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Three Equilibrating Variables  
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January 1982

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# MONETARIST FISCAL THEORY: THREE EQUILIBRATING VARIABLES

By Hans Brems

## Abstract

According to Milton Friedman, monetary policy cannot peg the rate of unemployment for more than very limited periods. A Friedman model, then, must dismiss and go beyond such limited periods and become a long-run model having, instead of the rate of unemployment, three other equilibrating variables, i.e., the rate of inflation and the nominal and real rates of interest.

Friedman himself has been reluctant to specify such a model, but the paper specifies a neoclassical growth model whose solutions are capable of delivering his conclusions, i.e., first, that money does not matter for any real variable; second, that money does matter for all nominal variables; and, third, that the rate of growth of the money supply may be thought of as a policy instrument used to control inflation.

Within such a neoclassical-growth framework the paper examines fiscal policy and crowding-out via the real rate of interest.



## MONETARIST FISCAL THEORY: THREE EQUILIBRATING VARIABLES

By Hans Brems

To state the general conclusion ..., the monetary authority controls nominal quantities .... It cannot use its control over nominal quantities to peg a real quantity.

Milton Friedman (1968: 11)

Monetarists wish to include the rate of inflation among their equilibrating variables. To do so they must unfreeze price. But it wouldn't do merely to move price  $P$  from the list of parameters to the list of variables. A static system can determine nothing but the levels of its variables, and it is one thing to tell how high price would be. It is quite a different thing to tell how rapidly price is changing-- which is what inflation is all about. Any model defining inflation will contain a derivative with respect to time  $dP/dt$ , hence be intrinsically dynamic. Any model admitting inflation as an equilibrating variable will immediately have two additional ones, i.e., the nominal and the real rate of interest.

Keynes, who paid less attention to price as a variable, did not appreciate Fisher's (1896) distinction between a nominal and a real rate of interest. Keynes (1936: 222-229) did consider "own rates" of interest like a wheat rate of interest, a copper rate of interest, and so on, and discussed their carrying-cost and liquidity aspects. On pp.

142-143 he discussed Fisher's aspect of such own rates but remained unconvinced. The distinction between a nominal and a real rate of interest is the strength of monetarists from Turgot (1769-1770) to Mundell (1971). The weakness of monetarists is the scant attention they pay to physical output.

Monetarists wish to exclude the rate of unemployment from their equilibrating variables: "Monetary policy," says Friedman (1968: 5), "cannot peg the rate of unemployment for more than very limited periods." A Friedman model, then, must dismiss and go beyond such limited periods and become a long-run model. Friedman himself has been reluctant to specify such a model, but a neoclassical growth model will require little modification to deliver his conclusions. Let us see how.

## I. A MONETARIST MODEL WITH THREE EQUILIBRATING VARIABLES

### 1. Variables

$C$   $\equiv$  physical consumption

$D$   $\equiv$  desired holding of money

$G$   $\equiv$  physical government purchase of goods and services

$g_v$   $\equiv$  proportionate rate of growth of variable  $v$

$I$   $\equiv$  physical investment

$L$   $\equiv$  labor employed

$P$   $\equiv$  price of goods and services

$R$   $\equiv$  tax revenue

$r$   $\equiv$  nominal rate of interest

$\rho$   $\equiv$  real rate of interest

$S$   $\equiv$  physical capital stock

$W$   $\equiv$  money wage bill

$w$   $\equiv$  money wage rate

$X$   $\equiv$  physical output

$Y$   $\equiv$  money national income

$y$   $\equiv$  money disposable income

$Z$   $\equiv$  money profit bill

## 2. Parameters

$a$   $\equiv$  multiplicative factor of production function

$\alpha, \beta$   $\equiv$  exponents of production function

$c$   $\equiv$  propensity to consume

$F$   $\equiv$  available labor force

$g_v$   $\equiv$  proportionate rate of growth of parameter  $v$

$\lambda$   $\equiv$  proportion employed of available labor force

$M$   $\equiv$  supply of money

$m$   $\equiv$  multiplicative factor of demand-for-money function

$\mu$   $\equiv$  exponent of demand-for-money function

$T$   $\equiv$  tax rate

The model will include derivatives with respect to time, hence is dynamic. All parameters are stationary except  $a$ ,  $F$ , and  $M$  whose growth rates are stationary.

### 3. The Model

Define the proportionate rate of growth of variable  $v$  as

$$(1) \quad g_v \equiv \frac{dv}{dt} \frac{1}{v}$$

Define investment as the derivative of capital stock with respect to time:

$$(2) \quad I \equiv \frac{dS}{dt}$$

Define the real rate of interest as the nominal one minus the rate of inflation:

$$(3) \quad \rho \equiv r - g_p$$

Let profit maximization under pure competition equalize, first, real wage rate and physical marginal productivity of labor:



$$(4) \quad \frac{w}{P} = \frac{\partial X}{\partial L}$$

and, second, the cost of capital and the physical marginal productivity of capital stock. In an inflationary economy, the cost of capital to a firm investing in physical goods is the real rate of interest, hence

$$(5) \quad \rho = \frac{\partial X}{\partial S}$$

The partial derivatives contained in (4) and (5) cannot be taken, and the system cannot be solved, until the production function thus differentiated has been specified. Monetarists have shown no interest in such specification but may not object, we hope, to a Cobb-Douglas form

$$(6) \quad X = aL^{\alpha}S^{\beta}$$

where  $0 < \alpha < 1$ ;  $0 < \beta < 1$ ;  $\alpha + \beta = 1$ ; and  $a > 0$ . Now we may take our partial derivatives

$$(7) \quad \frac{\partial X}{\partial L} = \alpha \frac{X}{L}$$

$$(8) \quad \frac{\partial X}{\partial S} = \beta \frac{X}{S}$$

Insert (8) into (5), rearrange, and find desired capital stock

$$(9) \quad S = \beta X / \rho$$

Insert (7) into (4), rearrange, and find the price equation

$$(10) \quad P = \frac{wL}{\alpha X}$$

saying that neoclassical price  $P$  equals per-unit labor cost  $wL/X$  marked up in the proportion  $1/\alpha$ .

Once priced, physical output becomes national income: Let capital stock be immortal, so we may ignore capital consumption allowances and define national income as the money value of physical output

$$(11) \quad Y \equiv PX$$

Define money disposable income before capital gains as national income minus government net receipts:

$$(12) \quad y \equiv Y - R$$

Let real wealth in the neoclassical model consist of real money stock  $M/P$  and the physical capital stock  $S$ . Real capital gains on real money stock are  $-g_p M/P$  and on physical capital stock zero. Consequently real disposable income after capital gains is  $(Y - R - g_p M)/P$ , and let consumption be the fraction  $c$  of that:

$$(13) \quad C = c(Y - R - g_p M)/P$$

Let labor employed be the proportion  $\lambda$  of available labor force:

$$(14) \quad L = \lambda F$$

where  $0 < \lambda < 1$ . The difference  $1 - \lambda$  is the "natural" rate of unemployment, on which Friedman (1968: 8) says:

A lower level of unemployment is an indication that there is an excess demand for labor that will produce upward pressure on real wage rates. A higher level of unemployment is an indication that there is an excess supply of labor that will produce a downward pressure on real wage rates.

Friedman (1968: 5) concludes that "monetary policy ... cannot peg the rate of unemployment for more than very limited periods." In other words, our long-run representation of a Friedman system may consider  $\lambda$  a parameter.

Let tax revenue be in proportion to money national income:

$$(15) \quad R = TY$$

and let the government finance its deficit, if any, by issuing noninterest-bearing claims upon itself called money. The government budget constraint is then

$$(16) \quad GP - R = \frac{dM}{dt}$$

Let the demand for money<sup>1</sup> be a function of money national income and the nominal rate of interest:

$$(17) \quad D = mYr^\mu$$

where  $\mu < 0$  and  $m > 0$ .

Goods-market equilibrium requires the supply of goods to equal the demand for them:

$$(18) \quad X = C + I + G$$

Money-market equilibrium requires the supply of money to equal the demand for it:

$$(19) \quad M = D$$

We may now proceed to solving the system for the growth rates of its variables and for the level of its real interest rate.

## II. STEADY-STATE EQUILIBRIUM-GROWTH SOLUTIONS

### 1. Growth-Rate Solutions

By differentiating equations (1) through (19) with respect to time the reader may convince himself that they are satisfied by the following steady-state growth solutions

$$(20) \quad g_C = g_X$$

$$(21) \quad g_D = g_M$$

$$(22) \quad g_G = g_X$$

$$(23) \quad g_I = g_X$$

$$(24) \quad g_L = g_F$$

$$(25) \quad g_M = g_Y$$

$$(26) \quad g_R = g_Y$$

$$(27) \quad g_T = 0$$

$$(28) \quad g_\rho = 0$$

$$(29) \quad g_S = g_X$$

$$(30) \quad g_W = g_Y$$

$$(31) \quad g_{w/P} = g_a/\alpha$$

$$(32) \quad g_X = g_a/\alpha + g_F$$

$$(33) \quad g_Y = g_P + g_X$$

$$(34) \quad g_y = g_Y$$

$$(35) \quad g_Z = g_Y$$

## 2. Properties of Growth-Rate Solutions

Our growth-rate solutions neatly deliver Friedman's conclusions.

First, money does not matter for any real variable. No growth-rate solution for the eight real variables  $C, G, I, L, S, \rho, w/P$ , and  $X$  has  $g_M$  in it, directly or indirectly.

Second, money does matter for all nominal variables: The growth rates of the eight nominal variables  $D, P, R, r, W, Y, y$  and  $Z$  all depend, directly or indirectly, upon the rate of growth  $g_M$  of the money supply.

Third, the rate of growth  $g_M$  of the money supply may be thought of as a policy instrument and used to control inflation: Take the growth-rate solutions (25) and (33) together insert (32) and find

$$(36) \quad g_P = g_M - (g_a/\alpha + g_F)$$

or, in English: Knowing the rate of technological progress  $g_a$  and the rate of growth of the labor force  $g_F$  and knowing the elasticity  $\alpha$  of output with respect to labor, the monetary authorities may control the

rate of inflation  $g_p$  by controlling the rate of growth  $g_M$  of the money supply. For example, if  $g_a = 0.016$ ,  $\alpha = 4/5$ , and  $g_F = 0.01$ , then alternative rates of growth of the money supply  $g_M$  will produce the following rates of inflation  $g_p$ :

$g_M$	$g_p$
0.03	0
0.05	0.02
0.07	0.04
0.09	0.06
.	.
.	.
.	.

### 3. The Steady-State Equilibrium Real Rate of Interest

So far, so good: Our growth-rate solutions neatly delivered Friedman's conclusions. Will level solutions do the same? The clue is the real rate of interest  $\rho$ . In accordance with the definition (2), differentiate desired capital stock (9), use (1), and write desired investment

$$(37) \quad I = \beta g_X X / \rho$$

Insert the definition (11) of national income and the tax function (15) into the consumption function (13) and the government budget constraint (16) and write physical consumption and government purchase



$$(38) \quad C = c[(1 - T)X - g_P M/P]$$

$$(39) \quad G = TX + g_M M/P$$

Finally insert (37), (38), and (39) into the goods-market equilibrium condition (18), rearrange, divide numerator and denominator alike by physical output  $X$ , insert the definition (11) of national income, and solutions (25) and (33), and write the real rate of interest

$$(40) \quad \rho = \frac{\beta g_X}{(1 - c)(1 - T) - [(1 - c)g_P + g_X]M/Y}$$

As long as the solution (25) holds, the money supply and money national income are growing at the same rate, hence the ratio  $M/Y$  is stationary, and so is the real rate of interest (40). Will the level at which the real rate of interest (40) remains stationary be affected by fiscal and monetary policy?

#### 4. Fiscal Policy

Let an increased government purchase  $G$  be tax-financed: In the government budget constraint (16) the tax rate  $T$  is up whereas the rate of growth  $g_M$  of the money supply is unaffected. If because of the

frozen "natural" rate of unemployment physical output has no give in it, room for increased government purchase must be found by reducing either consumption or investment or both. In the case of tax financing both will be reduced: In the consumption function (13) a higher tax rate  $T$  means less consumption. In the solution (40) for the level of the real rate of interest a higher  $T$  means a lower denominator, hence a higher real rate of interest  $\rho$ . In the investment function (37) a higher  $\rho$  means less investment.

In conclusion, fiscal policy does affect the level of the real rate of interest. Monetarists find this effect perfectly natural, indeed necessary: The effect is part of the crowding-out mechanism.

## 5. Monetary Policy

Let an increased government purchase  $G$  be money-financed: In the government budget constraint (16) the tax rate  $T$  is unaffected whereas the rate of growth  $g_M$  of the money supply is up. If because of the frozen "natural" rate of unemployment physical output has no give in it, room for increased government purchase must be found by reducing either consumption or investment or both. In the case of money financing both will be reduced: According to the solution (32) the rate of growth  $g_X$  of physical output has no give in it. According to the solution (33), then, a higher rate of growth  $g_M$  of the money supply must mean a higher rate of growth  $g_P$ , hence in the consumption function (13) heavier capital loss and less consumption. In the solution (40) for the level

of the real rate of interest a higher  $g_p$  means a lower denominator, hence a higher real rate of interest  $\rho$ . In the investment function (37) a higher  $\rho$  means less investment.

In conclusion, monetary policy, too, affects the level of the real rate of interest, and that effect, too, is part of the crowding-out mechanism. But such an effect is in ill accordance with Friedman's view that "the monetary authority cannot use its control over nominal quantities to peg a real quantity." The real rate of interest is real!

However this may be, given the form (17) of our demand-for-money function, none of our conclusions depended upon any particular value of the elasticity  $\mu$  of the demand for money with respect to the nominal rate of interest--and Friedman (1966) now agrees. No need for a vertical LM curve!

## 6. What Remains?

So far, we have accepted Friedman's "natural" rate of unemployment and found his conclusions to follow, at least as far as growth rates--if not levels--are concerned. More will be said on the "natural" rate in ch. 8.

Leaving out government bonds, we have formulated a very simple government budget constraint. But a government deficit may be financed either by expanding the money supply or the bond supply.

Bent Hansen (1955: ch. III) was perhaps the first to write an explicit government budget constraint in a macroeconomic model, and Ott

and Ott (1965) and Christ (1967) were the first to show that a macro-economic model becomes dynamic once it incorporates the government budget constraint. Like ours, their budget constraint failed to include the payment of interest on government bonds. Such payment might seem a detail but is more than that and was included in later work by Blinder and Solow (1974) and Turnovsky (1977).

In chs. 6 through 8 we shall build a short-run and long-run fiscal-policy models allowing for all this. But before we decide on the building blocks of such models, let us see the years 1965-1980 as experienced in six macroeconomic functions.

FOOTNOTE

<sup>1</sup>On the money-market side, monetarist tradition aggregates less than we are doing and distinguishes among money, credit, and securities markets. On the good-market side, monetarist tradition aggregates more than we are doing and does not even distinguish between consumption and investment demand [Brunner-Meltzer (1976)]. A good recent survey is Svindland (1980).

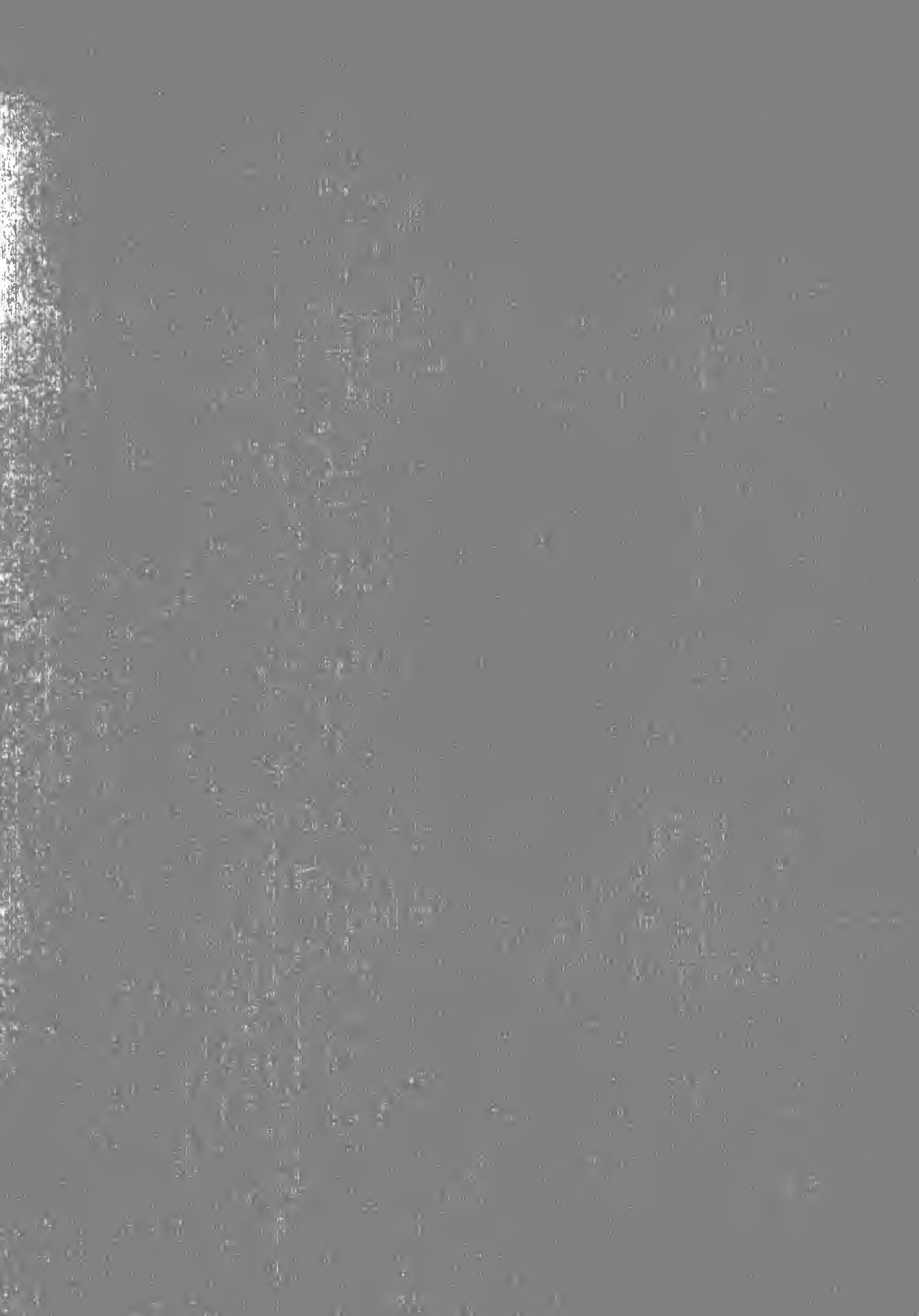
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