US production at the expense of its partners. However, increased US demand can more than offset the exchange rate effect leading to higher domestic and foreign production. US QE could also lower global risk-free interest rates and reduce uncertainty in the global economy that constrains international capital flows and domestic lending, especially in developing economies. Lane and McQuade (2014) and Rapih (2021) argue that domestic credit is closely related to international capital inflows, especially to the banking sector. The impact of international capital inflows on domestic lending is generally greater in emerging and developing economies than in advanced economies. But international capital flows can also have painful consequences. A great amount of literature has confirmed that excessive capital inflows can lead to balance of payments and currency crises (see e.g. Furceri *et al.*, 2012 and Frost *et al.*, 2020).

Conclusions

The article confirms the hypothesis that real and financial economic activity together with global liquidity positively influence domestic credit and thus money supply¹⁷.

Although the research results do not show a two-way causal relationship between changes in real GDP and prices and changes in domestic credit, the discussion of the nature of the money supply should go in the direction of mutual feedback. The monetary authority may introduce high-powered money into circulation (by granting loans, monetizing public debt or unsterilized foreign reserve increase), but it is the commercial banks which are responsible for credit creation. As the result the money supply is most of all determined by the demand for money and is under limited control of the central bank. The role of monetary policy turns on the effects of interest rate on relevant economic variables through price effect and credit rationing by banks (Arestis & Sawyer, 2006). The supplementary instruments in relation to interest rates policy comprise credit rationing by the monetary authorities. Prudential credit controls and restrictions are targeted to limit the volume of credit in a direct way or to manage it indirectly by influencing reserve requirements.

¹⁷ Future research may focus on finding better proxies for explanatory variables and empirical data for other countries and time periods.

The amount of money in an economy is driven not only by the real economy, but also by the financial economy. Especially the periods of financial instability are accompanied by excessive monetary and credit growth/shrinking. Prudential regulations that restrict leverage (and thus control the amount of credit) and limit risk-taking during price bubbles periods should be therefore taken into account¹⁸. The role of central banks and other regulators in slowing down the financial bubbles is the topic of discussion (e.g. Gerding, 2013; Greenspan, 2013; Phillips & Shi, 2020). The proposals go into 'ex ante' (prevention) or 'ex post' (crises management) prudential policies (Daripa & Varotto, 2010; Buch *et al.*, 2018). Other comprehensive proposals have been put forward to limit the excessive excess of non-GDP finance. In addition to the widely discussed various variants of a Tobin tax imposed on financial transactions (Hanke *et al.*, 2010, Rossi, 2019), Huber (2020) lists the other proposals that include e.g. lock-up periods for transactions in foreign exchange and securities, tiered interest rates different for GDP and non-GDP loans, temporal specific credit ceilings set by central bank for certain types of financial transactions, or the means to limit derivative contracts to the extent that attributable risk positions are in the possession of the authorized parties.

Money supply fluctuations can result also from external shocks, which can be exemplified in the last decade by the QE episodes in major economies. The increase in global liquidity influences the economies in many countries. In the research, the reaction of domestic money supply to the changes in US money supply is positive. It confirms the importance of spill-over effect of expansionary policy in major economies to other economies. Macroprudential policy should also consider that fact because the possible interaction of international capital flows and domestic credit can lead to various distortions, which can lead to inefficient credit booms and international overborrowing. Monetary authorities should control how international liquidity shocks are transmitted into their economies. In addition to the prudential instruments already mentioned, tools controlling international capital movements could be implemented. The examples are capital controls (manipulating availability and cost of foreign borrowing), and interventions in the foreign exchange market (Edwards, 1999; Davis and Devereux, 2019).

¹⁸ For examples of macro prudential tools see: IMF (2013).

Taking all this into account, it can be summed up that despite (or maybe because of) the endogenous nature of money, the role of central banks remains significant.

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Annex

Table 1. A list of selected research papers dedicated to endogeneity of money

Research paper	Dependent variable	Independent variables	Statistical method	Data set	The results
Lopreite (2012)	Money supply (M1, M2, M3)	monetary base, loans	VAR models with Granger causality procedure and Vector Error Correction models (VECM)	Euro area, M2:1999-M12:2010	Money endogeneity is partially confirmed
Nayan <i>et al.</i> (2013)	Money supply (M2/GDP)	Real GDP per capita, bank lending (domestic credit providing by the banking system/GDP), inflation (CPI)	Different panel methods (OLS, fixed effects, GMM)	177 countries, 1970-2011	Bank lending and real GDP per capita were significant determinants of money supply
Badarudin <i>et al.</i> (2013)	Bank loans, monetary base, money supply (M3), income	monetary multiplier,	VECM, a trivariate vector autoregression model (VAR) and Granger causality testing	G-7 economies	A broader evidence for money endogeneity except for support for exogeneity during two sub-periods in UK and US, both under a different monetary targeting regime in earlier years
Deleidi and Levreno (2017)	Monetary base, bank deposits, bank loans (bank credit granted by US commercial banks)	bank loans (bank credit granted by US commercial banks)	VAR and VECM methodology	USA, M1:1959-M9:2016	Money supply is mainly determined endogenously by the lending activity of commercial banks
Černohorská (2018)	Money supply (M3), monetary base, real GDP, bank loans provided to the private nonfinancial sector	monetary base, real GDP, bank loans provided to the private nonfinancial sector	Engle-Granger cointegration and Granger causality testing	Czechia, Q1:1996-Q2:2017	Two-way causal relationship between M3 and both GDP and loans was confirmed
Chai and Sang (2018)	Monetary base, bank loans and money supply	bank loans and money supply	Toda-Yamamoto Granger non causality test	7 Asia-Pacific countries, the sample periods depend on the availability of the data for countries	Bank loans Granger cause the monetary base during the inflation targeting period in all countries (except Japan), whereas the causality appeared diverse before inflation targeting regime
Mušinský and Siničáková (2020)	M1 and M3 money aggregates, the central bank's sum of assets, loans and deposits, GDP, industrial production, retail sales	the central bank's sum of assets, loans and deposits, GDP, industrial production, retail sales	Granger causality testing	Czechia, Germany, Slovakia M2:2009-M2:2020	Evidence for causality from loans to deposits and to M1 and M3 with no causality running in the opposite direction; no clear causal link between the assets of central bank and demand for loans

Table 2. Two types of variables influencing money creation process

Causes of money creation	
Demand-pull money creation	– demand from real sector (private and public) – demand from financial sector
Supply-push money creation	– credit rationing (banks, monetary authorities) – international capital flows

Table 3. List of countries

Group	Countries	Sample period
I (17)	Australia, Austria, Chile, Colombia, Germany, Greece, Hungary, Ireland, Israel, Japan, Korea, Luxembourg, Mexico, Norway, Poland, Spain, Turkey	2002-2018

Table 4. Description of variables

Variable	Definition
Domestic credit to private sector by banks growth (dDC)	Annual percentage growth of domestic credit to the private sector by banks refers to financial resources provided to the private sector by other depository corporations (deposit taking corporations except central banks), such as through loans, purchases of nonequity securities, and trade credits and other accounts receivable, that establish a claim for repayment. For some countries, these claims include credit to public enterprises.
Real GDP growth (dY)	Annual percentage growth rate of GDP at market prices based on constant local currency. Aggregates are based on constant 2010 U.S. dollars. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources.
Inflation, changes of GDP deflator (dP)	Inflation as measured by the annual growth rate of the GDP implicit deflator shows the rate of price change in the economy as a whole. The GDP implicit deflator is the ratio of GDP in current local currency to GDP in constant local currency.
Stock traded growth (dST)	Annual percentage growth of the value of shares traded which is the total number of shares traded, both domestic and foreign, multiplied by their respective matching prices. Figures are single counted (only one side of the transaction is considered). Companies admitted to listing and admitted to trading are included in the data. Data are end of year values converted to U.S. dollars using corresponding year-end foreign exchange rates.
US broad money growth (dMUS)	Annual percentage growth of broad money in the USA, which is the sum of currency outside banks; demand deposits other than those of the central government; the time, savings, and foreign currency deposits of resident sectors other than the central government; bank and travellers' checks; and other securities such as certificates of deposit and commercial paper.

Source: WDI online, <https://datacatalog.worldbank.org/dataset/world-development-indicators>.

Table 5. Results of PP – Fisher Chi-square test.

Panel Unit Root Test - Method: PP – Fisher Chi-square				
Null: Unit root (assuming individual unit root process)				
	Statistic	Prob	Cross-sections	Obs
dDC	85.3159	0.0000	17	264
dY	135,776	0.0000	17	271
dP	98,5510	0.0000	17	271
dMUS	79,1363	0.0000	17	271
dST	149,199	0.0000	17	271

Notes: Individual intercept; trend assumption: no deterministic trend; automatic selection of lag length (Schwarz info criterion); probabilities for Fisher test are computed using an asymptotic Chi-square distribution.

Source: author's computations based on WDI data.

Table 6. Pairwise Granger causality tests.

Stacked test (common coefficients); Lags to include 2/3^				
Null Hypothesis:	Obs	F-Statistics	Prob.	Remarks
dY does not Granger cause dDC	247	7.05	0,0011	causality at $p < 0,01$
dDC does not Granger cause dY	247	0.39	0,6721	no causality
dP does not Granger cause dDC	247	12.66	6.E-06	causality at $p < 0,01$
dDC does not Granger cause dP	247	1.65	0.1946	no causality
dMUS does not Granger cause dDC^	230	4,42	0,0049	causality at $p < 0,01$
dDC does not Granger cause MUS	230	8.82	1.E-05	causality at $p < 0,01$
dST does not Granger cause dDC	247	4,64	0,0105	causality at $p < 0,05$
dDC does not Granger cause dST	247	2,51	0,0831	causality at $p < 0,1$

Notes: Lag length selection based on Schwarz information criterion with the assumption that for annual data the number of lags is typically small, one or two (Wooldridge, 2018)

Source: author's computations based on WDI data.

Table 7. Results of panel regression of broad money growth

Variable	Panel Least Squares (Model 1)	Panel Least Squares (cross-section fixed effects) (Model 2)	EGLS (period random effects) (Model 3)	Panel EGLS (cross-section fixed and period random) (Model 4)	Panel GMM (two-step estimator) (Model 5)
α	-0.022 (-1.610)	-0.012 (-0.880)	-0.022 (-1.613)	-0.013 (-0.922)	
d DC(-1)	0.007 (3.477) ***	0.007 (3.143) ***	0.007 (3.483) ***	0.005 (2.170) **	0.159 (20.611) ***
dY	1.570 (6.539) ***	1.005 (3.148) ***	1.570 (6.550) ***	1.166 (3.425) **	0.007 (3.160) ***
dP	0.621 (2.949) ***	0.738 (3.484) ***	0.621 (2.955) ***	0.732 (3.291) ***	1.247 (2.266) **
dMUSA	0.032 (2.737) ***	0.030 (2.650) ***	0.032 (2.741) ***	0.030 (2.600) ***	0.628 (4.410) ***
dST					0.046 (4.382) ***
Model parameters					
R-squared	0.295	0.355	0.295	0.322	
Cross-section included	17	17	17	15	17
Periods included	17	17	17	17	15
Total panel	281	281	281	255 (balanced)	247

Notes: *** - significant at the 1 percent level; ** - significant at the 5 percent level; * - significant at the 10 percent level. Figures in parentheses are t-statistics.

Source: author's computations based on WDI data.

Table 8. Results of Hausman tests

	Panel EGLS (cross-section random effects) (Model II)	Panel EGLS (period random effects) (Model III)	Panel EGLS (cross-section random effects) (Model IV)	Panel EGLS (period random effects) (Model IIV)
Chi-Square Statistic	7.461611	7.801323	4,225795	8.662189
Probability	0.1134	0.0503*	0.3763	0.0341**

Notes: *** - significant at the 1 percent level ; ** - significant at the 5 percent level; * - significant at the 10 percent level

Source: author's computations based on WDI data.