



## Working Paper No. 441

---

### **Prolegomena to Realistic Monetary Macroeconomics: A Theory of Intelligible Sequences**

By

**Wynne Godley\***

and

**Marc Lavoie\*\***

**February 2006**

---

The Levy Economics Institute Working Paper Collection presents research in progress by Levy Institute scholars and conference participants. The purpose of the series is to disseminate ideas to and elicit comments from academics and professionals.

The Levy Economics Institute of Bard College, founded in 1986, is a nonprofit, nonpartisan, independently funded research organization devoted to public service. Through scholarship and economic research it generates viable, effective public policy responses to important economic problems that profoundly affect the quality of life in the United States and abroad.

The Levy Economics Institute

P.O. Box 5000

Annandale-on-Hudson, NY 12504-5000

<http://www.levy.org>

## **ABSTRACT**

This paper sets out a rigorous basis for the integration of Keynes-Kaleckian macroeconomics (with constant or increasing returns to labor, multipliers, mark-up pricing, etc.) with a model of the financial system (comprising banks, loans, credit money, equities, etc.), together with a model of inflation.

Central contentions of the paper are that, with trivial exceptions, there are no equilibria outside financial markets, and the role of prices is to distribute the national income, with inflation sometimes playing a key role in determining the outcome.

The model deployed here describes a growing economy that does not spontaneously find a steady state even in the long run, but which requires active management of fiscal and monetary policy if full employment without inflation is to be achieved.

The paper outlines a radical alternative to the standard narrative method used by post-Keynesians as well as by Keynes himself.

**Keywords:** Stocks and Flows, Social Accounting Matrices (SAM), Monetary Macroeconomics, Post-Keynesian Models

**JEL Classification:** E12, E17, E25

This paper sets out a rigorous basis for the integration of Keynes-Kaleckian<sup>1</sup> macroeconomics (with constant or increasing returns to labor, multipliers, mark-up pricing, etc.) with a model of the financial system (comprising banks, loans, credit money, equities, etc.) together with a model of the inflationary process.<sup>2</sup>

Mainstream macroeconomics (MM) is always based ultimately on some concept of equilibrium<sup>3</sup> with prices giving signals which either clear markets or (occasionally) fail to do so. A central contention of the paper will be that, with trivial exceptions, there are no equilibria (or disequilibria) outside financial markets<sup>4</sup> while the role of prices is to distribute the national income between wages, profits and creditors, with inflation sometimes playing a key role determining the outcome. Economies are organisms comprising interdependent activities which evolve sequentially through historical time in response to the circumstances in which they find themselves, and in accordance with the diverse motivations, constraints and resources of firms, governments, households, and banks.

The model deployed here<sup>5</sup> describes a growing economy which does not spontaneously find a steady state let alone an equilibrium, even in the long run, but which requires active management of fiscal and monetary policy if full employment without inflation is to be achieved.

Almost all the individual ideas deployed in what follows have antecedents in the canonical post-Keynesian literature and most of this paper might seem to be little more than a partial summary of what has gone before. That would be to miss the methodological departure which is being outlined here. Frank Hahn once told Nicky Kaldor, with good will, that his work was “poetry,” which we take to mean that it was not grounded in a rigorous and formal model of a complete system, capable of expression in a well-articulated mathematical model. We think that Hahn was right and that the same thing can be said of all the great pioneers of post-Keynesian thought. They were poets of the first order, with

---

<sup>1</sup> Major debts are to Hicks, Kaldor, Keynes, Minsky, and Tobin also to Geoffrey Harcourt, Warren Mosler, Gennaro Zezza, and Francis Cripps.

<sup>2</sup> An Eviews program to replicate results in this paper is available at <http://gennaro.zezza.it/software/eviews>.

<sup>3</sup> In a recent review of Geoffrey Ingham’s book *The Nature of Money*, Charles Goodhart remarks that Ingham “would dismiss many of the fundamental concepts of economics, e.g. long-run equilibrium, neutrality of money, natural rate of interest, etc., without providing any alternative structure.” In this paper, which is harmonious with the suggestions made in Pasinetti (2003) for the reinvigoration of Keynesian economics, it is our aspiration to adumbrate such a structure.

<sup>4</sup> The trivial exceptions are auctions for works of art, fish, etc.

<sup>5</sup> Nothing could be more different from the kind of empirical model currently in use, e.g. by the Bank of England, which postulates an unobservable “core” neo-classical growth model towards which the observed economy is assumed to be adjusting, the contingent lags being “discovered” by econometrics.

Keynes himself in the role of Shakespeare. The imaginative genius of both men was so towering that each in his own way changed the English language itself and also the way in which everybody thinks about the world.

What is being proposed here is a method which, though only a crude introduction, departs from the narrative method used by Keynes and his immediate progeny, with the sole exception of Richard Stone who created the Social Accounting Matrices (SAM) on which our work is largely based. Fundamental to our approach will be the presentation of a complete system of accounts in which all the major components of the national income and flow of funds (some thirty current price variables including money and equities) are represented in a matrix as transactions between sectors so that all sectoral inflows and outflows sum to zero and all financial balances cumulate so as to generate stock variables. From that starting point, a system of behavioral relations, describing processes occurring in historical time, will be specified which, while individually familiar, will build up into a single model capable of tracking how a whole economy might evolve through time, including every variable in the current price matrix as well as prices and every “real” variable of importance, conditional on a very small number of exogenous variables—namely real government expenditure, the average tax rate, the bill rate of interest and some representation of the way in which expectations are formed. As it stands, the model contains some eighty equations including identities. With some functions denominated in logs, and stock variables (generated endogenously) as arguments in many of the functions, the model is highly non-linear and an analytical solution is out of the question. Resort is therefore had to computer simulation. The quality of the model is to be judged by whether it solves, whether the accounting constraints are satisfied, whether it is stable over a range of parameters and whether repeated simulation, under alternative assumptions about exogenous variables and parameters, brings understanding about how real-life economies work, in particular how the financial system interacts with the “real” world of production, consumption, employment, etc. Unfortunately, the degree of understanding which can be achieved via this method cannot be adequately communicated by words and symbols alone. The full meaning of what is outlined here can only be reached by people who have, or are prepared to acquire, the appropriate degree of computer skills—just as mathematics is needed to understand general equilibrium theory. With some degree of such skill, it becomes possible to solve the model under a range of assumptions about exogenous variables and parameters so that it becomes an instrument to think with. The following matrix<sup>6</sup> sets out,

---

<sup>6</sup> The SAM in this form is derived from Backus et al. (1980).

using a double entry format, a simplified accounting framework which is yet complete in its own terms and also resembles, with some important qualifications, the world we can be seen to be actually living in.

***ELEMENTARY COMPREHENSIVE SYSTEM OF ACCOUNTS<sup>7</sup>***

	Households	Firms		Banks	CB	Govt.	E
		Current	Capital				
Pers. cons.	-C	+C					0
Govt. exp.		+G				-G	0
Investment		+I	-I				0
Inventory acc.		+IN	-IN				0
Wages	+WB	-WB					0
Firms' profits	+F <sub>d</sub>	-F	+Fu	+r <sub>l,1</sub> (L <sub>1</sub> -IN <sub>1</sub> )			0
Quasi stock appcn.		-r <sub>l,1</sub> IN <sub>1</sub>		+r <sub>l,1</sub> IN <sub>1</sub>			0
Interest on money	+ r <sub>m,1</sub> .M <sub>1</sub>			- r <sub>m,1</sub> .M <sub>1</sub>			0
Interest on bills	+ r <sub>b,1</sub> .B <sub>p,1</sub>			+ r <sub>b,1</sub> .B <sub>b,1</sub>		- r <sub>b,1</sub> .B <sub>1</sub>	0
Interest on bonds	+Bl <sub>1</sub>					- Bl <sub>1</sub>	0
Banks' profits	+Fb			-Fb			0
Taxes	-T					+T	0
<b>E</b>	<b>[V]</b>	<b>[0]</b>	<b>[FIN]</b>	<b>[0]</b>	<b>[0]</b>	<b>[DG]</b>	<b>0</b>
<b>Change in stocks of::</b>							
Cash	-)H <sub>p</sub>			-)H <sub>b</sub>	+)H		0
Money	-)M			+)M			0
Govt. bills	-)B <sub>p</sub>			-)B <sub>b</sub>	-)B <sub>cb</sub>	+)B	0
Govt. bonds	-)Bl.pb					+)Bl.pb	0
Loans			+)L	-)L			0
Equities	-)e.pe		+)e.pe				0
<b>E</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>

*N.B e describes the number of equity titles, pe their price. Bonds, Bl, are perpetuities—pieces of paper that each pay \$1 per annum with a price pb. V describes household wealth to which*

<sup>7</sup> All variables are measured at current prices. The major simplifying assumptions are that households do not invest or borrow, the economy is closed, firms don't issue bills, hold money, or pay tax, banks do not issue equity.

*capital gains (ignored here) must be added, FIN firms' external financing requirement and DG government debt.  $r_m$ ,  $r_l$  and  $r_b$  are interest rates on money, loans and bills.*

This economy is divided into five sectors—households, firms, banks, a central bank, and a government, each of which has distinct functions and objectives. The matrix describes the net transactions between all five sectors in some given period of time (say a year), measured at current prices. Everything comes from somewhere and everything goes somewhere, hence all rows and columns sum to zero. Each variable appears twice and will have to make behavioral sense in each place that it occurs.

Start with the first seven rows in the top half of the second column, written in bold characters. This list is nothing other than the national income identity comprising the major expenditure categories (government expenditure, personal consumption, and fixed investment) and flows of factor income (wages and profits). Every item in column 2 is revealed in the matrix as a transaction with another sector or with a different part of the same sector (e.g. when firms buy investment goods from other firms or profits are retained in the business) so a new column 3 has been created to record these capital transactions.

Every entry in the top half of the matrix is self-explanatory except for two unusual features. First, in column 2 the loan rate of interest multiplied by the opening stock of inventories has been substituted for conventional stock appreciation (aka inventory valuation adjustment). Second, interest payments by firms, other than with respect to loans for the finance of inventories, are included in line 6 as a component of distributed profits. The reasons for making these entries will be explained in those paragraphs in Section A below which deals, among other things, with the accounting of profits and the distribution of income.

The balances in line 9 show the sum of the columns up to that point. Column 1 shows personal saving, column 3 shows the external financing requirement of firms and column 6 shows the government's borrowing requirement.

The lower "flow of funds" half of the matrix shows exhaustively how these balances have counterparts in terms of transactions in stocks of assets and liabilities. Households acquire cash, credit money, two kinds of government security and newly issued equities, there being no other place for their wealth to be stored. Firms get any funds needed for finance in excess of retained profits by issuing equities and borrowing from banks. The government obtains finance to cover its deficit by issuing bills and bonds, the central bank issues cash and bills, and the banks deal with the non-bank private sector in cash and bills and also make loans to firms.

The disposition of households' wealth, including money, and of the components of firms' financing requirements, including loans, has led to the obvious need for a representation of a banking sector which makes the loans and creates the money.

This all seems very elementary. But nothing like it appears in any MM textbook which we know. Yet without it, it is impossible to understand how credit money comes into existence and fits, even at the level of accounting, into the macroeconomic system. And *a fortiori* it must be the case that those textbooks (or any other work not grounded in a similar complete accounting system) cannot encompass the essential role which money and credit fulfil in a modern industrial economy.

Note that in the flow of funds part of the matrix the existence of historical time has been introduced into the very system of concepts<sup>8</sup> since it describes changes in stock variables between the beginning and end of each period. We begin each period with one configuration of stocks, then the flow variables during the period heave the stock variables from their state at the beginning of the period to their state at the end to which must be added capital gains, which are not transactions. The system is thus designed to describe an evolutionary process and will generate neither an equilibrium nor a disequilibrium but rather a set of intelligible sequences.

The matrix below shows the interlocking system of balance sheets which is implied by the transactions matrix above and describes stock variables at the end of each period.

**SIMPLIFIED SYSTEM OF BALANCE SHEETS**

	Persons	Firms	Banks	CB	Govt	E
Fixed capital		+K				+K
Inventories		+I				+I
Cash	+H <sub>p</sub>		+H <sub>b</sub>	-H		0
Money	+M		-M			0
Govt. bills	+B <sub>p</sub>		+B <sub>b</sub>	+B <sub>cb</sub>	-B	0
Govt. bonds	+Bl.pb				-Bl.pb	0
Loans			+L			0
Equity	+e.pe	-e.pe				0
E	Wealth	Net Worth	0	0	Gvt. Dbt	I+K

*To derive the balance sheet variables from the flow variables an adjustment must be made for capital gains, more precisely  $\Delta(e.pe) = \Delta e.pe + \Delta pe.e.1$  and  $\Delta(Bl.pb) = \Delta Bl.pb + \Delta pb.Bl.1$*

---

<sup>8</sup> Emphasizing the crucial distinction historical and logical time made in Robinson (1962).

## HOW BITS OF THE MODEL WORK

The following sections outline the behavior and motivation of each of the five sectors. These will be followed by an assessment of how the postulated economy as a whole functions.

### Section A: The Decisions Which Firms Take

Firms continuously have to take a complex and interdependent set of decisions regarding output, investment, prices, employment, and finance. While this is familiar territory for post-Keynesians, the assumptions on which MM is based imply that these decisions can be totally ignored by economists. This is because MM assumes that there reigns an aggregate neo-classical production function with diminishing returns to labor plus perfect competition, in which case there exists at any time a profit-maximizing level of output with implied profit-maximizing levels of prices, wages, and employment which firms collectively are assumed to undertake. All profits are assumed (counterfactually) to be instantaneously distributed while the finance required for investment is assumed to be automatically forthcoming. Post-Keynesians stand aghast at this ubiquitous construction which, though extremely influential, is built on entirely counter-factual assumptions. They tell a different and, to those who actually look at the world, an infinitely more realistic story. Firms must continuously *decide* how much they are going to produce and what prices they will charge. These decisions will be based on the quantity they expect to sell at those prices and the change in inventories they intend to achieve. Firms must also decide how much fixed investment they will undertake depending (for instance) on their “animal spirits” and the existing pressure on capacity together with expectations about financial conditions and profitability. The stylized facts, which fit ill with every theory that postulates an aggregate neo-classical production function, are that, subject to an upward trend in productivity, there are roughly constant returns to labor in the long run and increasing returns in the short run. The demand for labor has an obvious implication for the wage bill which firms have to pay. Further stylized facts are that the prices which firms charge are insensitive to short-run fluctuations in aggregate demand, as argued in Coutts, Godley, and Nordhaus (1978) hence pro-cyclical fluctuations in demand and output tend to be associated with pro-cyclical fluctuations in profits. The prices set by firms must be consistent, not only with their expectation about the quantity they will sell (at those prices), it must also be such, relative to wage costs, as to generate enough profit to pay for some target proportion of their fixed investment while distributing enough



to satisfy shareholders and creditors.<sup>9</sup> Finally, the prices which firms charge, and the profits they hope to make and distribute, are not independent of the recourse which they must have to banks and financial markets as a residual source of funds for investment in fixed and working capital.

This whole syndrome of firms' decisions is represented in a crude and in some respects arbitrary way in the following formal model. We shall discuss, in turn, firms' decisions regarding output and employment, investment, pricing, and financing requirements—and in a later section the interactions between these decisions and the monetary system. While the modeling of behavior is crude, the accounting is solid and we shall reach conclusions which, when integrated into sub-models of other parts of a closed economy, will reveal some key features of the *modus operandi* of a modern industrial economy together with an account of the financial system and credit money. The main purpose of having a formal model, based on transactions accounts which have no black holes, is that one is forced to consider how each part of an economic system is interconnected with every other part.<sup>10</sup> For instance, pro-cyclical productivity combined with normal cost pricing must have counterparts in the monetary system since the sudden increase in profits when demand rises is likely to reduce the demand for loans without there being a comparable fall in the demand for money, thereby threatening banks' profits.

This paper is not designed to answer any empirical question, but rather to adumbrate a methodology and set a research agenda.<sup>11</sup> We are all too conscious of our failure to address a number of fundamental issues properly, for instance the full role of expectations and speculative activities<sup>12</sup> and the question of how whole sectors can be motivated to act as though they were individual agents.

In what follows, lower case stock and flow variables will be used to denote volumes, or “real,” variables. Conventional national income concepts make it difficult though not (quite) impossible to analyze firms' behavior with respect to mark-up pricing. The national accounts measure “real” flows by revaluing nominal final sales at base year prices and by

---

<sup>9</sup> The line of argument here accords with an enormous body of theoretical work, notably by Kalecki and Kaldor. Select references are supplied at the end.

<sup>10</sup> Keynes knew all about this since he emphasizes (GT p 297) that when analyzing a particular problem we should keep all related problems “at the back of our heads.” We are hoping that the computer makes it possible to do this in a formal way and even to bring those problems round to the front of the minds of lesser mortals.

<sup>11</sup> In the account of the model which immediately follows equations are presented in a way designed to facilitate the argument. The appendix will contain every equation needed for a solution of the model, including identities.

<sup>12</sup> Account must in due course be taken of the major insights in Kaldor (1939).

revaluing nominal inventory accumulation at base year cost, with price and cost deflators both equal to 100 in the base year. It therefore becomes difficult to derive expressions which capture the idea that the value of final sales is higher absolutely than what it cost to produce what was sold.<sup>13</sup> We are going to adopt an alternative way of thinking about quantities and prices, postulating that all decisions relating to consumption, fixed investment, inventory accumulation and production are taken in terms of physical quantities (numbers of machines, shoes, cars, etc.) and that prices and costs are denominated as \$s per unit. How are these diverse objects to be added together? They will be brought into equivalence using relative prices in a base year so that *changes* in aggregated quantities are the same as with conventional measures.

If volumes are to be measured as physical quantities, what collective name can be used for them? We propose to say that quantities are to be thought of as “T’s” (tonnes?). Thus the value of consumption, C, may be written as  $C = c.p$  and fixed investment as  $I = i.p$  where the lower case symbols describe the number of T’s purchased and p is the unit price measured in \$’s per T. On the other hand—and this is the key point—the value of inventories at the end of each accounting period (assuming this to be longer than the production period) is the number of T’s produced but not yet sold times the unit *cost* of their production,  $IN = in.UC$ , where UC is a sum of money, namely the wage bill per T. The first ten equations deal with the way in which aggregate supply is brought into equivalence with aggregate demand *via* a quantity adjustment process which dispenses altogether with the assumption common to all MM theory that equivalence is brought about *via* the adjustment of prices.

Firms’ *output* decision is assumed, in 1), to depend on the sales volume they expect to achieve plus the change in inventories they hope to bring about. That is

$$y = s_e + \Delta in^* \quad 1)$$

where y is the number of T’s to be produced,  $s_e$  is the number of T’s which firms expect to sell (the subscript denoting expected or planned values), in is the number of T’s held in inventory, the star (here and elsewhere) denotes an intention and  $\Delta$  is a first difference operator. We thus start out with a relationship between aggregate demand and supply which, as Hicks noted in (1989) defies the equilibrium condition on which the entire MM structure depends.

---

<sup>13</sup>Francis Cripps did it in Appendix 9.1 of Godley and Cripps (1983). However Cripps’s exposition was nigh on impenetrable because he restricted himself to the use of conventional deflators to measures real sales and real costs.

The output decision has a direct implication for desired employment,  $N$ , which, in 2), is assumed to depend on output and exogenous productivity

$$N^* = y/pr \quad 2)$$

where  $pr$  is normal, or steady state, productivity which is assumed to grow through time at a constant rate.

Actual employment follows a partial adjustment process towards its steady state relationship to output.

$$\Delta N = 0.(N^* - N_{-1}) \quad 3)$$

In this way there will be a short term increase in productivity when output rises above trend in accordance with a well established stylized fact.

Normal productivity is assumed, in 4), to increase at the rate  $prg$

$$pr = (1 + prg).pr_{-1} \quad 4)$$

and in 5) the wage bill,  $WB$ , is the nominal wage rate times employment

$$WB / W.N \quad 5)$$

where  $W$  is the wage rate measured in \$ per person per year.

$$s_e = s_{-1}.(1+prg+ra1) \quad 6)$$

In the simulation model it has been assumed, in 6), that expected sales are given by last period's sales times (one plus) the normal growth rate of productivity,  $prg$ , plus a random variable,  $ra1$ . This equation is not to be interpreted literally; it is a device to demonstrate that even when sales expectations are very disorderly, so long as they are not formed in a perverse way (as would happen if previous errors were systematically compounded), the inventory adjustment process will ensure that mistakes are eventually corrected.

$$i^{**} = \Delta .s_e \quad 7)$$

In 7) we postulate a desired long-run ratio of inventory to sales ratio with both variables measured in  $T$ 's. This long-run inventory-sales ratio is denoted by the double star while the short run intended inventory adjustment towards its long-term value is assumed to follow the partial adjustment process described in 8).

$$\Delta i^* = T.(i^{**} - i_{-1}) \quad 8)$$

Finally, realized inventories will be determined in 9) by the expected inventory level less any excess of realized sales over what was expected.

$$i = i^* - (s - s_e) \quad 9)$$

Realized sales are given by the sum of final sales

$$s / c + i + g \quad 10)$$

where  $c$  is real consumption,  $i$  is real fixed investment and  $g$  is real government expenditure.

These equations are sufficient to ensure that the level of inventories, though always vulnerable to errors in expectations in the short run, will generally be moving towards a desired ratio to realized sales. This is because when realized sales exceed expected sales, there will be a fall in inventories which leads to higher production in the succeeding period and a new inventory level and so on.

Next, regarding the *investment* decision, the choice of function will again be arbitrary. The purpose here is not to argue for one specification against another but to show how, given the investment decision, firms have to validate it by successfully generating the needed finance.

It will be assumed that the investment decision is such as to make the capital stock,  $k$ , grow at the rate  $gk$

$$k = k_{-1} \cdot (1 + gk) \quad (11)$$

Out of an endless range of possibilities, we have assumed, following Santos and Zezza (2005),

$$gk = g_0 + P \cdot u_{-1} - (r_{rl} \quad (12)$$

where  $g_0$  is a constant,  $u$  is capital utilization,  $y/k$ , and  $r_{rl}$  is the real rate of interest

$$r_{rl} / (1 + r_l) / (1 + B) - 1 \quad (13)$$

where  $r_l$  is the loan rate of interest,  $B$  is the inflation rate,  $p/p_{-1}$ , and  $p$  is the price level.

Total (real) gross fixed investment,  $i$ , must include depreciation of the capital stock

$$i = \delta k + k_{-1} \quad (14)$$

where  $\delta$  is the depreciation rate.

And so we come to firms' *pricing* decision. The expected value of sales is given by the expected volume of sales times the price

$$S_e = s_e \cdot p \quad (15)$$

But what is the price?

In the conventional national accounts profits,  $F$ , are defined by the residual

$$F \equiv S - WB + \Delta IN - SA \quad (16)$$

that is, the value of total sales,  $S$ , less wages,  $WB$ , plus the change in value of inventories,  $\Delta IN$ , less stock appreciation,  $SA$ . National income statisticians deduct stock appreciation from profits because it is a component of the income flow to which no production corresponds, so its deduction has the convenient property that it makes the total value of the income flow exactly equal to that of production. But what we, as economists, need is a definition of

profits which describes the amount of money which can be extracted from a set of business operations period by period while leaving its balance sheet intact—although distribution of profits in full cannot take place without borrowing from outside the sector against the collateral afforded by the increase in the value of inventories and the capital stock. In accordance with the transactions matrix presented above, profits in the form of extractable surpluses are given by the residual

$$F \equiv S - WB + \text{IN} - r_l \cdot \text{IN}_{-1} \quad (17)$$

where  $r_l$  is the loan rate of interest. The meaning of the final term is that, since production takes time, firms must accumulate inventories before sales take place, so firms incur an unavoidable interest charge whether or not they have individually borrowed to finance their inventories. For even if individually they finance inventories out of own funds, unless they realize that the interest charge (which they owe to themselves) must be taken into account before profits are struck, they can be led into serious error regarding the viability of their business operations—errors which can lead to bankruptcy, particularly under circumstances of hyperinflation. This was notoriously the case during the pre-war hyperinflations and the same thing probably started to happen in the UK during the so-called “profits crisis” in the mid seventies. For the sector as a whole it must be assumed that inventory accumulation (gross of stock appreciation) is financed by borrowing from banks and hence that the relevant interest payments are actually paid to banks—and this is what appears in the transactions matrix and in our formal model.

It is easy to show<sup>14</sup> that 17) is equivalent to

$$F \equiv S - (1 - \alpha) s \cdot UC - (1 + r_l) \dots s \cdot UC_{-1} \quad (18)$$

where  $s$  is the number of T's sold this period and  $\alpha$  is a variable describing the proportion of sales this period which were fabricated last period. The intuition is that profits are equal to the value of sales less what it cost historically to produce the goods sold less the unavoidable

<sup>14</sup> To save the reader time, the steps between 17) and 18) are spelled out below. The last two terms on the RHS of 17) may be rewritten

$$\text{IN} - r_l \cdot \text{IN}_{-1} / \text{in} \cdot UC - (1 + r_l) \cdot \text{in}_{-1} \cdot UC_{-1}$$

or, defining the variable  $\alpha = \text{in}_{-1} / \text{in}$  (i.e. the proportion of T's sold this period but produced last period) we have

$$\text{IN} - r_l \cdot \text{IN}_{-1} / \text{in} \cdot UC - (1 + r_l) \cdot \alpha \cdot s \cdot UC_{-1}$$

Total production this period is equal to T's made and sold this period,  $(1 - \alpha) \cdot s$ , plus T's made but not sold this period – i.e the end period inventory – so

$$y / \text{in} + (1 - \alpha) \cdot s$$

The total dollar cost of producing  $y$  – this year's output of T's – which is equal to the wage bill, can therefore be written

$$WB / y \cdot UC / \text{in} \cdot UC + (1 - \alpha) \cdot s \cdot UC$$

So we can now rewrite equation 17) in the text as

$$F \equiv S - \text{in} \cdot UC - (1 - \alpha) s \cdot UC + \text{in} \cdot UC - (1 + r_l) \cdot \alpha \cdot s \cdot UC_{-1}$$

which, after a minor simplification, yields 18) above.

interest cost of having held inventories. And this is the definition of profits, in the form both of 17) and of 18), which will be adopted in this paper.<sup>15</sup>

Next, note that, reading horizontally line 6 in the transactions matrix, total profits are made up of three components, by identity

$$F / Fu + Fd + rl_1.(L_{d-1} - IN_{-1}) \quad 19)$$

namely undistributed profits,  $Fu$ , distributed profits,  $Fd$ , and the payment of interest on loans other than those generated by inventories.<sup>16</sup> Of these components, the final term is a charge which will already have been determined at the time the pricing decision is made.

Next, let's suppose that distributed profits are determined as some proportion of profits earned last period

$$Fd = N.F_{-1} \quad 20)$$

and that planned undistributed profits pay for some proportion of nominal fixed investment,  $I = i.p$ , the previous period.

$$Fu_e = (1 - N3).L_{-1} \quad 21)$$

What mark-up will achieve the required level of profits?

First recall equation C)—the profits identity—but inverted to make it an equation in sales

$$S / F + (1 - \cdot) s.UC + (1 + rl_1)..s.UC_{-1} \quad 22)$$

which may be re-written using a mark-up expression

$$S / (1 + \Phi\text{bar}).[(1 - \cdot) s.UC + (1 + rl_1)..s.UC_{-1}] \quad 23)$$

where  $\Phi\text{bar}$  is a ratio measured *ex post*

$$\Phi\text{bar} / F / [(1 - \cdot) s.UC + (1 + rl_1)..s.UC_{-1}] \quad 24)$$

$$/ F/HC \quad 25)$$

where  $HC$  is historic costs, implying profits as a share of sales

$$F/S/ \Phi\text{bar}/(1+\Phi\text{bar}) \quad 26)$$

Now divide 23) through by  $s$ , the volume of sales, to obtain prices defined as a mark-up on historic unit costs

$$p / (1 + \Phi\text{bar}) [(1 - \cdot).UC + (1 + rl_1)..UC_{-1}] \quad 27)$$

$$/ (1 + \Phi\text{bar}).HUC \quad 28)$$

where  $HUC$  is historic unit costs.

---

<sup>15</sup> The two formulae 16) and 17) would only be equal to one another if the rate of cost inflation were exactly equal to loan rate of interest (i.e. if  $rl = \cdot UC / UC_{-1}$ ) which will normally not be the case—indeed sometimes the two will differ substantially e.g. if inflation rises suddenly by a very large amount.

<sup>16</sup> Interest payments on inventories have already been (negatively) subsumed in the definition of profits.

Now *so long as expectations about sales are fulfilled*, the mark-up which would exactly generate the profits required, adapting 25), is given by  $\Phi^*$  where

$$\Phi^* = F_e / HC_e \quad (29)$$

and required profits,  $F_e$ , are

$$F_e = Fu_e + Fd + rL_{.1} \cdot (Ld_{.1} - IN_{.1}) \quad (30)$$

Also, adapting 24), expected historic unit costs are

$$HC_e = (1 - .e) \cdot s_e \cdot UC + (1 + rL_{.1}) \cdot .e \cdot s_e \cdot UC_{.1} \quad (31)$$

and the ratio of opening inventories to expected sales is

$$.e / in_{.1} / s_e \quad (32)$$

Our hypothesis is that initially firms determine actual prices by making a rule of thumb mark-up,  $\Phi$ , (unadorned with bar) on “normal” historic unit costs, NHUC. The initial rule of thumb will be based on business know-how and past experience.

$$p = (1 + \Phi) NHUC \quad (33)$$

where NHUC is entirely composed of items which firms know

$$NHUC = (1 - .c) NUC + (1 + rlc) \cdot .c \cdot NUC_{.1} \quad (34)$$

where  $.c$  is a constant based on some past average ratio of inventory to sales,  $rlc$  is some estimate of the normal rate of interest and NUC, normal unit cost, is the nominal wage rate divided by trend productivity

$$NUC = W/pr \quad (35)$$

The rule of thumb mark-up,  $\Phi$ , will not, in general, generate the required level of profits. So to the extent that profits are too high or too low we assume that firms adopt a partial adjustment process

$$\dot{\Phi} = \Lambda(\Phi^* - \Phi_{.1}) \quad (36)$$

so that, while production adjusts to accord with actual sales as described in equations 7) – 10), the conventional mark-up also adjusts so to generate the required amount of profit. Thus the system is always moving towards a hypothetical full steady state where  $\Phi = \Phi^*$  so ensuring that profits are generally sufficient to pay for investment as well as dividends and interest.

Time lags between costs and prices are constrained by stock/output ratios as argued out in Coutts, Godley, and Nordhaus (1978) and again in Godley and Cripps (1978). But this has been ostentatiously ignored by econometricians who treat time lags as entirely contingent and entirely a matter for them to “discover” without apparently realizing that the relationship between costs and prices has precise and centrally important implications for the distribution of income.

The rules of thumb which firms adopt will never exactly succeed in generating the required profit because sales, inventories, and interest rates will all undergo unexpected short-term variations. To derive a representation of realized profits (which solution of the model obviously requires) we simply write in the profits identity devoid of any term in expectations and including the actual loan rate of interest, as already shown in equation B) above which is reproduced (and renumbered) here for completeness

$$F \equiv S - WB + )IN - r_{l,1}.IN_{-1} \quad (37)$$

Finally, coming to the firm sector's *financial requirements*—while planned profits pay for last period's fixed investment, this still leaves a residual financing requirement to fund inventory accumulation, the initial cost of this year's fixed investment and any shortfall of realized compared with planned profit. It will be assumed, in accordance with the stylized fact, (at least in the U.S. during recent years), that firms only finance a small fraction of their investment via the sale of new equities

$$)e_{s,pe} = N3.I_{-1} \quad (38)$$

Consequently in 39) the residual financing requirement is met by borrowing from banks over which firms, in the short run, have no direct control.

$$)L_d = I + )IN - Fu - )e_{s,pe} \quad (39)$$

where  $L_d$  describes required bank loans and all the RHS variables describe realized, not planned or expected, values.

Consider what happens if expectations are not fulfilled. There will be windfall profits or losses resulting (as written here) in an immediate shock both to inventories and to the need for residual financing  $)L$ . Lets imagine what happens if sales turn out lower than expected. If this happens for a temporary reason, the consequences are not very large or important. The postulated response of inventories will soon set everything to rights so long as loan finance is indeed forthcoming. But if the sales shortfall is permanent, and unless firms modify their behavior, total profits and distributed profits will both be lower than planned and firms will find that they have a growing liability to the banks with the rise in interest payments which this implies. It is rising indebtedness which is the binding constraint which forces firms to modify their behavior—there has to be some mixture of cutting production, employment, investment, issue of equity, or some modification to the mark-up.



## Section B: Inflation—A Preliminary Sketch

We cannot aspire to cover this enormous subject<sup>17</sup> at all thoroughly. All we do here is show how one plausible account of how the key processes look when integrated into a model of a whole economic system.

It may be as well to start with the account in Layard, Nickell and Jackman (1991) hereafter LNJ. The basic LNJ story is, seemingly, quite a simple one. On p12, their claim is that

“[S]table inflation requires consistency between

- a) the way in which wage setters set wages ( $W$ ) relative to prices ( $P$ ) and
- b) the way in which price setters set prices ( $P$ ) relative to wages ( $W$ )

Only if the real wage ( $W/P$ ) desired by wage setters is the same as that desired by price setters will inflation be stable.”

The key process deployed by LNJ is one in which there is a “price mark-up” defined simply as the ratio (using our notation)  $p/W_e$  and a “wage mark-up” defined as  $W/p_e$ . In the contention of LNJ

“If a worker produces 100 units of output priced at \$1 and wage setters set his wage at \$60, then the worker gets 60 units of output and profit receivers get 40 units per worker. But if wage-setters aim at 61 units ( $W/p=61$ ) and price setters aim to provide profits per worker equal to 41 units ( $W/p=59$ ) we have an inconsistency. This leads to a wage-price spiral, as wage-setters try to recoup the loss imposed on them by price-setters, and vice versa.”

This statement, which lies at the heart of the LNJ story, seems simple enough, but it falls apart on closer examination. The terms  $p/W_e$  and  $W/p_e$  are not really “mark-ups” at all, whereby something is sold at a price higher than what it cost to buy; rather they describe the real wage itself expected by respectively price setters and wage setters. In particular  $p/W_e$  carries no implication as to what profit firms aim to achieve and LNJ give no explanation of why firms should formulate their target in terms of profits per worker—a meaningless objective. It is hard to see how the real wage rate for an individual worker (61 real units out of an arbitrary total of 100) can be translated into a demand for a money wage rate which could be put forward by a union negotiator on behalf of a whole industry. And there is no characterization of how, exactly, the wage-price spiral is supposed to play out in terms of sequences in time.

---

<sup>17</sup> The “conflictual” theory of inflation was pioneered (in particular) by Bob Rowthorn (1977).

The fundamental defect of the LNJ story (as that of Phelps and Friedman in their earth-shaking contributions to the debate) is that it is not grounded in a fully articulated macroeconomic model. This grounding is attempted in the passage which follows.

We start with an analysis how the real national income is distributed.

Starting with the identity already derived in 27)

$$p \equiv (1+\Phi\text{bar})[(1 - \cdot) \cdot UC + (1+rl_1)\dots UC_{-1}] \quad 27)$$

where  $\Phi\text{bar}$  is the mark-up measured *ex post* without any behavioral significance. Next define the real rate of interest defined with respect to cost inflation,  $rrc$

$$rrc / (1 + Bw)/(1+rl_1) - 1 \quad 40)$$

where  $rl$  is the loan rate of interest and the rate of cost inflation is  $Bw / )UC/UC_{-1}$ .

This may be substituted into 27 ) to obtain

$$p / (1+\Phi\text{bar})(1 + \cdot rrc) \cdot UC \quad 41)$$

Divide through by  $p$  to get the adding-up identity

$$1 / (1+\Phi\text{bar})(1 + \cdot rrc) \cdot uc \quad 42)$$

where  $uc$  is real wages per T, and then multiply by total output

$$y / (1+\Phi\text{bar})(1 + \cdot rrc) \cdot w \cdot N \quad 43)$$

where  $w$  is the real wage rate.

Equation 43) divides real output in each period exhaustively in a *three way split*<sup>18</sup> between real profits, real wages, and real interest payments in such a way that no one of these shares can change without an equal and opposite change in the sum of the other two. The extent to which inflation alters the distribution of the real national income depends on the extent to which these various shares can be protected. The share of real interest can be important when inflation is high and variable<sup>19</sup>. It should be noted in advance that discussion of the causes and consequences of inflation must not be confined to the way in which conflicting claims on real income are resolved. Inflation will change the size and distribution of real wealth and it cannot be assumed that the level of output, as distinct from its distribution, will not be changed by its onset.

How are wage rates determined? We assume, realistically, that wage rates only change at discrete intervals of time and, for convenience, that they only change at the beginning of each period.

---

<sup>18</sup>See Graziani (2003).

<sup>19</sup> See Godley and Cripps (1983) Chapter 10 for a full discussion.

In the preceding period, the real wage rate was  $w_{-1} (= W_{-1}/p_{-1})$ . It is assumed, first, that workers come to the bargaining table with an aspiration to obtain a real wage rate  $w^*$  valued at the price level ruling at the time the settlement is to be negotiated, the size of which depends on the pressure of demand for labor and on the level of labor productivity.

$$w^* = \Delta 0 + \Delta 1 \cdot \mathbf{pr} + \Delta 2 \cdot \mathbf{N}/\mathbf{Nfe} \quad (44)$$

where  $Nfe$ , the supply constraint of the whole economy, means the employment that would obtain at “full employment” and the bold characters denote logarithms. It is assumed that some proportion,  $\Delta 3$ , of the real wage aspiration is achieved.<sup>20</sup>

$$)W = \Delta 3 \cdot (w^* \cdot p_{-1} - W_{-1}) \quad (45)$$

According to our theory, the price will be set equal to the conventional mark up on normal historical unit costs reproduced below

$$p = (1 + \Phi)NHUC \quad (46)$$

and we assume that this mark-up will have been adjusted so as to approximate quite closely to that proportion which will generate the profits which will be just right—a sum of money that will be roughly equal to the amount required for dividends, the required proportion of fixed investment and interest payments on debt. The important point here is that firms can choose a mark-up on historical unit costs which will generate the desired ratio of profits to sales during this period—and hence necessary profits themselves—so long as expectations about the volume of *sales* turn out to be correct. Firms’ expectations about future wage rates need not come into the story; it is only historic normal unit wage costs which are relevant and firms always know what these are.

Taking these wage equations in combination with the price equations, we can now establish a coherent series of sequences in time. Workers obtain awards at discrete intervals. They have a real wage target, in principle measurable as a money wage rate divided by the price of  $T$ ’s, which rises through time with productivity and which is also influenced by the pressure of demand for labor (as well as other, perhaps political, factors). Workers succeed in getting a money award which goes some way towards meeting their immediate real wage aspiration. Then firms fix prices as a mark-up on normal historic costs which will erode some part of the real wage at the time the last bargain was struck. This sequence of events

---

<sup>20</sup> An alternative and more popular but, we believe, less plausible theory is that the nominal value of the real wage aspiration uses expected prices to revalue it. The two theories are mutually exclusive. If the nature of the bargain were to be such that the real value of wages recoups what was lost since the last settlement and also to anticipate loss of real income as a result of future inflation the whole process blows up. (Neither of us has ever been party to a wage bargain in which expected inflation was a factor!)

ensures that firms get the profits they need and that real wages always rise by something close to the normal rise in productivity in the economy as a whole.

The fact that the real value of the money wage bargain is partially eroded between settlements does not necessarily mean that workers' expectations about their real wages over the forthcoming period have been disappointed. It is more likely that they come to expect the thing that normally does actually happen, given that settlements occur at discrete intervals while inflation is continuous, namely that there turns out to be a rise in real wages which roughly matches the rise in productivity in the economy as a whole. The outcome of the wage bargaining processes in terms of inflation will obviously be dependent on the quasi-parameters  $\Delta 2$  and  $\Delta 3$  which may be very different at different times.

Inflation under these assumptions does not necessarily accelerate if employment stays in excess of its "full employment" level. Everything depends on the parameters and whether they change. If  $\Delta 2$  turns out to be constant then a higher pressure of demand will raise the inflation rate without making it accelerate. On the other hand inflation will accelerate if the value of  $\Delta 2$  rises through time or if the interval between settlements shortens.

In our simulation model we have assumed that firms always successfully apply that mark-up which secures the share of real output they need to carry on business, normally making real wages the residual. But it is recognized that lots of things can change the story. If the economy is an open one, firms may be unable to retain the mark-up without a reduction in sales while import prices may affect the total cost of production. Wages may come to be partially or wholly indexed in which case the whole process may accelerate out of control, and so on.<sup>21</sup>

While the model as it stands contains these mechanical equations we believe the real-world process to be far more contingent. Indeed the evidence relating to the UK with regard to the years prior to 1975 as well as the last few years supports the view that there is quite a range of values of  $N/N_{fe}$  within which the inflation rate will be unmoved (or will move perversely).

---

<sup>21</sup> Many of these possibilities were elaborated in Godley and Cripps (1983) Chapter 10.

### Section C: Decisions Taken By The Household Sector

Households' allocate expected disposable income between consumption and wealth accumulation while simultaneously allocating wealth between the various assets listed in the accounting matrices. As households' expected income is always different from realized income there must be a flexible component in the wealth allocation process which takes up any slack. Cash is not a good candidate for this role in the days of credit cards and banks. A better candidate is credit money which acts as the passive variable giving signals in much the same way as inventories give to firms.

The consumption decision is determined by expected real disposable income,  $y_{pd}$ , and the inherited stock of real wealth,  $v$ .

$$c = \forall 1.y_{pd}e + \forall 2.v_{-1} \quad (47)$$

The demand for cash,  $H_{pd}$  is assumed to be related to nominal consumption

$$H_{pd} = \delta c.C \quad (48)$$

So investable wealth,  $V_n$ , is given by total wealth,  $V$ , less cash

$$V_n = V - H_{pd} \quad (49)$$

Assets are allocated according to Tobinesque principles.

$$[M_d^* = V_{n-1}(\delta_{10} + \delta_{11}.rm_{-1} - \delta_{12}.rb_{-1} - \delta_{13}.rbl - \delta_{14}.rk_{-1} + \delta_{15}.Y_{pd}/V)] \quad (50)$$

$$B_{pd} = V_{n-1}(\delta_{20} - \delta_{21}.rm_{-1} + \delta_{22}.rb_{-1} - \delta_{23}.rbl - \delta_{24}.rk_{-1} - \delta_{25}.Y_{pd}/V) \quad (51)$$

$$Bl_{d.pb} = V_{n-1}(\delta_{30} - \delta_{31}.rm_{-1} - \delta_{32}.rb_{-1} + \delta_{33}.rbl - \delta_{34}.rk_{-1} - \delta_{35}.Y_{pd}/V) \quad (52)$$

$$e_{d.pe} = V_{n-1}(\delta_{40} - \delta_{41}.rm_{-1} - \delta_{42}.rb_{-1} - \delta_{43}.rbl + \delta_{44}.rk_{-1} - \delta_{45}.Y_{pd}/V) \quad (53)$$

where  $Y_{pd}$  is nominal disposable income, where the sum of constants is equal to one and the sum of every other column is zero.

The price of bonds,  $pb$ , is the inverse of the long rate of interest,  $rbl$

$$pb = 1/rbl \quad (54)$$

The rate of return on equity,  $rk$ , is

$$rk = F_d/(e_{-1}.pe_{-1}) \quad (55)$$

The demand for equities given in 53) has to be confronted with the supply of equities arising from firms' needs in 38), which gives rise to the model's only equilibrium condition namely

$$e_d = e_s \quad (56)$$

which determines the price of equities in 53).

$M_d$  has a star in 50) to denote that it is a planned quantity and the signs denote that this is positively related to the money rate of interest. But the punch line of the whole exercise is that the "demand" for money measured *ex post*, while fulfilling one of its traditional roles as the means of payment, will also be the residual which reconciles expected

with actual outcomes and which gives an important signal regarding the future adjustment both of portfolios and of consumption, in a manner comparable with the way in which inventories reconcile actual with expected sales by firms.

$$M_d / V - H_p - B_p - B_l.pb - e.pe \quad 57)$$

where all the terms on the RHS are realized outcomes and hence have no demand or supply subscripts.

For completeness the equations (mainly identities) which generate real disposable income and wealth are given below

$$Y_p / F_d + F_b + W_B + r_{m.1}.M_{.1} + r_{b.1}.B_{p.1} + B_{l.1} \quad 58)$$

where  $Y_p$  is personal income and  $F_b$  describes bank profits to be discussed below.

$$T = 2.Y_p \quad 59)$$

where  $T$  is the yield of taxes.

Nominal disposable income,  $Y_{pd}$ , is

$$Y_{pd} = (1 - 2).Y_p \quad 60)$$

and real disposable income,  $y_{pd}$ , is

$$y_{pd} = Y_{pd}/p - \Delta p.v_{.1}/p \quad 61)$$

The change in the stock of nominal wealth stocks includes capital gains

$$\Delta V / Y_{pd} - C + \Delta pb.B_{l.1} + \Delta pe.e_{.1} \quad 62)$$

The real stock of wealth,  $v$ , is

$$v / V/p \quad 63)$$

Expected real disposable income is generated in the computer model, like expected sales by firms, using a random variable

$$y_{pd_e} = y_{pd.1}.(1 + pr + ran2) \quad 64)$$

As was the case with sales expected by firms, there is no pretense that equation 64) describes how households really form expectations about incomes. The purpose will be to show how the banks can handle the fluctuating demand for money which arises when expectations are disorderly.

#### **Section D: Decisions Made By The Government, The Central Bank And Commercial Banks**

It may help if we start with an arithmetical example, in advance of the equation system, which gives an instance of how the monetary merry-go-round can work. Assume that for some reason households change their asset preferences, everything else being held constant, so that they decide to hold \$100 [1] more in the form of credit money and therefore \$100

less in the form of government securities, in the example [2 & 3] split evenly between bills and bonds.

**PART OF THE BALANCE SHEET MATRIX**

	Households	Firms	Banks	CB	Govt	E
Cash			+10 [5]	-10 [7]		0
Money	+100 [1]		-100 [4]			0
Govt. bills	-50 [2]		+90 [6]	+10 [8]	-50 [10]	0
Govt. bonds	-50 [3]				+50 [9]	0
Γ	0	0	0	0	0	0

If this happens, there have to be seven simultaneous changes in the balance sheets of commercial banks, the central bank and the government. First, the money “owed” by banks must obviously, by [4], rise \$100 which, being a liability, appears as a negative item. Assuming the fractional reserve ratio (set at 10%) is obeyed immediately, the banks’ holdings of cash will rise \$10, by [5]. By their balance sheet identity, the banks must therefore, by [6], acquire bills worth \$90. By the horizontal identity at the top, the central bank must [7] have reduced its vault cash by \$10 so, by [8], it must have increased its holdings of bills by \$10. The government has bought, by [9], \$50 worth of bonds which implies, since its total debt is given, that it must, by [10], have withdrawn \$50 worth of bills—the exact amount which makes both line 3 and column 5 sum to zero.

The counterpart equation system is as follows. It will be assumed that bill and bond rates of interest are both held constant, which is another way of saying that all supplies of assets passively match all demands.

The balance sheet of commercial banks is

$$Bb_d / M - Hb - L \tag{65}$$

where Bb and Hb are respectively bills and cash held by banks. We first account for each item in 65).

Banks are required to hold a certain ratio of their assets to their total liabilities in the form of cash.

$$Hb_d = \Delta.M_s \tag{66}$$

Banks accommodate households’ demand for cash, whatever that turns out to be, normally in exchange for credit money.

$$Hp_s = Hp_d \tag{67}$$

By the argument of equation 56), the “demand” for credit money by households is a residual number, being what households are left with after they have made their decisions

with respect to their (previously unexpected) receipts of income and their expenditure on goods and services also their purchases of bills, bonds, and equities plus acquisitions of cash. It is assumed that banks will always credit (debit) the account of a householder who receives (pays) a check from (to) another party, including the government, or exchange credit money for cash and vice versa. But when we say that banks accommodate households in this way, their function is not well described by saying that they are “supplying” money to households, and the whole notion of a supply of credit money which is distinct from demand is chimerical in the extreme, as Kaldor used to maintain so vehemently.

$$M_s = M_d \quad (68)$$

Similarly it is implicit in our account of firms’ behavior that the demand for loans is a residual financing requirement which is only precisely known at the end of each period, when inventory changes will have reconciled actual with expected sales. And this too has to be accommodated by banks, noting that there is automatically collateral, mainly in the form of inventories.

$$L_s = L_d \quad (69)$$

Meeting these demands, banks collectively are left with a residual requirement for cash and bills which is met automatically by the central bank though perhaps at a penal rate of interest.

$$Bb_s = Bb_d \quad (70)$$

$$Hb_s = Hb_d \quad (71)$$

The government must decide how much it is going to spend,  $G = g.p$ , and the proportion of personal income it is going to take in tax. It must also pay interest on its debt, as shown originally in the transactions matrix, and it must match any shortfall of receipts compared with outlays by issuing bills and bonds.

$$)B_s / G - T + rb_{-1}.B_{-1} + Bl_{-1} - )Bl_s pb \quad (72)$$

where  $Bl$  describes bonds (perpetuities) and  $pb$  is their price.

The bond supply matches demand, given long interest rates

$$Bl_s = Bl_d \quad (73)$$

There are three places that the total bill supply can go to, namely banks, the central bank, and households

$$Bb_s = B_s - Bp_s - Bcb_s \quad (74)$$

and, given the bill rate of interest, all demands are matched passively by supplies

$$Bp_s = Bp_d \quad (75)$$

$$Bcb_s = Bcb_d \quad (76)$$

$$Bb_s = Bb_d \quad (77)$$



The balance sheet of the central bank, the economy being closed, is simply

$$B_{cb_d} = H_s \quad (78)$$

where  $B_{cb}$  describes bills held by the central bank and  $H$  is the total supply of cash.

Cash is supplied on demand to households and banks

$$H_s = H_{p_d} + H_{b_d} \quad (79)$$

At the end of this tedious recital of demands and supplies we reach a point of supreme importance. We are faced with a double-headed paradox. We have two equations, (74) and (77), in  $B_{b_s}$ . We also have equations both in the supply of bills to the banks, described in (77) and in the demand for bills by banks, (65), two quantities reached by quite distinct routes. It might for a moment be supposed that an equilibrium condition is required to bring supply into equivalence with demand and thereby, conceivably, making the bill rate of interest endogenous. But no such equilibrium condition is required. We have reached the point at which every other demand has been matched by supply, and therefore under quasi-Walrasian principles, this last equation must hold as well by the logic of the comprehensive accounting system, without any equation to make this happen. So the solution to the problem is simply to drop (77) from the computer model. The equality between demand and supply for bills from and to banks is the inconspicuous headstone which validates the entire structure and breathes life into it.

Our definition of banks' profits, which ignores commissions and administrative costs, is simply the sum of interest receipts less the sum of interest payments

$$F_b / r_{l_1} \cdot L_{-1} + r_{b_1} \cdot B_{b_1} - r_{m_1} \cdot M_{-1} \quad (80)$$

and it will be assumed that all bank profits are instantaneously distributed to households.<sup>22</sup>

In the arithmetical example given above, and many other examples which it is easy to imagine, there is nothing to stop the banks' requirement for bills becoming negative, which is to say that they need to borrow from the central bank, typically at a rate of interest which exceeds the bill rate, set exogenously by the central bank.

If the banks have no direct control over any item in their balance sheet, how can they be sure of making profits? And how can they avoid dependence on advances from the central bank eventually at a penal rate of interest?

While the banks have no direct control over their balance sheets, they do have full control over the rates of interest they pay on money and charge on loans. This gives them indirect control over their balance sheets and (something like) direct control over their

---

<sup>22</sup> This involves the dangerous simplifying assumption that banks do not issue equity. One consequence of this is that we ignore all problems connected with capital adequacy.

profits. To guard against having to borrow from the central bank, all banks have to do is preserve an adequate cushion in the form of positive holdings of bills, which may be expressed in the form of a target liquidity ratio, LR, defined as the ratio of bills to liabilities (credit money).

$$LR = B_b/M \quad (81)$$

If the liquidity ratio approaches zero, or becomes negative, the response of banks must be to raise the rate of interest they pay on money relative to the given bill rate. If they do this, they will set in train exactly the series of responses illustrated in the arithmetical example above. This example shows the stock of bills held by banks rising while the stock of money “owed” by banks rises by a roughly equivalent amount. Hence, since the stock of money is very much larger absolutely than the stock of bills held by banks, the liquidity ratio must rise. On the other hand, banks will not wish to raise their liquidity ratio beyond a certain point because the rate of interest on bills will be far below that on loans, so the average rate of interest on banks’ assets will be diluted unnecessarily. In the formal model we employ logical functions which say that banks raise the money rate of interest if the liquidity ratio falls below a certain level and reduce it if the liquidity ratio rises above a certain level. The money rate remains constant if the liquidity ratio resides within these upper and lower bands. Put formally, the change in the money rate of interest is given by

$$\Delta r_m = \Delta r_m \quad (82)$$

and

$$\Delta r_m = Z \cdot A1 - X \cdot A1 \quad (83)$$

where A1 is an adjustment parameter and

$$X = LR_{-1} \cdot GT \cdot B1 \quad (84)$$

$$Z = LR_{-1} \cdot LE \cdot B2 \quad (85)$$

where B1 and B2 are the limits within which the liquidity ratio can fluctuate without the money rate changing, and GT, (LE) means “greater than” (“less than or equal to”), with X and Z taking on the value 1 or 0 depending on whether the proposition on the RHS is true or false.

When banks raise the money rate of interest, they must be assumed to simultaneously raise the loan rate if their profits are to be sustained. In the model, and in our general contention, the banks can always choose rates of interest on money and on loans, relative to the exogenous bill rate of interest, which will generate profits for them while simultaneously respecting the interest rate hierarchy—that the loan rate exceeds the bill rate, while the bill rate exceeds the money rate.

In the simulation model we have assumed, very crudely, that banks have a target for their profits,  $Fb^*$ , which is equal to some proportion of nominal sales by firms.

$$Fb^* = :1.S \quad 86)$$

To achieve this target the loan rate must be set above the money rate by the formula

$$rl = rm + :2 \quad 87)$$

where<sup>23</sup>

$$:2 = (1/L_{s-1}).[Fb^* - rb_{-1}.Bb_{-1} + .rm.(M_{-1} - L_{-1})] \quad 89)$$

### **Section E: The Model As A Whole**

Up to now our style of exposition has not been enormously different from the narrative style used by most post-Keynesian authors as well as by Keynes himself. Equations have been attached to all substantial propositions, but there has been little suggestion that these are more than decorations. However, from the authors' point of view the building of a fully articulated simulation model has been the fundamental tool which has made this work possible. Starting from models similar to Godley (1999), Lavoie and Godley (2001-2), and Santos and Zezza (2005), the computer model underlying this paper has grown by accretion; and without it, it would have been impossible to be even remotely sure that the system functioned as an organic whole when the individual propositions were strung together.

Not only does the model exist, it solves freely, it satisfies all the accounting constraints (including the identity between demand and supply of the bank's holdings of bills, although there is no equation to make this happen) and it has, when simulated, all the properties claimed for it. For instance, when shocked from its steady state, prices do not immediately respond either way, yet profits are generated which in due course are sufficient to pay for fixed investment and to make adequate distributions to creditors and shareholders.

We end by describing some of the main findings, noting that alternative solutions to the model all start from a "base line" solution extending over fifty odd "years" in which all stocks and all flows rise at the same rate—namely 3% per annum. The nominal wage rate rises by about 4% per annum, normal productivity by 3% and prices by about 1%.

There is one strong "real" conclusion to this modelling and simulation work which concerns the conduct of fiscal policy. This point should really be obvious but the explicit solution of a growth model brings it into a high relief. We start by defining the fiscal stance

---

<sup>23</sup> This formula will be fully explained in the final chapter of our forthcoming book. This will incorporate the concepts of bank equity, the capital adequacy ratio, and the way in which the profits target adjusts to allow for this.

as  $g'/2'$  where  $g'$  is defined to include all transfer payments and  $2' = T/Y$ . Although government expenditure and the tax rate defined in this way are formally exogenous variables,<sup>24</sup> this does not imply that the government has much discretion regarding what the fiscal stance has to be. In the growth steady state there is only one value for the fiscal stance which is consistent with full employment for more than a very short time. This follows from the fact that flows into the economy consist of government outlays broadly defined and rate of outflow consist of taxes as a share of total income—combined with the fact that all stock variables tend towards norms relative to flows. And there is no escaping the fact that the fiscal stance, other than in the very short term, must be made to grow at the same rate as the economy itself. Any other growth rate must imply that the budget balance explodes or collapses, with devastating consequences for aggregate demand as well as for the financial system, which is either flooded with assets or starved. The strong conclusion is that, given the proportion of nominal income taken in tax, public expenditure must normally rise at the same rate as the economy and the government has virtually no discretion with regard to this. The failure to appreciate this relationship in the public discussion may be due to the mistaken notion that the government's fiscal stance can be appropriately measured by the PSBR (measured *ex post*) as a share of GDP which will have no secular trend.

It is argued above that the level and growth rate of the fiscal stance is predetermined if economic growth at full employment is to be achieved. But the government's budget deficit is equal, by identity, to personal saving plus firms' net saving (undistributed profits less investment in fixed and working capital) which we call "private net saving." There is no way in which the government can change private net saving measured at full employment, which will normally be positive. It necessarily follows that the steady state budget deficit is determined by private net saving rather than the other way round and that the budget deficit must normally be in deficit. This is in accordance (or at least consistent) with one of Minsky's major contentions, but it is quite inconsistent with the ignorant assumption often made by politicians that the budget balance should be zero; it is also inconsistent with Gordon Brown's Golden Rule and with the Maastricht fiscal rules. It is a major anomaly that governments' fiscal policies, throughout the world, are judged by their budget deficits, measured *ex post*, over which they have little more control than over "the money supply," while the fiscal stance itself is a number which is not often calculated, let alone admitted to the public discussion.

---

<sup>24</sup> This is not quite true because of interest payments.

To give a concrete example of the way in which the model works, the following three charts illustrate some of the effects of adding a step to the nominal bill rate of interest.

Chart 1 shows the effect on total output—illustrating the new path divided by the original steady state path.

As the chart shows, there is an initial negative effect on output. This comes about partly because there is a rise in the real loan rate of interest which reduces investment, and partly because households suffer a capital loss on equities and bonds which reduces consumption. However the fall in output (compared with what would otherwise have happened) is eventually more than reversed. The reason for this is that, as the economy attains a new steady state, the flow of interest payments by the government will have increased as a result of the rise in interest rates. Put another way, if government expenditure proper and the average rate of tax are unchanged, the level of the “fiscal stance” defined as  $g'/2'$  has been raised (since  $g'$  is defined to include interest payments) although its growth rate is unaffected.

The timing of the eventual reversal of the negative effect is most uncertain and will depend on the maturity structure of government debt. The more government debt is composed of long-term securities, the longer will be the time it will take for a rise in interest rates to raise the fiscal stance.

Chart 2 shows how the loan rate and the money rate of interest respond to the increase in the bill rate. The money rate rises because initially the rise in the bill rate causes a switch out of money into bills and therefore a fall in the liquidity ratio which the banks have to rectify by raising the money rate. And they have to raise the loan rate in order to preserve their profits.

Chart 3 simply shows how the loan rate and the money rate respond to a rise in the bill rate. Some indulgence is required regarding the very long time which it apparently takes for the money rate to adjust. This comes about because we have not yet found a way to describe the adjustment process which does not result in overshooting.

In a second experiment government expenditure is raised in a step by 3% and its growth rate thereafter is resumed at a rate of 3% per annum.

The immediate effect on real output is less than the addition to government expenditure because the shock was unexpected so inventory accumulation turns negative. Total output then rises to about twice the addition to government expenditure as inventory accumulation recovers and there are multiplier effects on consumption and (in this model small) quasi-accelerator effects on investment (not shown in the chart). The main reason for the subsequent fall in consumption and total output is that the addition to output has raised

the inflation rate which by itself reduces the real stock of wealth. But this negative effect is very much increased because we have introduced the assumption that the authorities increase the nominal bill rate *pari passu* with inflation so as to keep the real rate of interest constant. The rise in the nominal bill rate now has exactly the same effect on consumption and the economy at large as was illustrated in the first experiment. Initially it reinforces the downturn. Then eventually, as interest payments by the government rise, the real fiscal stance of the government rises as well, generating a recovery which more than compensates for the downturn.

Chart 5 shows counterpart changes in the liquidity ratio and the nominal money rate of interest. The liquidity ratio first falls because the rise in lending causes banks' bill holdings to fall. When the liquidity ratio falls below the permitted lower band, banks put up the rate of interest on money and this continues until the ratio regains the safety area.

Chart 6 simply shows how the real bill rate has been held constant while all the other nominal rates have moved up.

Chart 7 measures variables at current prices.

Immediately after the unanticipated shock there is a rise in undistributed profits because of the windfall gain to total profits. This is why, at the start, the fall in bank lending is smaller than the fall in inventory accumulation. Subsequently there is a big rise in bank lending, partly to finance a recovery in inventory accumulation and partly to finance "initial" investment. Then undistributed profits pay for an increasing share of investment and bank lending levels off. Nominal investment keeps rising partly because of the rise in the price level.

Further points:

1) The inventory adjustment process readily reconciles actual with expected sales (however wild and mistaken expectations turn out to be) and the money creation/destruction process does the same thing for mislaid expectations about personal income. The banks have no difficulty reconciling their profitability with divergent demands for loans and money, if necessary by changing the money rate of interest, and therefore the loan rate as well, relative to the bill rate.

2) The model defies the ridiculous assumption made almost universally in MM textbooks (on which the entire structures they purvey crucially depend), that the quantity of credit money is determined by the "money multiplier." By our model, a rise in the fractional reserve ratio has no immediate effect on the money stock at all. Instead banks raise their cash reserves by buying bills, thereby initially reducing the liquidity ratio. The banks then have to raise the money and (therefore) loan rates of interest, over which they do have control and as

a result of which, in the process of restoring their liquidity ratio, the stock of credit money will actually be raised compared with what it was before the increase in the fractional reserve ratio.

3) On the vexed question of capacity (or capital) utilization, a step rise in the fiscal stance (without changing its growth rate thereafter) generates a net addition to aggregate demand and the whole system eventually achieves a new (growth) steady state. The rate of capacity utilization,  $(y/k)$ , is initially raised but reverts, to a close approximation, to its initial level. If aggregate demand is raised by an exogenous rise in investment itself, there is a permanent fall in capacity utilization—but isn't that part of what the rise in investment was intended to achieve?

### **OBITER DICTA**

One distinguished commentator made the discouraging statement that this paper contains “only one model” and this is obviously true. But the model is rooted in a solid, comprehensive, and realistic accounting framework and, as we believe, accords with many stylized facts backed up by a lot of theory well grounded in the post-Keynesian tradition.<sup>25</sup> In short, our conjecture is that subject to admitted major simplifications (in particular no foreign trade and no lending to households) the model does indeed provide important insights regarding the evolution of a modern industrial economy through historical time and the way in which the financial system fulfils an essential role, given that production takes time and all decisions have to be taken under conditions of uncertainty.

---

<sup>25</sup> All our major theoretical propositions are harmonious with the detailed structures presented in Harcourt (2006).

## APPENDIX

A1) $y = s_e + )in^*$	real output decision
A2) $N^* = y/pr$	desired employment
A3) $N = N_{-1} + 0.(N^* - N_{-1})$	actual employment
A4) $pr = (1 + prg).pr_{-1}$	productivity
A5) $WB / W.N$	nominal wage bill
A6) $s_e = s_{-1}.(1+prg+ra1)$	expected real sales
A7) $in^{**} = >.s_e$	long-run inventory target
A8) $in^* = in_{-1} + T.(i^{**} - i_{-1})$	short-run inventory target
A9) $in = in^* - (s - s_e)$	actual inventory level
A10) $s / c + i + g$	actual real sales
A11) $k = k_{-1}.(1+gk)$	capital stock
A12) $gk = go + P.u_{-1} - (.rrl$	growth of capital stock
A13) $u / y/k$	capacity utilization
A14) $rrl / (1 + rl) / (1 + B) - 1$	real loan rate of interest
A15) $B / )p/p_{-1}$	inflation
A16) $i = )k + *k_{-1}$	gross investment
A17) $S_e / s_e.p$	value of expected sales
A18) $F \equiv S - WB + )IN - rl_{-1}.IN_{-1}$	profits of firms
A19) $F_e = Fu_e + Fd + rl_{-1}.(L_{d-1} - IN_{-1})$	planned ditto
A20) $F_d = N.F_{-1}$	distributed profits
A21) $Fu_e = (1 - N3).I_{-1}$	planned undist. profits
A22) $S / s.p$	value of actual sales
A23) $IN / in.UC$	inventories at current cost
A24) $UC / WB/y$	unit cost of inventories
A25) $\Phi^* = F_e / [(1 - .e). s_e.UC + (1 + rl)..e.s_e.UC_{-1}]$	ideal mark-up
A26) $.e / in_{-1}/s_e$	opening inventory/expected sales
A27) $p = (1 + \Phi).NHUC$	price level
A28) $NHUC / (1 - .c)NUC + (1 + rlc)..c.NUC_{-1}$	normal hist. unit cost
A29) $NUC / W/pr$	normal unit cost
A30) $\Phi = \Phi_{-1} + \Lambda(\Phi^* - \Phi_{-1})$	actual mark-up
A31) $w^* = \Delta 0 + \Delta 1.pr + \Delta 2.N/Nfe$	real wage aspiration
A32) $W = W_{-1} + \Delta 3.(w^*.p_{-1} - W_{-1})$	realized nominal wage



A33)	$L_d = L_{d-1} + )IN - Fu - )e_s \cdot pe$	demand for loans
A34)	$Fu = F - Fd - rl_1 \cdot (L_{d-1} - IN_{-1})$	undistributed profits
A35)	$e_s = (e_{s-1} \cdot pe + N3 \cdot I_1) / pe$	supply of equities
A36)	$c = \forall 1 \cdot ypd_e + \forall 2 \cdot v_{-1}$	consumption
A37)	$ypd_e = ypd_{-1} \cdot (1 + prg + ra2)$	expected real disposable inc.
A38)	$Yp / Fd + Fb + WB + rm_{-1} \cdot M_{-1} + rb_{-1} \cdot Bp_{-1} + Bl_{-1}$	nominal personal income
A39)	$T = 2 \cdot Yp$	tax payments
A40)	$Ypd = (1 - 2) \cdot Yp$	nominal disposable income
A41)	$Ypd = Ypd/p - \Delta p \cdot v_{-1}/p$	real ditto
A42)	$V / V_{-1} + Ypd - C + )pb \cdot Bl_{-1} + )pe \cdot e_{-1}$	nominal wealth
A43)	$Hpd = 8c \cdot C$	demand for cash
A44)	$Vn / V - Hp$	investable wealth
A45)	$v / V/p$	real stock of wealth
A46)	$vn / Vn/p$	ditto of investable wealth
	$[M_d^* = Vn_e \cdot (8_{10} + 8_{11} \cdot rm_{-1} - 8_{12} \cdot rb_{-1} - 8_{13} \cdot rbl - 8_{14} \cdot rk_{(-1)} + 8_{15} \cdot Ypd/V)]$	
A47)	$Bpd = Vn_e \cdot (8_{20} - 8_{21} \cdot rm_{-1} + 8_{22} \cdot rb_{-1} - 8_{23} \cdot rbl - 8_{24} \cdot rk_{(-1)} - 8_{25} \cdot Ypd/V)$	
A48)	$Bld = Vn_e \cdot [(8_{30} - 8_{31} \cdot rm_{-1} - 8_{32} \cdot rb_{-1} - 8_{33} \cdot rbl + 8_{34} \cdot rk_{(-1)} - 8_{35} \cdot Ypd/V)] / pb$	
A49)	$ed = Vn_e \cdot [(8_{40} - 8_{41} \cdot rm_{-1} - 8_{42} \cdot rb_{-1} - 8_{43} \cdot rbl + 8_{44} \cdot rk_{(-1)} + 8_{45} \cdot Ypd/V)] / pe$	
A50)	$M_d / V - Hp - Bp - Bl \cdot pb - e \cdot pe$	demand for money
A51)	$pb / 1/rbl$	price of bonds
A52)	$rk / Fd / (e_{-1} \cdot pe_{-1})$	rate of return on equity
A53)	$e_d = e_s$	equilibrium condition
A54)	$Bb_d / M - Hb - L$	bills held by banks (= their balance sheet)
A55)	$Hb_d = \Delta \cdot M_s$	vault cash of banks
A56)	$Hp_s = Hp_d$	supply equals demand
A57)	$M_s = M_d$	ditto
A58)	$L_s = L_d$	ditto
A59)	$Hb_s = Hb_d$	ditto
A60)	$)B_s / G - T + rb_{-1} \cdot B_{-1} + Bl_{-1} - )Bl \cdot pb$	total bill supply (govt. budget restraint)
A61)	$Bb_s = B_s - Bp_s - Bcb_s$	allocation of bill supply
A62)	$Bp_s = Bp_d$	supply equals demand
A63)	$Bcb_s = Bcb_d$	ditto
	$[Bb_s = Bb_d]$	ditto

A64) $Bl_s = Bl_d$	ditto
A65) $Bcb_d = H_s$	central bank's bills (its balance sheet)
A66) $H_s = Hp_d + Hb_d$	total cash supply
A67) $Fb / rl_{-1} \cdot L_{-1} + rb_{-1} \cdot Bb_{-1} - rm_{-1} \cdot M_{-1}$	banks' profits
A68) $LR / Bb_d / M_s$	liquidity ratio
A69) $rb_l = rb_{add3}$	bond rate of interest
A70) $rm / rm_{-1} + dr_m$	money rate of interest
A71) $dr_m = Z \cdot A1 - X \cdot A1$	change in money rate
A72) $X = LR_{-1} \cdot GT \cdot B1$	logical function taking on value of 1 or 0
A73) $Z = LR_{-1} \cdot LE \cdot B2$	ditto
A74) $Fb^* = :1 \cdot S$	target profits for banks
A75) $rl = rm + :2$	loan rate of interest
A76) $:2 = (1/L_{s-1}) \cdot [Fb^* - rb_{-1} \cdot Bb_{-1} + rm_{-1} \cdot (M_{-1} - L_{-1})]$	mark-up on money rate

Exogenous variables are  $g$ ,  $2$  and  $rb$

## REFERENCES

- Backus, D. Brainard, W. Smith, G. and Tobin, J. 1980. "A Model of U.S. Financial and Non-Financial Behavior." *Journal of Money Credit and Banking* 12: 289-95.
- Coutts, K. J. Godley, W. and Nordhaus, W. D. 1978. *Industrial Pricing in the United Kingdom*. Cambridge: Cambridge University Press
- Davidson, Paul. 1972. *Money and the Real World*. London: Macmillan.
- Godley, W. 1999. "Money and Credit in a Keynesian Model of Income Determination." *Cambridge Journal of Economics* 23 (4): 393-411.
- Godley, W. and Cripps, T. F. 1983. *Macroeconomics*. Cambridge: Cambridge University Press.
- Godley, W. and Lavoie, M. Forthcoming. *Monetary Economics: An Integrated Approach to Credit, Money, Income, Production and Wealth*.
- Goodhart, C. A. E. 1984. *Monetary Theory and Practice*. Macmillan.
- Goodwin, R.M. 1953. "The Problem of Trend and Cycle." *Yorkshire Bulletin of Economic and Social Research*, 5. 89-97:
- Goodwin, R.M. and L. F. Punzo. 1987. *The Dynamics of a Capitalist Economy: A Multi-Sector Approach*. Cambridge: Polity Press.
- Graziani, A. 2003. *The Monetary Theory of Production*. Cambridge: Cambridge University Press.
- Harcourt, G. Forthcoming. *The Structure of Post-Keynesian Thought*. Cambridge: Cambridge University Press.
- Hicks, J. R. 1989. *A Market Theory of Money*. Oxford: Oxford University Press.
- Kaldor, N. 1939. "Speculation and Economic Activity." *Review of Economic Studies* 7: 1-27.
- . 1996. *Causes of Growth and Stagnation in the World Economy*. Cambridge: Cambridge University Press.
- Kalecki, M. 1968. "Trend and Business Cycles Reconsidered." *Economic Journal* 78: 263-76.
- Keynes, J. M. 1936. *The General Theory of Employment, Interest and Money*. London: MacMillan, C W. Vol. VII. 1973.
- Lavoie, M. and Godley, W. 2001-2002. "Kaleckian Models of Growth in a Coherent Stock-Flow Monetary Framework: A Kaldorian View." *Journal of Post Keynesian Economics* 24 (2).
- Layard, R., Nickell, S., and Jackman, R. 1991. *Unemployment*. Oxford: Oxford University Press: 12-14.

- Marglin, S. A. 1984. "Growth, Distribution and Inflation: A Centennial Synthesis." *Cambridge Journal of Economics* 8: 115-44.
- Pasinetti, L. L. 2005. "The Cambridge School of Keynesian Economics." *Cambridge Journal of Economics* 29: 837-848.
- Robinson, Joan. 1962. *Essays in the Theory of Economic Growth*. London: MacMillan.
- Rowthorn, Bob. 1977. "Conflict, Inflation and Money." *Cambridge Journal of Economics* 1: 215-239.
- Santos, C. and Zezza, G. 2005. "A Simplified Stock-Flow Consistent Post-Keynesian Growth Model." Working Paper 421. Annandale-on-Hudson, N.Y.: The Levy Economics Institute.