Endogenous Money and Monetary Policy

Koppány Krisztián, assistant lecturer,
Széchenyi István University, Győr

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Abstract

Orthodox macroeconomic models assume that money stock is exogenously determined by the central bank. Post Keynesian doctrine argues that not only the money stock but the monetary base is endogenous too. This argument fits today's central banking practice. Most central banks set a fixed interest rate and accommodate to the demand for high-powered money. The model of such a monetary policy is a necessary part of the framework for endogenous money.

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1 Introduction

Today's macroeconomic textbooks commonly present two frameworks: the Keynesian IS-LM-AS set-up for describing the economy in the short run and the classical/neoclassical model for the long run analysis.[1] In both approaches the quantity of money is determined exogenously by the central bank. This paper lines up some arguments against this assumption and show the possibilities of modelling monetary policy in the Keynesian framework when central bank follows an interest rate rule and therefore lets the quantity of money to form endogenously in compliance with the money demand. Section 2 summarizes briefly the orthodox view of monetary policy and challenges the main assumption mentioned above. Section 3 discusses the models. Section 4 contains the conclusion.

2 Is Exogenous Money a Tenable Assumption?

In the orthodox theories of money and monetary policy quantity of money is determined exogenously by the central bank. According to the portfolio approach of monetarists, money can appear as the result of the injection of some high-powered money by the central bank and the intention of economic units (usually households) to modify their asset portfolios. The base money is then related to a broader money stock with the well-known credit multiplier:

$$M = MB \cdot \frac{1}{c + (1-c) \cdot res},$$

where MB is the monetary base, res is the reserve ratio, c is the cash to money ratio, and M is the monetary aggregate containing cash in circulation and bank loans. Monetarists proved that the credit multiplier shows historical stability: modifying high-powered money generates proportional changes in the money stock. This is the rationale for the assumption that the quantity of money can be and is determined exogenously by the central bank.

Recently, the dominant part of the money stock is in the form of bank deposits or other claims created by the financial intermediary system. Thus, money is largely a financial asset today. However, in earlier times money was a commodity. Those who say that the quantity of money can be exogenously determined by the central bank at all times, neglect that financial assets and commodities are of very different nature

[1] See *Mankiw* [1997].

in the manner of their creation. We can produce computers and cars, or mine gold and coin money out of it without any demand for them. We cannot lend money though without a demand for credit. The quantity of money can be determined exogenously by the supplier when money is a commodity. In the credit money system, on the other hand, the quantity of money (without other constraints) is largely determined by the demand for credit. If the latter is a function of other endogenous variables of the model, then also the quantity of money is endogenous.

Post Keynesian economist, Marc Lavoie argues that credit is demanded basically by firms for productive investment: "When entrepreneurs determine the effective demand, they must plan the level of production, prices, distributed dividends, and the average wage rate. Any production in a modern or in an "entrepreneur" economy is of a monetary nature and must involve some monetary outlays. When production is at a stationary level, it can be assumed that firms have at their disposal sufficient cash to finance their outlays. This working capital, in the aggregate, constitutes credits that have never been repaid. When firms want to increase their outlays, however, they clearly have to obtain extended credit lines or else additional loans from the banks. These flows of credit then reappear as deposits on the liability side of the balance sheets of banks when firms use these loans to remunerate their factors of production." (Lavoie [1984] p. 774)

According to Lavoie, the quantity of money is determined endogenously by the level of nominal output. Industry and production, being dynamic concepts, cannot be explained by the substitution effect designed for static behaviour (that is, portfolio theory), thus the theory of endogenous money is incompatible with the monetarist or neoclassical framework. That's why we use Keynesian models in Section 3.

In these models we apply the post Keynesian assumption of reverse casualty in the credit multiplier equation.[2] Post Keynesians read this equation in the following way:

$$MB = M \cdot [c + (1 - c) \cdot res] \, .$$

Here, the money stock containing cash and loans created by credits, M, needs $M \cdot c$ amount of base money as cash, and $M \cdot (1 - c) \cdot res$ amount of base money as bank reserves from the central bank in the background. The term between square brackets above must be stable if the central bank accommodates to the demand for money in this way. It can also be an explanation of strong correlation between MB and M different from that of monetarists, and it means that not only M, but MB is endogenous too.[3]

Despite these factors, can the central bank still control the money stock? The arguments above say that in determining the quantity of money the demand side is the crucial point. Central banks cannot decide on the amount of deposits (it's the decision of the banks and mainly their clients) but can determine the price of money (i.e. the interest rates). Adequate moving of interest rates can result in a quasi-fixed quantity demanded which seems to be a quantity that is exogenously determined. In this case better to say that *central banks have monetary targets*, rather than determine the quantity of money exogenously, but there's no need to challenge the orthodox assumption.

Central banks still cannot control interest rates relevant for loans and deposits directly. They can control only the interest rate for bank reserves, i.e. for monetary base and thus can affect only the high-powered money. Expanding the base money does not guarantee money stock expansion: if nobody wants to borrow, there is no effect if bank reserves increase. The other direction is more efficient. Monetary restriction can be achieved more easily.[4] However, in the eyes of Nicholas Kaldor it can not achieve its aim, namely to decrease aggregate demand: Even a very strict monetary restriction could not prevent the buying spree in the Christmas season. "There would be chaos for a few days, but soon all kinds of money substitutes would spring up: credit cards, promissory notes, etc., issued by firms or financial institutes which would circulate in the same way as bank notes ... a complete surrogate money-system and payments-system would be established, which would exist side by side with "official money"." (Kaldor [1970])

To conclude this section this paper brings three more arguments against targeting monetary aggregates: (1) Keeping the quantity of money as close as possible to an exogenous path when demand for money changes largely and frequently implies high interest rate volatility which can cause financial instability. One of the most important functions of central banks evolved through the times is to guarantee

[2] This assumption is fairly confirmed by central banking practice today, as we will discuss later.

[3] See Kaldor[1970] p. 12

[4] Central bankers prefer making monetary policy when money is scarce. In this case the transmission mechanism can be effective in both directions. Therefore central bankers are ready to generate these circumstances of scarcity even if artificially.

the stability of the banking system as a lender of last resort. This role is incompatible with a strict monetary aggregate targeting. (2) In the orthodox Keynesian IS-LM framework with exogenous money stock, the transmission of monetary policy takes place in two-step. Firstly, a change in the quantity of money modifies – if it can – the interest rate on the money market; and secondly, the interest rate change increases or decreases aggregate demand. Thus money market interventions affect the aggregate demand only if they can change the level of interest rates. Does it make any sense to use policy rules for monetary aggregates in a Keynesian framework? Theory suggests to central banks to rule interest rates directly. (3) Current practice of monetary policy at the operative level corresponds to the former advice. Today most central banks use short-term interest rates as main policy instruments and pay little attention to money stock. Thus a model where the central bank follows interest rate rule is more realistic.

3 A More Realistic Approach to Modelling Monetary Policy

These developments in monetary policy have created difficulties for the IS-LM-AS model. *Romer* [1999, 2000] and *Taylor* [2000] have proposed an alternative framework to solve these problems. This section briefly puts in the main characteristics of this new approach with a comparative static presentation and then define a simple four equation model that produces the dynamics equivalent to the former.

3.1 Interest Rate Rule in the Keynesian Framework

Figure 1 shows three related co-ordinate systems. The one on the right represents the central bank's activity on the market of base money. Fixing the interest rate (i) implies a horizontal supply curve at the desired level. The practice of monetary policy also supports this by setting the central bank's liquidity management the task of controlling the supply of reserves to achieve the operative target, namely the desired short-term interest rate.[5] However, the panel is not complete: we can see no demand curve for base money (MB). That's because in modelling monetary policy with interest rate rule, there is no explicit need for money market. Only the nominal interest rate matters, the manner of achieving it does not. Actually this approach can abandon money markets at all. That's why this part is in grey.

Abandoning the role of money removes also the LM curve form the analytics. On the left side panel at the top we can see the standard IS and a new upward-sloping MPR curve; the latter refers to the monetary policy rule. Consider that the interest rate on this side is not equivalent to the one on the right. The real interest rate (r) is relevant to the demand for goods and thus to the IS curve, while a central bank can only fix the nominal rate. Nominal and real rate differs in the term of expected inflation. These two types of interest rates and these two parts of the model can be related by specializing the assumption: when central bankers decide whether to change their target level of the nominal rate, they take changes in expected inflation into account; thus, they are effectively deciding how to set the real rate by which they can encourage or restrict aggregate demand.[6] Higher inflation π (or higher inflation above the target level) or goods market excess demand (i.e. a demand higher than the potential output, Y^P, which generates inflation in the next period) makes central bankers more rigorous with the real interest rate.[7]

The model is closed by a third relationship for inflation adjustment (IA). Inflation in a period of time depends on some factors of the previous period (for instance on the output gap or expectations for actual period's inflation, as we will see later in the dynamic approach). This assumption says that inflation at any point in time is given and inherited from the economy's past. Accordingly actual conditions of the goods market affect only future inflation in the following way: inflation rises when output is above its natural rate ($Y > Y^P$) and falls when output is below this capacity benchmark. When output equals its natural rate and there are no inflation shocks, inflation is steady and maintained by expectations.

After understanding the background dynamics, go back to deriving an aggregate demand curve from the monetary policy rule and IS curve. If central bank observed only the inflation when it sets the interest

[5] See *Antal – Barabás – Czeti – Major* [2001] p. 11

[6] Consider that the supply curve in the co-ordinate system on the right refers to the monetary base not to the money stock. Therefore the real rate determined by the central bank instrument rate and expected inflation does not coincide with the real interest rate underlying households' and firms' demand decisions on the goods market. Even if the latter follows the former, does it only with a not omissible transmission lag. Interest rate transmission and the functioning of the banking system and credit market remain open questions in this model. For further concerns about abandoning LM curve see *Friedman* [2003]. In the model above we implicitly assume that there's no transmission lag.

[7] Exchange rate can also be an independent variable for the monetary policy reaction function in an open economy with fixed exchange rate. We discuss only the case for a closed economy in this paper.

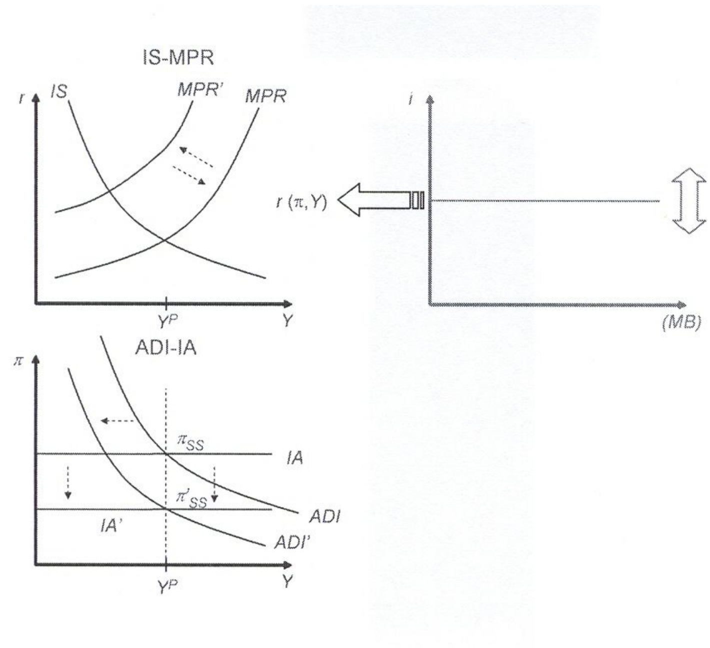

Figure 1

rate then MPR would be a horizontal line because the inflation is given at a point in time. An increase in inflation causes the central bank to raise the real rate. Thus the MPR line would shift up. This shift occurs (as Figure 1 shows) even if deviations from potential output are also considered in the monetary policy rule and it gives a positive slope to the MPR curve. The economy moves up along the IS curve, and so output falls. Thus there is an inverse relationship between inflation and output on the demand side of the economy. This aggregate demand curve, however, differs from the traditional AD relating the price level and output. That's why we use the notation ADI in the bottom panel of Figure 1.

The aggregate supply side is represented by a short-run Phillips-curve involving the inflation adjustment relationship described above. Since current inflation is independent from current output, AS (or as we call IA) curve is horizontal in the output-inflation place. Its intersection with the ADI curve determines inflation and output.

In Figure 1 the intersection of the ADI and IA is at the level of potential output. This means that inflation is steady at π_{SS} level. Assume that the central bank decides to reduce the inflation and shifts to a tighter monetary policy. The MPR curve shifts to MPR', the real interest rate rises and demand falls (ADI'). The immediate impact of this decrease in aggregate demand falls entirely on output, whereas inflation decreases only in the next period. As inflation falls, IA shifts down and the central bank starts to ease the restriction and raise the aggregate demand moving back the MPR' curve step by step to its initial position. The new steady state emerges when IA' reaches the inflation rate $\pi^{'}_{SS}$ and output equals its potential level again.

3.2 Dynamic Modelling: An Inflation Targeting Framework

The IS-MPR-IA model described above is not only a good synthesis of recent developments in modelling monetary policy but with its very simple and clear graphical representation exposes the new approach at a level suitable also for undergraduates. For a more subtle analysis we show a framework which is a dynamic counterpart of *Walsh* [2002]. In this model monetary policy is made with an explicit inflation target. Inflation targeting is a widespread practice among central banks today.

3.2.1 Price Adjustment

The next period's inflation rate depends on the current output gap, inflation expectations for the next period and price shocks.

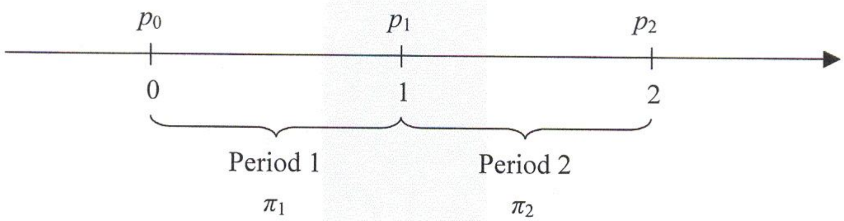

Figure 2

$$\pi_{t+1} = \alpha \cdot x_t + \pi^e_{t+1} + \varepsilon_{t+1}, \tag{1}$$

where π_{t+1} is the (log) inflation rate in the next period, $x_t = \frac{y_t - \bar{y}}{\bar{y}}$ is the output gap (y_t is the current aggregate demand, and $\bar{y}$ is the potential output, which we assume to be constant), π^e_{t+1} is the (log) inflation expectations for the next period, and ε_{t+1} is a serially uncorrelated, zero mean random variable for the next period's exogenous shocks that are not known in period t. The coefficient $\alpha > 0$ denotes the sensitivity of the next period's inflation on current output gap.[8]

3.2.2 Inflation Expectations

Assume that inflation expectations are adaptive and determined by

$$\pi^e_{t+1} = \theta \cdot \pi_t + (1 - \theta) \cdot \pi^e_t, \tag{2}$$

where $0 < \theta < 1$.[9]

3.2.3 Optimal Central Bank Behaviour

Central bank fixes up the inflation target (π^T) in moment $t = 0$. From that time monetary board comes to the optimal decision considering this reference value in each $t = 1,\ 2,\ 3,\ ...$ moment.

Figure 2 helps to distinguish variables applying to a point in time from variables applying to a period, as well as helps to recognize their relations. For example the inflation rate for period 1 is the difference between the (log) price levels (p) in moment $t = 1$ and $t = 0$, that is $\pi_1 = p_1 - p_0$. Like the inflation rate, variables x_t and π^e_t also apply to a period.

A central bank decision made in moment t adjusts $t+1$ period's output gap, which affects the inflation rate only in the period $t+2$ by equation (1). Thus the optimal monetary policy decision in time t is the function of the loss caused by next period's output gap, and the deviation of $t+2$ period's inflation rate from the target value. For simplicity the loss function is

$$L_t(x_{t+1}, \pi_{t+2}) = \frac{(\pi_{t+2} - \pi^T)^2}{2} + \omega \cdot \frac{x^2_{t+1}}{2}, \tag{3}$$

where ω is a nonnegative parameter regarding central bank's concern for real costs of disinflation relative to concern for inflationary distortion.

Equation (4) and (5) show how the central bank's loss changes with marginally modifying output gap and inflation rate.

$$\frac{\partial L_t}{\partial x_{t+1}} = \omega \cdot x_{t+1} \tag{4}$$

$$\frac{\partial L_t}{\partial \pi_{t+2}} = \pi_{t+2} - \pi^T \tag{5}$$

[8] A formula similar to (1) is used by *Gerlach – Svensson* [2000] and *Hall – Taylor* [1997] p.526.

[9] See *Frisch* [1983] p.24.

Assume that $x_0 < 0$, thus the central bank decides to encourage aggregate demand slightly, $\Delta x = x_1 - x_0 > 0$. In consequence, aggregate demand gets closer to the potential output level. The marginal gain of monetary expansion is $\Delta x \cdot \omega \cdot x_{t+1}$ by (4). The demand growth generated by the central bank causes $\alpha \cdot \Delta x$ size extra inflation. Thus the marginal loss of the monetary expansion is $\alpha \cdot \Delta x \cdot (\pi_{t+2} - \pi^T)$ by equation (5).

The central bank's decision is optimal when its marginal gains and losses are equal:

$$-\Delta x \cdot \omega \cdot x_{t+1} = \alpha \cdot \Delta x \cdot (\pi_{t+2} - \pi^T). \tag{6}$$

From (6) we can get the monetary policy rule for the output gap:

$$x_{t+1} = -\frac{\alpha}{\omega}(\pi_{t+2} - \pi^T).$$

One can add a serially uncorrelated, zero mean stochastic component, u_{t+1}, which results in the following equation:

$$x_{t+1} = -\frac{\alpha}{\omega}(\pi_{t+2} - \pi^T) + u_{t+1} \tag{7}$$

Formula (7) shows that higher inflation deviation and higher inflation sensitivity to market disequilibrium leads to a more intensive restriction as an optimal monetary policy decision. The size of the restriction dampens when consequences on real economy matter with greater weight. The stochastic component in (7) relates to exogenous shocks that are not foreseeable in period t or not observed by the central bank.

Equations (1), (2) and (7) give a closed model. This framework, however, says nothing about the instrument by which the central bank adjusts aggregate demand according to relation (7).

3.2.4 Explicit Interest Rate Rule

Assume the following IS relationship:

$$x_{t+1} = \lambda - \beta \cdot (i_{t+1} - \pi^e_{t+1}) + u_{t+1} \tag{8}$$

where λ and β are positive parameters, i_{t+1} is the nominal interest rate, and u_{t+1} is a serially uncorrelated, zero mean random variable for modelling demand shocks occurring in period $t+1$. The negative β coefficient on the real interest rate can reflect intertemporal effects on consumption as well as traditional effects on investment operating through both the cost and availability of credit.

Equation (8) shows the relationship between the output gap and real interest rate for the period $t+1$. In this way the logic of the model is more apparent: the interest rate level determined in the moment t and sustained over the period $t+1$ affects the output gap in the period $t+1$.

In the long run equilibrium (i.e. in steady state) the output gap is zero, $x_{SS} = 0$, expected and actual inflation are equal, and coincide also with inflation target, $\pi^e_{SS} = \pi_{SS} = \pi^T$. Thus in steady state:

$$0 = \lambda - \beta \cdot (i_{SS} - \pi^e_{SS}),$$

$$\beta \cdot (i_{SS} - \pi^e_{SS}) = \beta \cdot r_{SS} = \lambda, \tag{9}$$

$$r_{SS} = \frac{\lambda}{\beta},$$

where $r_{SS} = \frac{\lambda}{\beta}$ is the steady state value of the real interest rate.

Substituting λ from (9) into equation (8) we can write IS function in the following form:

$$x_{t+1} = \beta \cdot \left[r_{SS} - (i_{t+1} - \pi^e_{t+1})\right] + u_{t+1}. \tag{10}$$

Equating (7) and (10) then rearranging results the explicit nominal interest rate rule:

$$i_{t+1} = r_{SS} + \pi^e_{t+1} + \frac{\alpha}{\omega \cdot \beta}(\pi_{t+2} - \pi^T), \tag{11}$$

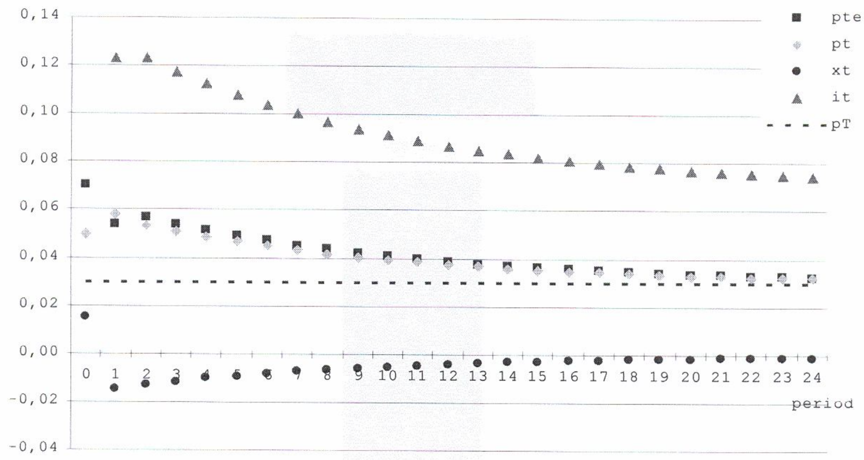

Figure 3

that higher expected inflation, larger deviation from inflation target and more sensitive inflation response to output gap leads higher nominal interest rates for the next period. The optimal interest rate level for disinflation is lower when aggregate demand is more sensible to the interest level and/or central bank gives more attention to the output gap. Equation (11) does not involve stochastic term because, by assumption, the central bank must set i_t prior to observing the disturbance u_{t+1}.

To summarize, equations (1), (2), (8) and (11) constitute a simple inflation targeting framework with an interest rate rule which gives a more realistic description of how monetary policy works today. Next section presents a simulation to demonstrate the dynamics of the model.

3.2.5 Simulation

Figure 3 shows the deterministic path of the nominal interest rate, output gap, expected inflation and actual inflation rate in the case of the following parameter levels, initial and steady state values: $\alpha = 0.25$, $\theta = 0.8$, $\omega = 0.4$, $\lambda = 0.02$, $\beta = 0.5$, $x_0 = 0.015$, $\pi_0^e = 0.07$, $\pi_0 = 0.05$, and $\pi^T = 0.03$. Shocks are ignored. The economy starts in a state of excess demand, and inflation is much higher than the target value. The central bank raises the nominal rate to make restrictions, and demand falls below the potential output. As inflation starts to fall, the interest rate is lowered, and demand gets back to the capacity in the long run. Inflation reaches the target level in the long run.

4. Conclusion and Further Research

In the simple model described above monetary policy is formed through the nominal interest rate. This is a plausible description of how most central banks conduct monetary policy today: short-term interest rates are both operative targets and policy instruments. Fixing the interest rate for monetary base requires perfectly elastic supply of reserves where central banks accommodate to the demand for base money. Thus monetary base becomes endogenous determined by the banking system's demand for reserves. Banks lend money and make loans multiplying the amount of money base. Anyhow banks optimize, they cannot lend more than non-banks want to borrow. Thus a broader money stock including also bank deposits depends on the behaviour of both the banking and non-banking sector and maximized by the credit demand of the latter.

With the models in section 3 neither the money stock nor the monetary base can be explained. Like in today's standard monetary policy models with interest rate rules money plays little or no role in them. However, a model of endogenous money should contain the market of base money with both the supply and demand side. Assuming that central banks set the interest rate is insufficient, we must also involve how this is done. We should take into account also the functioning of the banking system, modelling both the supply and demand side of the credit market. Post Keynesians say that credit is demanded by firms for productive investment and thus it depends on real business cycles. With involving an adequate real business cycle model we can dissolve the assumption of the time-constant equilibrium level of output. Cyclical factors are important not only on the demand side of the credit market but in the lending decisions too. Finally we must reconsider original Post Keynesian assumptions about demand for credit: if it was ever true that loans originated largely with firms' need for working capital, it is now clear that the demand for credit rests very heavily upon asset transactions which have grown much more rapidly than GDP.[10] All these points should also be parts of a complex model of endogenous money and are subjects for further research. Monetary policy described above is one of the main reasons of money stock endogenity and thus only a part of the framework.

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