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Money as an Inflationary Phenomenon

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Abstract

Empirical tests of the quantity theory and particularly the neutrality of money are based on the idea that money growth "explains", to some extent, inflation. Modern macroeconomic theory, however, considers inflation targeting central banks which use the interest rate as a policy tool, while money is seen as an endogenous outcome of financial intermediation, i.e. credit creation. A simple NKM model with fiat money demonstrates that money growth is tied to inflation, changes of output and interest rate changes. The latter are determined by inflation and output gap if we consider an inflation-targeting central bank. The quantity equation emerges from the macroeconomic transmission process but the economic causalities run from output and inflation to money creation. Hence, money growth does not explain inflation. Besides, the result does not require a sophisticated microfoundation of money demand but simply emerges from the transmission process.

Keywords: quantity equation; endogenous money; New Keynesian Macroeconomics; inflation targeting; money demand

JEL Classification: E44, E51

1 Introduction

Most empirical investigations of the quantity equation $Mv = PY$ are performing regressions of the type

$$\pi = \beta_0 + \beta_1 g_M - \beta_2 g_Y + \epsilon$$

with g_M and g_Y as the growth rates of M and Y, where $\beta_1 = 1$ would be indicating money neutrality. The parameter β_0 might capture a trend in the velocity of money. Regression models like this are then applied to panel data (see Moroney (2002) for an overview). Alternatively, time series models are considered for testing whether there is a cointegration relationship between money growth and inflation. The latter approach is much more reasonable than a regression since the methodology does not require a decision whether money growth or inflation is the independent variable. Regression models, instead, suggest that inflation variance is *explained* by money

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growth variance. A couple of authors come to the result that in the long run money is neutral – in the sense that it does not *affect* the real output, and inflation is thus a monetary phenomenon (e.g. MacCandless/Weber 1995, Hillinger et al. 2015). Other authors are more skeptical and find evidence for non-neutrality of money (e.g. Hsing 1990, DeGrauwe and Polan 2005, Gertler/Hofman 2016). Without episodes of very high (or hyper) inflation in the sample, the correlation typically becomes very weak.

Such regression models have been criticized for various reasons. Moroney (2002) summarizes and categorizes the critical literature: instability of the velocity of money; unclear evidence about cointegration relationship between money growth and inflation; and the role of fiscal policy which could "break the link between money growth and inflation". This paper adds another critical point: regression models suffer from an endogeneity problem as money is *not* an exogenous variable. Instead, money is created predominantly by banks by providing credits to non-banks or by buying bonds from the non-bank sector. We will concentrate on the credit market in this paper. Credit supply and demand depend on macroeconomic variables such like the interest rate and expected income. The central bank is accommodating this process accordingly. It doesn't mean that the quantity equation is false but it is simply an algebraic relationship where money growth, inflation and output growth are simultaneously determined by macroeconomic variables. The (change of) velocity is not a given behavioral parameter but turns out to be an endogenous outcome of these macroeconomic relationships as well.

The following sections show that money growth is tied to inflation and output growth via the macroeconomic transmission processes which are considered in modern macroeconomics. A quantity equation relationship emerges as an outcome of the model. Its interpretation, however, is contrary to the monetaristic view. It also provides an alternative to the interpretation that individual's money demand depends on output, expected inflation and real interest rate, as no microeconomic calculus is required in this model in order to establish the nexus between these macroeconomic variables and growing money demand.

2 A simple NKM model with fiat money

Consider a simple New Keynesian model with an IS curve, a Phillips Curve and a forward looking monetary policy rule:

$$y_t = Ey_{t+1} - \alpha r_t \tag{IS}$$
$$\pi_t = E\pi_{t+1} + \gamma y_t \tag{PC}$$
$$r_t = \delta_1 E\pi_{t+1} + \delta_2 Ey_{t+1} + \mu_t \tag{MPR}$$

where y_t denotes the output gap (as a percentage of potential output), and $r_t = i_t - E\pi_{t+1}$ is the real interest rate (Fisher equation). In addition, we assume that money is used for transactions in the sense of a *cash-in-advance* constraint (Clower 1967, Svensson 1985). Cash-in-advance models are applied to the households's maximization problem implying that money is needed for transactions on markets for consumption goods. Most models in this tradition are equilibrium models where

consumption equals income in equilibrium. Henceforth, money used for transaction is tied to income in the cash-in-advance restriction. Alternatively, one could argue that money is used for all kind of transactions, also on intermediate goods and labor markets in order to justify the dependency on the real income[2]. Thus, we assume that real money demand is proportional to the real output (which is potential output y^* plus output gap y, all variables in logs):

$$m_t - p_t = y_t + y_t^* \tag{CIA}$$

and using the IS equation

$$m_t - p_t = Ey_{t+1} + y_t^* - \alpha r_t \tag{M}$$

In modern financial systems with intermediates, money is created by providing loans (fiat money). Although this fiat money has to be backed by reserves which can be created by the central bank only, we assume that the central bank is accommodating the demand for reserves and using the interest rate as their policy instrument (see McLeay et al. 2014, Romer 2000). Meanwhile, most economists agree that this is what central banks around the world are practically doing so that this view meanwhile entered even undergraduate textbooks (e.g. Blanchard 2017). In fact, if the banking sector's demand for reserves is changing e.g. due to a credit expansion, the central bank cannot stabilize both, the interest rate *and* the money base. An inflation targeting central bank has to find a suitable compromise to respond to such demand changes. Typically they will try to keep control over the interest rate (as assumed in equation (MPR)), and thus fully accomodating the demand for reserves.

In the euro area, approximately 85% of M1 and 90% of M3 is fiat money, and even cash is produced by the central bank *on demand* of commercial banks on behalf of their customers. The relevant policy tool of the central bank is the interest rate, not the money volume[3]. Credit (or money) supply by banks is not explicitly modeled here as we assume, for sake of simplicity, that credit supply is completely elastic, and that there is no markup on the policy rate. Therefore, (M) represents a *credit demand function* which depends positively on prospective income (growth) and negatively on the real interest rate. Both determinants of credit demand are empirically highly relevant (Behrendt 2016). Debitors have to pay interest for a credit, while banks have to pay interest on borrowed reserves to the central bank. Assuming that all period profits from banks as well as the central bank's seignorage are returned to the households in the same period, these interest payments will not affect the intertemporal budget restriction.

It is remarkable that a similar nexus between money, output, inflation and interest rates could also be established without a full macroeconomic model but considering a sophisticated microfoundation of a money demand function (Goldfeld and Sichel

[2]In addition, it is widely overlooked that money is also used for transactions on asset markets which have a significantly larger daily turnover than goods markets. The traditional quantity equation, however, does not take asset market transactions into account.

[3]Therefore, this model might have limitations if looking to periods of zero lower bound where central banks are using Quantitative Easing instead.

1990). The simple model presented in this paper suggests an alternative explanation for the correlations reported in Benati et al. (2017): the cointegration between the velocity of money and interest rates is not necessarily a feature of a money demand function which is derived from a sophisticated calculus, but they are an outcome of a simple macroeconomic transmission process. Although the methodology applied by Benati et al. (2017) is by far more sophisticated than the simple model in this paper, the latter provides a different (and easy) approach to interpret the nexus between these variables.

3 The emergence of the quantity equation

Consider Y_t being the log output level. Hence, $Ey_{t+1} = EY_{t+1} - Ey^*_{t+1}$. Moreover we have $Ey^*_{t+1} - y^*_t = Eg^*_{t+1} = Eg^*$ as the expected growth rate of the equilibrium output which is assumed to be constant. Therefore we re-write eq. (M) as

$$m_t - p_t = EY_{t+1} - Eg^* - \alpha r_t \tag{M'}$$

We are now looking at the link between money growth and inflation. As (M') contains the (log) price level and the demanded (log) money stock, we express the equation in growth rates.

$$g_{mt} - \pi_t = \underbrace{(EY_{t+1} - EY_t)}_{Eg_{t+1}} - \alpha(r_t - r_{t-1}) \tag{Q}$$

with $g_{mt} = m_t - m_{t-1}$ as the money growth rate. Recall, that the differences of the expected equilibrium output growth rate drops out because of assumed stationarity of the equilibrium growth rate. Equation (Q) indicates that real money growth is tied to real output growth and changes of the real interest rate. Hence, equation (Q) *establishes the quantity equation* where the change of the velocity of money, g_v, is tied to the change of the real interest rate: $g_v = \alpha(r_t - r_{t-1})$. In conrast to the quantity equation which is a pure algebraic relationship, equation (Q) is an outcome of a simple NKM model with fiat money and a cash-in-advance constraint and thus establishing an economic explanation of money growth. In a long-run stationary equilibrium (output gap is zero so the expected output growth is given by $Eg_{t+1} = g^*$, no changes of monetary policy, inflation is on the target level π^*) equation (Q) simply reduces to

$$g_{mt} = \pi^* + g^*$$

which is, again, the quantity equation with constant velocity of money. However, (Q) explains money growth, not inflation, i.e. g_{mt} is explained by inflation, real output growth and interest rate change, while the latter is determined by the central bank via eq. (MPR). The macroeconomic causality thus runs from y and π to m, not from m to π. Henceforth, the formulation that *money is an inflationary phenomenon* – through the macroeconomic transmission mechanism – is much more reasonable than Friedman's (1963) famous reverse monetaristic statement.

As in (Q) current money growth is explained by expected (future) output growth which might induce future inflation according to the Phillips Curve, we should expect a lag between money growth and inflation. This is due to the forward-looking behavior of rational agents. If expectations are not systematically wrong, a time series analysis might conclude that money growth Granger causes inflation which speaks in favor of the monetaristic approach. Given the model above, such a conclusion is misleading.

We now make use of the assumption that the central bank is targeting inflation according to eq. (MPR). Equation (Q) thus reads

$$\begin{aligned} g_{mt} =& Eg_{t+1} - \alpha\delta_2(Ey_{t+1} - Ey_t) \\ &+\pi_t - \alpha\delta_1(E\pi_{t+1} - E\pi_t) \\ &- \alpha(\mu_t - \mu_{t-1}) \end{aligned} \tag{Q'}$$

So money growth is positively tied to expected output growth but negatively to the expected *change* of the output gap (because this induces monetary policy responses). Furthermore, it is positively tied to inflation but negatively to expected *changes* of the inflation rate for the same reasons mentioned before. And finally, monetary policy shocks (third line in (Q')) play a role. So the change of the velocity of money g_v is determined by changes of expectations on output gap and inflation as well as on policy shocks. It is not a given behavioral parameter but it is based on endogenously determined changes of central bank policy and thus inherently depending on the macroeconomic causalities in this model.

4 Empirical evidence

The main purpose of this paper is to provide a theoretical argument why money should be treated as an endogenous variable which makes "money neutrality tests" according to the Quantity Equation implausible. The link between money creation and inflation is explained by the underlying macroeconomic causalities, based on forward looking behavior which influences the velocity of money. Whatever empirical tests might suggest, i.e. whether money growth and inflation are highly correlated or not, these statistical relationships do not say much about the monetaristic explanation of inflation. Any regression which explains inflation by money growth is inconsistent with macro models with fiat money, and it suffers from the endogeneity problem mentioned at the beginning. Moreover, these statistical relationships are also not necessarily telling something about the underlying money demand calculus as many of these relationships emerge inherently from standard macroeconomic interdependencies even without any money demand calculus.

Although not being the primary goal of this paper, we should provide empirical evidence for the euro area, indicating that the arguments are not systematically contradicting the data. The most problematic part is the identification of the monetary policy shocks ($\mu_t - \mu_{t-1}$) as well as the estimation of (expected) output gaps which are highly depending on the chosen methodology (see Àlvarez and Gómez-Loscos 2017). Therefore, I use eq. (M') which implies that the velocity of money is

tied to the real interest rate. This idea could be directly tested by

$$v_t = \beta_0 + \beta_1 r_t + \epsilon_t \tag{1}$$

where either $v_t = \ln(GDP_t^{\text{real}}) + p_t - m_t$ in accordance to equation (M'), or $v_t = GDP^{\text{nom}}/M$ as the usual definition of velocity of money. The data for the nominal GDP, price levels, and monetary aggregates are taken from the ECB's database. The real interest rate is proxied by the average government bonds interest rate for Euro area provided by the IMF, and the HICP inflation rate from the ECB's database.

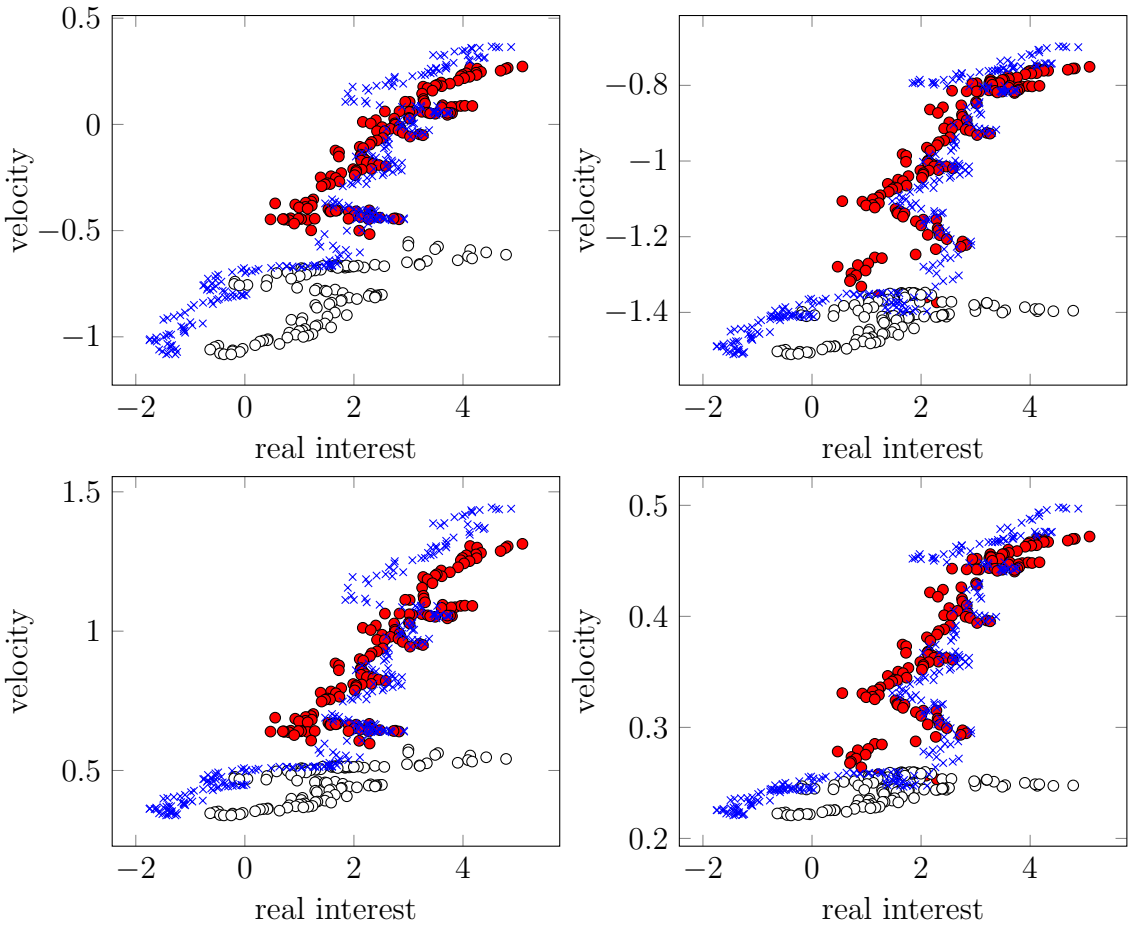

Figure 1: Real interest rate versus velocity of money (left panel: M1, right panel: M3, upper row: velocity as $\ln(GDP^{\text{nom}}) - \ln(M)$, lower row: velocity as GDP^{nom}/M, red filled: pre 12/2008, not filled: post 12/2008, blue X: German 10-year gov. bonds real rate)

Figure 1 displays the relationship between both variables without an explicit regression. As can directly be seen, there is a very clear positive relationship for both forms of measuring the velocity of money, and the relationship is robust even when taking M3 instead of M1 although M1 is the most suitable money aggregate considering the underlying cash-in-advance motivation. The graphic shows that the relationship seems to have changed after the Global Financial Crisis. Especially

after the crisis, the massive quantitative monetary policy measures, i.e. the Asset Purchase Program, have a direct effect on M1. Such effects are of course not captured by this simple model which assumes the accommodation of money demand by the central bank. Therefore, the pre-crisis period is more relevant for this model. Moreover, the partially higher real interest rates in post-crisis times is due to the fact that it is a European average where the strongly increased interest rates of the Southern European countries are included which suffered from a massive debt crisis. Correcting for these extraordinary effects, the clear positive relationship between the real rate and the velocity is also intact after the crisis. This can be seen if we take the German 10-year governmental bonds expected real rate (source: Deutsche Bundesbank) instead of the Euro average. Here, the robust positive relationship is evident. Regarding the development in the last 22 years, both time series (velocity of M1 and real interest rate) have a similar negative trend where the interest rates are more volatile (see figure 2, *real* means that the HICP has been subtracted). But the common trend over such a long period indicates a strong tie.

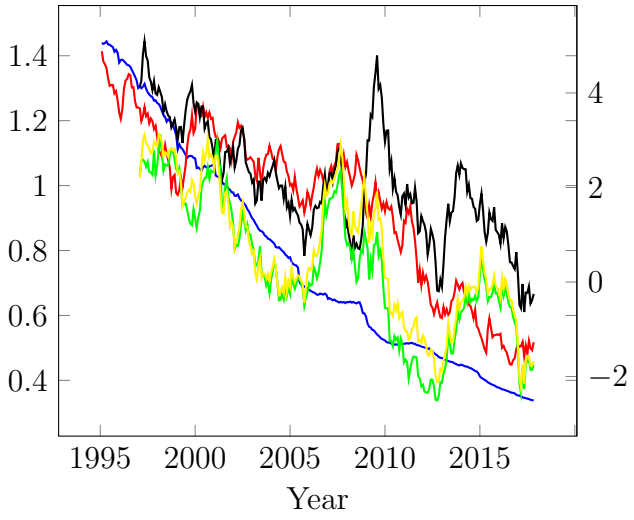

Figure 2: Long-run trend in velocity and real interest rate 1995 - 2017 [red: German real 10 year interest rate, black: EU average real interest rate, green: real EONIA, yellow: real EURIBOR 6 months (right scale); blue: velocity of M1 (left scale)]

5 Conclusion and possible extensions

The paper argues that we should not use money growth as an explanation for inflation. This view is inconsistent with modern macroeconomic theorizing. Also the question whether money is "neutral" or not appears to be misleading as it implicitly suggests that money "affects" the real sphere. This might be an interesting issue in an economy where the central banks exclusively buy bonds from non-banks via banks (Quantitative Easing), and thus directly creating M0 *and* M1. But it is a misleading idea in a world of financial intermediation, credit markets, and fiat money. Instead, the simple NKM model (eventually extended by explicitly modeling

financial intermediation, see below) states that the process of generating money is driven by inflation and output, and especially by the expectations about it. This process, however, is affected by monetary policy. Policy shocks as well as changing expectations drive the velocity of money.

There are a couple of possible extensions: first, based on a more explicit model of financial intermediation, including e.g. frictions on financial markets, the interest rate on loans becomes an endogenous variable, too. Term premia and risk premia will play a role so that the interest rate depends on the public's expectations. The central bank's policy rate influences the process of endogenous interest rate formation and money creation but doesn't *determine* it. Second, such a market of fiat money should also account for the fact that debt contracts have a (eventually varying) average maturity. Hence the debt stock will not instantaneously adapt to new future expectations, and thus money used for transactions will show some inertia. Such an approach requires a distinction between a change of the money stock and new lending activities (see Behrendt 2016). Third, money is used for transactions also on asset markets. Empirically, the daily turnovers on asset markets are enormously larger than the turnovers on goods markets. Henceforth, the velocity of money and probably also the creation of money is also determined by its function on asset markets. Consequently, the CIA approach would have to take asset transactions into account.

Beside the various extensions of the model, one could also question whether the modeling style of NKM is really suitable for understanding how money works. In a (Non-Walrasian) model with non-clearing markets and therefore effective demand, the role of money demand might significantly change.

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