A Neo-Classical Macro-Economic Model: Entrepreneurs Bankers, Innovations and Excess Profits

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I. Introduction

In the history of economic analysis two macro-economic models were developed which dealt with the core process of a neoclassical economy, yet are today relatively little used. They are *Schumpeter's* model of entrepreneurial innovation and economic growth and *Wicksell's* model of the "cumulative process."[1] Both models were stated verbally and they reveal profound insights in the working of a market economy. In this paper an attempt is made to bring together various elements contained in these two models and to set up a dynamic neoclassical model. The underlying ideas are the following ones.

A competitive capitalist market economy is a dynamic one. If it is to function well, it must grow. According to *Schumpeter* such an economy is characterized by the presence of entrepreneurs who take the risk of introducing more efficient, cost reducing innovations. If successful they are rewarded for this through excess profits — until the imitation of their innovation by others wipes excess profits out and forces them to look for new ones. Entrepreneurs are the driving force in a market economy. They propel it forward in their search for excess profits; no outside impulses are needed. Without the entrepreneurial drive the economy will go sideways. It falls back into a dull, no-growth stationary state, where the competitive equilibrium will award factors of production with normal rates of return only; a state much discussed in economic analysis but not at all characteristic for a market economy.

[1] *Joseph A. Schumpeter*, "The Theory of Economic Development," Harvard University Press, Cambridge, Mass. 1934; and "Business Cycles," McGraw-Hill Comp., New York, 1939. *Knut Wicksell's* „Vorlesungen über National Ökonomie" which were published in 1901 and 1906. The English translation is "Lectures on Political Economy," (Lionel Robins, editor) 2 volumes, London, 1934; especially volume 2, p. 190 ff.

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A second characteristic of a capitalistic market economy is a financial superstructure with a banking system able to create money. The behavior of bankers, with respect to portfolio choices — their desire to stay liquid or to acquire earning assets — has, as *Wicksell* showed some 70 years ago, a great influence on capital formation, future production and prices. Innovations, the incentives to introduce them by investing in new capital goods and the financing of the latter in a credit economy, form thus the core of the neo-classical economy growth process. At its center is the behavior of entrepreneurs and bankers with respect to expected earnings, risk-taking and liquidity.

It will be shown that the *Schumpeter*ian and *Wicksell*ian approaches lead to a general dynamic neoclassical model which is helpful for the understanding of the actual working of market economies. The model contains as special cases a number of other macro-models, the simplistic seven equations "neoclassical model," the *Keynes*ian model, *Friedman*'s "Simple Common Model" and *Solow's* neoclassical growth model.

II. The Neoclassical Model

We assume a competitive economy with upward and downward price and wage flexibility. There are two factors of production, capital and labor. The former is owned by entrepreneur-capitalists. Labor is supplied by workers.

The economy produces two types of goods, consumer goods and capital goods. Consumer goods are consumed by both workers and entrepreneurs. Capital goods may either be used for reinvestments to keep the existing capital stock intact or for net investments to enlarge and/or deepen it. To simplify our model we assume that the production functions for both types of goods are the same, thus the aggregate production function is written as

$$O = O\,(K, L) \tag{1}$$

where: O is real output of consumer goods and capital goods
K is capital stock, in real terms
L is labor force

The production function shall be linear homogeneous, there are constant returns to scale, but diminishing returns to each factor of

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production. The real rental of capital is equal to the marginal product of capital

(2) $$R_r = \frac{\delta O}{\delta K} \qquad \frac{\delta O}{\delta K} > 0 \qquad \frac{\delta^2 O}{\delta K^2} < 0$$

where R_r stands for real rental. The real wage rate is equal to the marginal product of labor

(3) $$W_r = \frac{\delta O}{\delta L} \qquad \frac{\delta O}{\delta L} > 0 \qquad \frac{\delta^2 O}{\delta L^2} < 0$$

The money wage rate is

(3a) $$W_m = P_c \, W_r$$

where W_m stands for money wages, P_c for consumer goods price level and W_r for real wage rate.

The demand for new capital goods shall be a function of the rate of return entrepreneurs expect to obtain on them and the bank rate charged on loans to finance these new capital goods. We write the investment demand function therefore as

(4) $$\frac{dK}{dt} = g\,(\Pi_{\mathrm{exp}}, R_B)$$

$$\frac{\delta\left(\frac{dK}{dt}\right)}{\delta \Pi_{\mathrm{exp}}} > 0 \qquad \frac{\delta\left(\frac{dK}{dt}\right)}{\delta R_B} < 0$$

Π_{exp} is the expected rate of return on new capital goods and R_B the bank rate. The expected rate of return on new capital goods consists of two components. The first one is the "normal rate of return." If the economy is initially in a competitive stationary state, this rate is equal to the marginal efficiency of capital $\frac{\delta O}{\delta K}$. With this rate of return all investments shall consist of reinvestments in capital goods embodying the generally known technology of the stationary state. At the same time known to some entrepreneurs shall be advanced technologies, which, when introduced, will result in more efficient, cost reducing production. This gives those entrepreneurs a chance to break out of the "normal profit" range. They may expect excess profits, provided they take the risk of introducing innovations. We write the expected rate of return equation as

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(5) $$\Pi_{\exp} = \frac{\left(\frac{\delta O}{\delta K}\right) K + \left(\frac{\delta O}{\delta K} + E_{\exp}\right) \frac{dK}{dt}}{K + \frac{dK}{dt}}$$

In this $E_{\exp}$ is the expected excess profit rate. We assume, for the sake of simplicity, that it is given exogenously. If $E_{\exp}$ should be equal to zero, the expected profit $\Pi_{\exp}$ reverts to the marginal productivity of capital.

In order to realize the excess profits, entrepreneurs have to make net investments in more efficient, new capital goods. Yet to finance these, loanable funds are needed. Their amount is equal to

(6) $$F = P_K \left(\frac{dK}{dt}\right)$$

where: F stands for loanable funds needed
P_K is the price index of capital goods.

In the fully employed economy the loanable funds F can come from two sources, from monetary savings and (or) from money creation by the fractional reserve banking system. We write therefore

(7) $$M^* = F - S_{\mathrm{mon}}$$

where M^* stands for new money created and S_{mon} for monetary savings.

If $F > S_{\mathrm{mon}}$ entrepreneurs have to try to obtain loans from the banking systems. On these loans they have to pay the bank rate of interest. We assume that the banks consider three factors when they determine the bank rate of interest. They shall orient themselves on a long-run stationary state rate of interest R_0. In addition they shall take into account increases in the price level $\frac{dP}{dt}$. Finally they shall consider the degree to which they are loaned-up. If $\overline{M}_s$ is the theoretical maximum amount of money they could create with given bank reserves, they may prefer to lower this amount, for risk and liquidity, to $\alpha \overline{M}_s$, where $\alpha < 1$. The smaller α the greater the risk aversion of the bankers, the greater their liquidity preference. Thus it is reasonable to assume that bankers compare the actual amount of money supplied, M_s, with what they think would be the desirable amount supplied, namely $\alpha \overline{M}_s$. We write therefore the equation, determining the bank rate as

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(8) $$R_B = h\left(R_0, \frac{dP}{dt}, (M_s - \alpha\, M_s)\right)$$

The behavior of bankers shall be such that if $\frac{dP}{dt} > 0$, ceteris paribus, R_B rises and vice versa. At the same time we have, ceteris paribus,

$$(M_s - \alpha\, \overline{M}_s) < 0,\ R_B \text{ falls}$$
$$(M_s - \alpha\, \overline{M}_s) = 0,\ R_B \text{ unchanged}$$
$$(M_s - \alpha\, \overline{M}_s) > 0,\ R_B \text{ rises}$$

If the demand for money in the initial equilibrium state was M_0 (before entrepreneurs obtain loans equal to the amount of M^* from the banking system) the new demand for money is

(9) $$M_D = M_0 + M^*$$

Further, the actual supply of money is equal to the demand for money and we have

(10) $$M_D = M_s$$

The new price level in the economy is therefore, according to the quantity equation

(11) $$P = \frac{M_D\, \overline{V}}{O}$$

where P is the general price level and $\overline{V}$ the velocity of money, which depends on payment habits and attitudes towards holding of money. We shall consider it as given. Once the total price level is known the consumer goods price level P_c is equal to

(12) $$P_c = \frac{P\left[B_1\left(\frac{\delta O}{\delta L}\, L\right) + B_2\left(O - \frac{\delta O}{\delta L}\, L\right)\right]}{\left(O - \frac{dK}{dt}\right)}$$

Furthermore knowing P and P_c the investment good price level P_K can easily be obtained. We have

(13) $$P0 = P_c\left(O - \frac{dK}{dt}\right) + P_K \frac{dK}{dt}$$

It remains to determine the monetary savings in the economy. These are equal to

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(14) $$S_{\text{mon}} = P\left[(1-B_1)\frac{\delta O}{\delta L}L + (1-B_2)\left(O - \frac{\delta O}{\delta L}L\right)\right]$$

or

(15) $$S_{\text{mon}} = P\left[(1-B_2)\,O + (B_2 - B_1)\frac{\delta O}{\delta L}L\right]$$

In (12) and (15) B_1 and B_2 may be considered average propensities to consume and thus constant,

(16a) $$\overline{B}_1 = \overline{B}_1, B_2 = \overline{B}_2$$

Alternatively, B_1 and B_2 may be considered to be functions of the bank rate R_B and thus

(16b) $$B_1 = B_1(R_B)$$

(16c) $$B_2 = B_2(R_B)$$

As a last equation we finally have the supply of the labor. This can be either exogenously given,

(17a) $$\frac{dL}{dt} = nL$$

or be a function of the real wage rate

(17b) $$L = g(W_r)$$

The basic system consists thus of 16 equations, namely (1), (2), (3), (3a), (4), (5), (6), (7), (8), (9), (10), (11), (12), (13), (15), and (17a) or (17b). These suffice to determine 16 variables, namely O, K, L, R_r, W_r, W_m, Π_{exp}, F, M^*, S_{mon}, R_B, M_D, M_s, P, P_c and P_k. The system is thus determined. If the system is enlarged there are two more variables, B_1 and B_2, and two additional equations, namely (16b) and (16c). The system contains then 18 variables and 18 equations.

It is a pleasant task to show now how the derived neoclassical model is related to other, well-known macro-economic models.

III. Relationship to other Models

1. The Special Case of the Conventional Seven Equation Neoclassical Model

The widely used simple neoclassical seven variable, seven equation model can be written as,[2]

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(1*) $$O = F(L, \bar{K})$$

(2*) $$W_r = \frac{\delta O}{\delta L}$$

(3*) $$L = L\left(\frac{\delta O}{\delta L}\right)$$

(4*) $$S = S(r)$$

(5*) $$I = I(r)$$

(6*) $$I = S$$

(7*) $$P = \frac{M\bar{V}}{O}$$

The model is a special, simple case of the neo-classical model presented in Section II. It refers to a stationary state economy which is in competitive long-run equilibrium. There is no technological progress and there are no innovations and no excess profits.

Equation (1*) of this model is equal to (1) except that the capital stock is generally considered constant. Equation (2*) is the same as (3). Equation (3*) is the same as (17b), and equation (7*) is the same as equation (11).

The equation (4*) for real savings is a special version of equation (15). Because the classical model does not distinguish between workers and entrepreneur-capitalists, we may set in (15) $B_1 = B_2 = B$. With this (15) becomes

$$\frac{S_{\text{mon}}}{P} = (1 - B)\, O$$

Furthermore, in the long-run classical model $R_B = R_r = R$. The real output O is at maximum. Thus B determines what will be saved. If B, is in line with (16b), a function of the rate of interest, $B = B(r)$, real savings become a function of the rate of interest.

The investment function (5*) is identical with equation (4) if, the expected excess profits rate E_{exp} is zero. Π_{exp} is then equal to $R_r = R_B = R$.

Equation (6*) states the equality of real savings and investment. This equation is contained in the neoclassical model in Section II, as a

[2] See for instance: *Gardner Ackley*, Macroeconomic Theory, The MacMillan Company, New York, 1961, p. 156.

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special case. In the simple neoclassical model investments cannot be financed through money creation. Thus equation (7) becomes

$$F = S_{\text{mon}}$$

With this equation (6) becomes

$$\frac{S_{\text{mon}}}{P_K} = \frac{dK}{dt} = I$$

The classical model does not distinguish between consumer goods and investment goods price level. Thus

$$P = P_c = P_K. \textit{ Thus}$$

$$S = \frac{S_{\text{mon}}}{P} = \frac{dK}{dt} = I$$

2. *The Special Case of the Keynesian Model*

If we assume that all prices are constant and that consumer goods prices are equal to investment goods prices, that is $P_c = P_K = P = 1$, we can write equation (12a) as

(13) $$PO = P\left(O - \frac{dK}{dt}\right) + P\frac{dK}{dt}$$

Thus we have the *Keynes*ian aggregate demand equation

(1**) $$Y = C + I$$

From equation (4) we get the *Keynes*ian investment function if $\Pi_{\text{exp}} = R_B = R_r = R$. Thus

(2**) $$I = \frac{dK}{dt} = g\,(r)$$

If the rate of interest charged by banks depends solely on the amount of money supplied equation (8) simplifies to

(3**) $$R = h_1\,(\overline{M}_s)$$

This is the *Keynes*ian liquidity preference function.

Finally, if workers and entrepreneurs have the same propensity to consume we have in (15) $B_1 = B_2 = B$ and

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$$S = \frac{S_{\text{mon}}}{P} = (1 - B)\, O$$

or in *Keynes*ian terms,

$$S = (1 - B)\, Y$$

Going back to (13) it is evident that the total product PO can either be consumed or non-consumed. The non-consumed part is called savings. Thus we have as an alternative equation to (1**)

$$Y = C + S$$

From this and (1**) we get

$$I = S$$

Furthermore,

$$S = Y - C$$

Thus

$$C = BY \tag{4**}$$

The equations (1**) to (4**) represent a simple *Keynes*ian system. Equation (1**) states the equality of aggregate supply and demand, equation (2**) is an investment function, (3**) represents a liquidity preference function and (4**) a consumption function. With the money supply $\overline{M}_s$ exogenously given the variables Y, I, C and r can be determined.[3] The *Keynes*ian model is thus a special case of the neoclassical one.

3. The Case of Professor Friedman's Simple Common Model

In 1970 Professor Milton *Friedman* of the University of Chicago published what he called a "highly simplified aggregate model of an economy that encompasses both a simplified quantity theory and a simplified income-expenditure theory as special cases." He referred to this model as "A Simple Common Model."[4] It is of interest to detect

[3] If equation 4** is substituted in 1** a three equation model is obtained. For this see *Paul A. Samuelson*, "Foundations of Economic Analysis," Harvard University Press, Cambridge, 1955, p. 276.

[4] *Milton Friedman*, "A Theoretical Framework for Monetary Analysis", Journal of Political Economy, Vol. 78, No. 2, March/April 1970, p. 217 – 219.

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how this model relates to the neoclassical one. *Friedman*'s model has six equations. The first one is

$$\frac{C}{P} = F\left(\frac{Y}{P}, R\right) \tag{1***}$$

Real consumption is a function of real income and the interest rate. By implication real savings are a function of the same variables. The savings function in equation (15) of the neoclassical model in Section II can thus replace (1***) if $B_1 = B_2 = B$ and $B = B(R)$. The second equation in the *Friedman*'s model is

$$\frac{I}{P} = g(r) \tag{2***}$$

Real investment is a function of the interest rate. Equation (4) can take the place of this equation if excess profits are zero $R_r = R_B = R$.

The third equation is written as

$$\frac{Y}{P} = \frac{C}{P} + \frac{I}{P} \tag{3***}$$

or alternatively

$$\frac{S}{P} = \frac{Y - C}{P} = \frac{I}{P} \tag{3***a}$$

This equation is the same as (13) if $P = P_K = P_c$.

The demand for real money is in *Friedman*'s model a function of real income and the interest rate.

$$M^D = Pi\left(\frac{Y}{P}, R\right) \tag{4***}$$

We obtain this equation by dividing equation (9) on both sides by the price level P,

$$\frac{M_D}{P} = \frac{M_0}{P} + \frac{M^*}{P}$$

From (6) and (7) we have with $P_K = P$

$$\frac{M^*}{P} = \frac{dK}{dt} - \frac{S_{\text{mon}}}{P}$$

In this, according to (4)

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$$\frac{dK}{dt} = g\,(\Pi_{\text{exp}}, R_B)$$

and according to (15) if $B_1 = B_2 = B$ and $B = B\,(R)$

$$\frac{S_{\text{mon}}}{P} = (1 - B)\,O$$

Thus, if the economy described in Section II expands along neoclassical lines, we have

$$\frac{M^*}{P} = m_1\,(O, \Pi_{\text{exp}}, R_B)$$

This is the case if there are not enough savings to finance investments. Yet in *Friedman*'s static model $\frac{M^*}{P} = O$. Also $\Pi_{\text{exp}} = R_B = R_r = R$. The whole demand for money is now the demand $\frac{M_0}{P}$ in the initial state. This demand is assumed to be a function of O and R.

Thus to satisfy (3***a) we write

$$\frac{M_D}{P} = \frac{M_0}{P} = m_2\,(O, R)$$

and

$$M_D = Pm_2\,(O, R)$$

The equation for the supply of money is:

(5***) $$M^S = h\,(R)$$

This equation is a special form of equation (8). Finally, the equilibrium in the money market is

(6***) $$M^D = M^s$$

which is equal to equation (10).

The *Friedman* system has seven variables

$$C, I, Y, R, P, M^D, M^S$$

but it has only six equations, (1***) to (6***). To make it determinate *Friedman* suggests either to add the quantity equation, with y_0 as a given real income,

(7***a) $$Y = P\,y_0$$

which is equivalent to our equation (11).

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Alternatively, one can resort to the *Keynes*ian approach and set

(7***b) $$P = P_0$$

which is the same as setting in (12a) all *P's* constant.

Using (7***a), results in a modified neoclassical model, using (7***b) leads to a modified *Keynes*ian model.

4. *Neoclassical Growth Models: The Solow Growth Model*

It can be shown that the pioneering *Solow* growth model is contained in the neoclassical one.[5] *Solow*'s model is written as,

(I) $$\frac{dK}{dt} = s\,Y$$

(II) $$Y = F\,(K, L)$$

(III) $$L\,(t) = L_0\,e^{nt}$$

It has three equations and three variables, Y, K, L.

In terms of the neoclassical model, equation (I) is based on (13) which stipulates for a fixed $P = P_c = P_K = 1$, that real savings must be equal to real investment. The right side of equation (I) is readily obtained from (15). If $B_1 = B_2 = B$

$$S_{\text{real}} = \frac{S_{\text{mon}}}{P} = (1 - B)\,O = s\,O = s\,Y$$

The equation (II) is equal to the production function (1), and the equation (III) is the same as (17a). The basic *Solow* equations are thus a rather restricted subset of the equations contained in the neoclassical model. *Solow*'s model is a highly truncated neoclassical one. It does not account for entrepreneurial or bankers' behavior nor does it inform us about the financial side of neoclassical economic growth.

Zusammenfassung

Ein neoklassisches, makroökonomisches Modell:
Unternehmer, Bankiers, Innovationen und Gewinnstreben

Mit diesem Beitrag wird der Versuch unternommen, ein dynamisches neoklassisches Modell zu formulieren. Die zugrundeliegenden Vorstellungen

[5] *Robert M. Solow*, "A Contribution to the Theory of Economic Growth", Quarterly Journal of Economics, February 1956, p. 65 - 94.

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gehen auf *Wicksels* kumulatives Wachstum und *Schumpeters* Prozeß der Innovation und des Wirtschaftswachstums zurück. Unternehmer sind die treibende Kraft in einer Marktwirtschaft. In ihrem ständigen Betreben nach zusätzlichem Gewinn treiben sie die Wirtschaft an, so daß keine Impulse von außen notwendig sind. Innovationen und die Anreize sie durch neue Investitionen einzuführen und letztere in einer Geldwirtschaft zu finanzieren, bilden den Kern des neoklassischen Wachstumsprozesses. Im Mittelpunkt steht das Verhalten der Unternehmen und Bankiers in Hinblick auf die zu erwartenden Gewinne, Risikoübernahme und Liquidität.

Das Modell besteht aus 18 Gleichungen und 18 Variablen. Es enthält als Spezialfall das konventionelle neoklassische Gleichungsmodell mit 7 Gleichungen, *Keynes* Modell, möglicherweise *Friedmans* einfaches Grundmodell und Solows Modell des Wirtschaftswachstums.

Summary

A Neo-Classical Macro-Economic Model: Entrepreneurs, Bankers, Innovations and Excess Profits

In this paper an attempt is made to formulize a dynamic neo-classical model. Its underlying ideas go back to *Wicksell's* cumulative process and *Schumpeter'* process of innovation and economic growth. Entrepreneurs are the driving force in a market economy. They propel an economy forward in their continuous search for excess profits, no outside impulses are necessary. Innovations, the incentives to introduce them by investing in new capital goods, and the financing of the latter in a credit economy form the core of neo-classical economic growth process. At its center is the behavior of entrepreneurs and bankers with respect to expected earnings, risk taking and liquidity.

The model has 18 equations and 18 variables. It contains as special cases the conventional seven equation neo-classical model, *Keynes* model, possibly *Friedman's* Simple Common Model and *Solow's* model of economic growth.

Résumé

Un modèle macroéconomique néoclassique: Entrepreneurs, banquiers, innovations et but lucratif

Cet article est un essai de formulation d'un modèle dynamique néoclassique. Les idées de base sont empruntées à l'expansion cumulative de *Wicksell* et au processus de l'innovation et de la croissance économique de *Schumpeter*. Les entrepreneurs sont la force motrice d'une économie de marché. Dans leur recherche constante d'accroissement de leurs profits, ils éperonnent l'économie, ce qui rend inutiles les impulsions de l'extérieur. Les innovations

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ainsi que les incitations à les mettre en oeuvre grâce à de nouveaux investissements, ceux-ci étant à financer dans une économie monétaire, forment le noyau du processus néoclassique de l'expansion. Et au coeur de ce noyau se situe le comportement des entrepreneurs et des banquiers à l'égard des bénéfices, des acceptations de risques et des liquidités qu'ils anticipent.

Le modèle se compose de 18 équations et de 18 variables. Il comprend comme cas particulier le modèle conventionnel d'équation néoclassique avec 7 équations, le modèle de *Keynes*, dans la mesure du possible le modèle simple de base de *Friedman* et le modèle de la croissance économique de *Solow*.

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