Money, Finance and National Income Determination: An Integrated Approach

by

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INTRODUCTION[1]

Modern textbooks on macroeconomics treat money in a remarkably uniform - and remarkably silly - way. In the primary exposition the stock of "money" is treated as exogenous in the two senses a) that it is determined outside the model and b) that it has no accounting relationship with any other variable. The reader is then invited to assume, pro tem, that the central bank controls "the money supply" so that it is constant through time. When the operations of banks are described, typically some thirty chapters later, the quantity of money is some multiple of commercial banks' reserves as a consequence of these institutions having become "loaned up".

Silly? The money stock, as revealed in real life financial statistics, is as volatile as Tinkerbell - for good reasons, as I shall argue below. How can it be sensible to undertake a thought experiment in which the flickering quantity called "money" is literally constant through periods at least long enough for capital equipment to be planned, built and commissioned - and for lots of other things to happen as well? And the other, "money multiplier", story has the strange defect that, while giving some account of how credit money might be created, it completely ignores the impact on spending of the counterpart changes in bank loans which are assumed to be taking place; perhaps it is because loan expenditure would mess up the solution of the IS-LM model when alternative assumptions about "the money supply" are used, that the supposed process of money creation normally gets separated from that of income determination by so many chapters[2].

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[1]This paper is part of a research programme I am undertaking in collaboration with George McCarthy and owes a special debt to Ken Coutts and Anwar Shaikh. I am grateful to Sheila Dow and George Bibow for their comments on an earlier draft.

[2]It is interesting that Joseph Stiglitz, in his 1996 Marshall lectures at Cambridge, emphatically took the view that the ISLM model could not be used for realistic policy guidance, drawing particular attention to the fact that the ISLM model assumes a constant money stock and has no place for a financial

The bibles of the neo-classical synthesis don't help. There is a spectacular lacuna in the constructions presented, for instance, by Patinkin, Samuelson and Modigliani with regard to the asset side of commercial banks' balance sheets. Usually the role and even existence of bank credit is simply ignored. Modigliani (1963) gives banks (with regard to their assets) no role other than to hold government bonds; and Milton Friedman famously used a helicopter when he wanted to get more money into the system.

There is a reason for all this. It is that mainstream macroeconomics postulates in its basic model that macroeconomic outcomes are all determined by relative prices established in Walrasian markets. Individual agents are held to engage in a market process of which the outcome is to find prices for product, labour and money which clear all three markets plus, by Walras's law, the market for "bonds". But as is now well known, there is no use for money in the Walrasian world even though, paradoxically, "money" is a logical necessity if the model is to be solved.

The impoverished and ambiguous role of money and credit in the standard model carries over when the market process does not quite work because of rigidities or information failures. Thus in the system proposed by Malinvaud (1974) (to take only one example), in which the prices of labour and product are assumed to be wholly exogenous, no market clears except by accident. Yet all agents know exactly what to do - how much of x they are going to exchange for y (?having produced it instantaneously) - as soon as exogenous prices are declared, so there is still neither any need nor any place for inventories or finance. But the Malinvaud model still needs a money stock if it is to have a solution though this is not emphasised!

ANOTHER TRADITION

A radically different macro-economic tradition does exist although this is largely, for the time being, ignored. The names which come first to (my) mind are Wicksell, D.H. Robertson, Keynes (when not writing the General Theory), Kaldor, Graziani and Hicks, particularly Hicks (1989) as well as a large number of authors in the post-Keynesian tradition (e.g. Chick, Davidson, Sheila Dow, Wray, Minsky and Moore). Threads linking these authors, and distinguishing them sharply from today's mainstream, is first their perception that investment, production and distribution are processes which take up historical time - a period which must elapse before sales can take place, hence generating a systemic need for finance. A second thread is the perception that all decisions have to be taken in a state of uncertainty, without agents knowing what their sales or incomes are going to be.

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system.

In what follows I am going to present a greatly simplified, but within its limitations realistic, model of how a modern monetary economy may work. Looked at one way, it contains nothing new. Keynes, Kaldor and Hicks (I hardly need say) all had very well worked out notions as to how economies - extremely complicated interdependent systems changing through historical time - function. The trouble is that none of these authors chose to formalise their systems, so it is extremely difficult to teach them reliably or rigorously, and there remains a penumbra of ambiguity around too much of what they wrote; for instance, there is still much room for argument about "what Keynes really meant".

I shall instead adopt the methodology pioneered by James Tobin[3] wherein a whole model is set out formally and then subjected to numerical simulation; it is perhaps the only way in which the properties of a very complicated dynamic system can be ascertained with precision. The model is large by the standards of theoretical models, having about eighty equations. But even so, a great many simplifying assumptions have been made to prevent the scale of this (preliminary) operation from getting completely out of hand. I am all too aware that for some people I will have simplified away some of the features of a monetary economy which they regard as crucially important. For instance, I have assumed that the economy is closed and that households neither borrow nor invest; and all my asset demand and supply functions work mechanically so there is no place for waves of confidence which can generate substantial cycles of activity. I just have to ask the reader to suspend disbelief on these, and some other questions.

It is a matter of ascertainable fact that the real world is characterised by a huge and complex structure of interdependent institutions such as governments, firms, banks and households. I do not accept that these institutions are "veils" with nothing more to do than passively sponsor or facilitate the optimising aspirations of individual agents; and wish, rather, to start from a conceptual framework which takes cognisance of (something remotely approaching) the real world as we know it. However crudely motivated and characterised, my model will provide an account of a complete system of physical and financial stocks and flows between four sectors, evolving through historical time.

At a more theoretical level, following Hicks (1989), my model incorporates the fact that "markets" in real life can only, with extremely rare exceptions, function by virtue of the activities of professional intermediaries who both buy and sell, and who

[3] My debt to Tobin is enormous; I could not possibly have made this model without his work, particularly on asset choice.

therefore hold inventories[4] and quote fix-prices. As Hicks' put it

The increment in...stock, during a period, is the difference between what is held at the end and what was held at the beginning, and the beginning stock is carried over from the past. `...the demand-supply equation can only be used in a recursive manner, to determine a sequence; it cannot be used directly to determine price, as Walras and Marshall had used it.' (Emphasis added)

Investment, production and distribution all take time and are all activities which have to be undertaken under conditions of uncertainty. One role of the financial system will be to provide the finance required for investment in fixed and working capital (in advance of sales taking place) if production and distribution are to proceed smoothly or at all. And it will also provide residual "buffer" finance for fluctuating inventories as short term expectations are falsified. But simultaneously the financial system accommodates the needs of the household sector with regard to asset accumulation and allocation under conditions of uncertainty analogous to, but quite distinct from, those facing firms. The model will show how the banking system is motivated to carry out all these functions simultaneously and how it can achieve this profitably so long as its debtors do not default. A subsidiary, but still very important, purpose of the model is to show how prices determine the distribution of income and wealth.

THE ACCOUNTING FRAMEWORK

[Note. A summary of variables is provided in the appendix. The convention will be adopted that stock and flow variables at current prices will be described by upper case symbols; lower case symbols will describe constant price "volume" variables. The suffixes _e, _p, d and s will denote, respectively, that a variable is expected, planned, demanded or supplied. A star means that the variable is in a steady state relationship. The full model, in the exact form in which it is read by the computer, is given in the appendix. For various reasons this differs slightly - though in unimportant ways - from what is described in the text; for one thing the computer demands a degree of rigour which becomes tedious in a verbal exposition. The keen reader may, however, wish to have recourse to the appendix version, which has been tried in the fire of numerical simulation1

The standard macro-economic model employs a very impoverished

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[4]The statement holds as well for financial assets as for merchandise as Kregel (1995) has shown.

'Ibid. p.11

conceptual framework, consisting of little more than the national income identity (between expenditure and factor income) plus, having deducted taxes and transfers from both sides of the equation, the identity between the aggregate financial balances of the three main sectors - government, overseas and private domestic. It is left mysterious how credit money and, more generally, financial institutions, fit into the story at the level of accountancy.

In what follows, I start from the real world as described in, for instance, Table 11.1 of the National Income Blue Book which shows, for single years, a comprehensive matrix describing flows of funds in the British economy. The table which follows shows the adaptation of the Blue Book table which I shall use in this paper and which forms the accounting basis of my simulation model. Like much of what follows it is heavily indebted to Tobin's work (e.g. in Backus et al.(1980))

Table 1: Flow of funds at current prices

	H'hlds.	Firms Crnt.	Firms Cptl.	Banks Crnt.	Banks Cptl.	Gov't.	Total
Consumption	-C	+C					0
Government expenditure		+G				-G	0
Fixed investment		+IN	-IN				0
Stockbldng. (bef. IVA)		+ΔI	-AI				0
[Stock app.]		[-IVA]					
[National income]		[+Y]					
Tax		-T				+T	0
Wages	+WB	-WB					0
Profits	+FD	-FN	+FU				0
Debt interest		-rl.L$_{-1}$		+rl.L$_{-1}$			0
Interest on – money	+rm.M3$_{-1}$			-rm.M3$_{-1}$			0
– bills	+rb.Bsp$_{-1}$			+rb.Bsb$_{-1}$		-rb.Bs$_{-1}$	0
– bonds	+Bp$_{-1}$					-Bp$_{-1}$	0
A stocks of – cash	-ΔHp		-AHf		-ΔHb	+ΔH	0
– current deposits	-ΔM1				+ΔM1		0
– demand deposits	-AM3				+ΔM3		0
– bills	-ΔBsp				-ABsb	+ΔBs	0
– bonds	-ABp.pb					+ABp.pb	0
– equities	-Ae.pe		+Δe.pe				0
– loans			+ΔL		-AL		0
Total	0	0	0	0	0	0	0

N.B. Nominal capital gains or losses (on bonds and equities) are:
Δpb.Bp$_{-1}$
and Δpe.e$_{-1}$

Variables in square brackets are important accounting auxiliaries which are not transactions and therefore have no counterpart entries in other columns.

In some respects Table 1 is simpler than the Blue Book table. As already mentioned, the model assumes that the economy is closed and also that the household sector neither invests nor borrows and this is reflected in my table. On the other hand it does use a double entry matrix so that every flow can be seen to be a transaction involving at least two sectors. And while many of the component parts of Table 1 are more aggregated than the Blue Book table, others are less so; in particular, credit money and government securities are disaggregated and interest flows are represented as opening asset stocks multiplied by the interest rate appropriate to the asset in question.

Table 1 defines most of the symbols which describe the current price flows of the model and it is hoped that the general schema will be largely self-explanatory. It is assumed that "bonds", Bp, are perpetuities, each paying #1 per period, hence the interest flow is given by Bp(-1), the long interest rate by 1/pb where pb is the price of bonds and the end period value of the stock of bonds is Bp.pb. Similarly, equity consists of bits of paper, e, which entitle their owners to receive the flow of distributed profit, FD, and which have a price, pe.

Central to the methodology I am putting forward is the notion that the accounting should be comprehensive in the sense that there are no "black holes" - every flow comes from somewhere and goes somewhere. But this is easier said than done. In a fully articulated model with N equations, the Nth equation is always implied by the other N - 1, so a numerical solution can only be found if one equation is dropped from the specification. It is then possible to test the model's accounting by ascertaining whether or not the "dropped" equation is indeed satisfied. In the model deployed here I have habitually dropped the equation which makes banks' demand for bills equal to the supply of bills to the banks. It was my experience that, to a humiliating extent, the dropped equation initially turned out not to be satisfied and it was often a devil of a job to find out why. All of which is some justification for the very tedious section on accounting which immediately follows. I found the definition of profits and the way in which prices distribute the national income particularly difficult to sort out. And I found too that recourse to manuals and textbooks was fruitless. But unless we are operating with a logical system we will get nonsense answers. Stocks should be accumulating somewhere but are not in fact doing so etc. etc.

So here goes.

The top six entries in Column 2 of Table 1 show the familiar National Income identity as part of the current transactions of firms.

1) $Y = C + G + IN + \Delta I - IVA$

where Y is GDP, C is consumption, G government consumption, IN fixed investment, ΔI the change in the value of inventories and IVA stock appreciation. Note that the change in the value of inventories, in common with the change in the value of all stock variables, may be divided into two components

2a) $\Delta I = i.UC - i_{-1}.UC_{-1}$

2) $= \Delta i.UC + \Delta UC.i_{-1}$

where the lower case describes the volume of inventories and UC is the deflator for inventories. As inventories are assumed to be valued at cost, the deflator is taken to be equal to wage costs per physical unit of output

3) $UC = \frac{WB}{\bar{y}}$

where WB is the wage bill and $\bar{y}$ is output valued at the unit cost obtaining in some base year (so that unit cost (UC) takes on the value 1 in the base year).

Of the two terms on the RHS of 2) above, the first describes the change in the volume of inventories at current prices while the second describes stock appreciation (IVA stands for "inventory revaluation adjustment"). As only the first of these two expressions (Δi) corresponds with a production flow, the second, which describes the change in the value of the opening volume of inventories, IVA, is always deducted in official statistics from the total flow of expenditure to derive aggregate production and this practice has been followed here.

Unlike consumption and government expenditure, investment in fixed capital and stockbuilding do not originate in other sectors, so in a double entry system of accounts they have to come from a capital account within the firm sector. The funds to pay for this capital expenditure have, in turn, to come from somewhere - to be precise, from some combination of undistributed profits, issues of securities (here assumed all to be equities) and, as a residual source of finance, the change in bank loans net of cash stocks. So, to make column 3 sum to zero

4) $IN + \Delta I = FU + \Delta Hf_d + \Delta e_s.pe + \Delta L_d$

where FU is undistributed profits, Hf is cash held by firms, e is equities, pe the price of equities, L bank loans and Δ is a first difference operator. The subscripts d and s, describing demands and supplies are included in the identity to denote that firms plan consistently.

The standard assumption that all profits are instantaneously distributed is absurdly unrealistic, by-passing and trivialising the role of the financial system which is the main focus of interest here. The empirical fact is, of course, that investment is preponderantly financed out of undistributed profits.

I had better bite the bullet at this point and derive profits from the appropriation account of firms shown in column 2 of Table 1 as this will have important implications later on. So long as they are defined gross of all interest and dividends (as well as depreciation), gross profits (FG) are given by the identity

5) $FG = S - T - WB + \Delta I$

where T describes taxes, assumed here all to be indirect and paid by firms. I have found that people who have not made a special study of accounting sometimes have difficulty in penetrating 5), although the matrix clearly implies (since column 2 sums to zero) that this expression correctly evaluates the flow which can potentially be appropriated by the owners of firms and their creditors (subject to a liquidity constraint) while leaving the firm intact.

Since, with a closed economy and no production taking place outside the firm sector, all costs resolve into wage costs, and since we assume the production period to be shorter than the accounting period, end-period inventories valued at cost are given by

6) $I = \sigma.WB$

where σ is the proportion of the wage bill paid out in the period which was not embodied in sales which took place in that period. Similarly, the opening inventory is given by

6a) $I_{-1} = \sigma_{-1}.\ WB_{-1}$

Putting 6) and 6a) into 5) and collecting terms we now have an intuitive definition of 5)

7) $FG = S - T - (1 - \sigma)\ WB - \sigma_{-1}\ WB_{-1}$

- an identity which makes gross profits equal to net-of-tax sales less the outlays, counting on a FIFO basis, necessary to produce those sales. To spell it out, the cost of inputs embodied in sales in any period is equal to payments made in the previous period but not embodied in sales that period plus payments made this period which were embodied in sales this period.

As mentioned earlier, the definitions in 5) and 7) refer to profits gross of all interest and dividends. But this is not good enough because, as production and distribution take time, funds are necessarily tied up until sales actually take place. Accordingly there is un unavoidable cost, additional to the wage and salary bill, generated in the course of producing goods and services which is equal each period to the loan rate of interest times the opening value of inventories. Thus the net profit, FN, potentially extractable by the entrepreneur from his whole set of business operations is given by

8a) $FN = S - T - WB + \Delta I - rl.I_{-1}$

or (using 7)

$$8)\ FN = S - T - (1 - \sigma)WB - \sigma_{-1}(1 + rl).WB_{-1}$$

It seems to be the universal practice of national income statisticians, having justifiably defined the national income "with" IVA (= after deducting stock appreciation) to go on to define "profits" as gross profits (equation 2) net of stock appreciation as well - for this has the convenience that total factor income is then equal to total production.

But this procedure does not, in general, produce a definition of net profits that is justifiable in balance sheet terms - the one shown in 8) and 8a) above - that is, the profit flow which can be extracted by entrepreneurs (subject to a liquidity constraint) yet leave the business intact. The official definition of profits will only accord with the "balance sheet" definition in the unusual case where (using 2) and 8a))

$$9)\ I_{-1}.rl = I_{-1}.\frac{\Delta UC}{UC_{-1}}$$

- that is, when the loan rate of interest is exactly equal to the rate of cost inflation.

In what follows, the unconventional but conceptually coherent definition of profits described in 8) and 8a) will be retained. For nothing else will fit meaningfully (i.e without generating meaningless residuals) into the matrix format of Table 1; payments of interest to cover the inevitable financing costs are shown (a component of the entry in column 2) as an explicit charge on gross profits. The balance is net profits, FN, part of which is distributed (FD) and rest is undistributed (FU) and this, in turn, becomes an important source of funds for fixed investment. Stock appreciation is only a memorandum item which has no place at all in the transactions matrix!

ACCOUNTING OF THE HOUSEHOLD SECTOR

Receipts of household income (YP) above the line are shown in column 1 of Table 1 and comprise labour income and flows of property income in the form of interest and dividends.

$$10)\ YP = WB + FD + rm.M3_{-1} + rb.Bsp_{-1} + BP_{-1}$$

Any difference between receipts of household income and payments for consumption <u>all has to accumulate somewhere</u>. As we are assuming that households neither invest nor borrow, all their saving must accumulate in the form of financial assets. It has been assumed here that households have a choice between six financial assets, cash (Hp), two kinds of money (Interest bearing (M3) and non-interest bearing (Ml)), two kinds of bonds (long (Bp) and short (Bsp)) and equities. Assuming (until we get to the behavioural section) perfect foresight and consistent planning

$$11)\ YP - C = \Delta Hp\_d + \Delta M1\_d + \Delta M3\_d + \Delta Bsp\_d + \Delta Bp\_d.pb + \Delta e\_d.pe$$

Note that the change in the nominal stock of household wealth (V) differs from the sum of the flows described in the RHS of equation 11) above by the amount of any nominal capital gain on bonds and equities. To be precise, the change in nominal wealth is given by

12a) $\Delta V = YP - C + CG$

where capital gains are

12) $CG = \Delta pb.Bp_{-1} + \Delta pe.e_{-1}$

It will be convenient to adopt a quasi-Hicksian definition of disposable income (YD) as the flow which, if entirely consumed, will leave the wealth stock unchanged[6]. In nominal terms

13a) $YD = C + \Delta V$

13) $= YP + CG$

The flow identity given in equation 13) above has the important operational meaning that, given the balance between income and expenditure, more of one asset can be acquired only if less of other assets (taken together) are transacted to an equal extent.

THE GOVERNMENT

The accounts of the government (defined here to include the central bank) are very conventional. The government receives taxes and pays for its own expenditure plus interest payments. Any deficit must be met by some combination of changes in cash, bills or bonds.

14) $G + rb.Bs_{-1} + Bp_{-1} = \Delta H\_s + \Delta Bs\_s + \Delta Bp\_s.pb$

As with the household sector, the operational meaning of the identity is that given the financial deficit, no one component can be altered (say, the supply of cash) without an equal and opposite change in the sum of the other entries.

THE BANKS

The appropriation account of the banks is shown in column 4 of Table 1. Strictly speaking there should be a residual item, banks profits, to ensure that the column sums to zero by definition. However, we have assumed that it is legitimate, in a preliminary model like this one, to assume that commercial banks, operating in competition with one another, make zero profits; one could imagine the banking system, for the purpose of this study, to be operating as a kind of public service, following a set of humdrum rules rather like building societies in the UK. Sc, to

[6]But in the computer model flow capital gains are not included in the definition of income although they do generate changes in wealth

make the appropriation account balance, we write, as though it were an identity

15) $rm.M3_{-1} = rb.Bsb_{-1} + rl.L_{-1}$

and this makes the flows into and out of the banks balance one another.In column 5 we have the capital account of the banks, which shows the two forms of credit money as banks' liabilities while their assets consist of loans, reserves and government securities.

16) $Ml\_s + M3\_s = Hb\_d + Bsb\_d + L\_s$

We can now draw a conclusion of considerable importance from consideration of accounting relationships alone. We have a matrix in which every row and every column sum to zero. As there are no entries above the line in the banks' capital account, it follows that, ignoring the possibility of default by a debtor, there is no way in which non-bank agents can behave which can unbalance the (consolidated) balance sheet of the banking system; banks' assets must every second be equal to their liabilities, although a "run" on banks (e.g if household want to convert their deposits into cash) can generate a liquidity crisis unless the government acts as lender of last resort. The operational problem for banks will not be to balance their accounts, but to make sure that their operations are indeed profitable - apart from anything else they must be motivated to perform the functions they do.

ACCOUNTING FOR PRICES AND THE DISTRIBUTION OF INCOME

We have been too accustomed to thinking of prices as things which clear markets (or fail to clear them) and not enough about the fact that prices are set by firms in the expectation of making profits. It is realised sales (a quantity times a price) relative to costs that is going to determine the distribution of the national income. The following accounting equations will make it possible to endogenise the flow of profits in the model[7].

We first rewrite the appropriations identity (8) with sales on the LHS and taxes, net profits and historic costs on the RHS

17) $S = T + FN + (1-\sigma).WB + \sigma_{-1}(1+rl).WB_{-1}$

If we now define the tax rate

18) $$\tau = \frac{T}{S - T}$$

the profit mark-up on historic costs

[7] An extended derivation of equation 24) - the main eshibit of the following section is to be found in Godley & Cripps (1983) pp.186-195

$$19)\quad \gamma = \frac{FN}{(1-\sigma).WB + \sigma_{-1}(1+rl).WB_{-1}}$$

and then divide 17) through by the volume of sales, we can derive an expression for the average price level of goods

$$20)\quad p = \frac{S}{s} = \frac{(1+\tau).(1+\gamma).[(1-\sigma).WB+\sigma_{-1}(1+rl).WB_{-1}]}{s}$$

Finally, using the identities relating real sales to real output and inventory accumulation

$$21)\quad s = y + \Delta i$$

the rate of cost inflation

$$22)\quad \pi c = \frac{\Delta UC}{UC_{-1}}$$

and the real loan rate of interest defined with respect to cost inflation

$$23)\quad rrc = \frac{rl-\pi c}{1+\pi c}$$

the price identity may be written as a set of mark-ups on wage costs per unit of output with no lagged terms[1].

$$24)\quad p=(1+\tau).(1+\gamma).(1+\sigma.rrc).WB/y$$

The absence of lags means that if 24) is divided through by the price level (p) and multiplied by real output (y), *we* have an expression which describes how the real national income is divided, period by period, into receipts by the government net profits, *real* wages and the real income of the creditors of system[1]

$$25)\quad y = (1+\tau).(1+\gamma).(1+\sigma.rrc).wb$$

Note that 24) and 25) are both accounting identities and that τ and γ are both variables, one of which determines taxes, the other profits.

We can now derive a large number of deflated variables - consumption, investment, government expenditure, real disposable income and real

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[1]Equation 24) is, in effect, identical in form and substance to that proposed by Graziani in, for example, "Production, circulation et monnaie". The differences are that Graziani omits the government and assumes an accounting period which is equal to the accounting period.

wealth by dividing them each by the price level, assumed equal to 1 in some base year.

The flow of real disposable income is

26) $yd = c + \Delta v = YP/p + CG/p - v_{-1} . \pi/(1+\pi)$

where cg is real capital gains, π is the inflation rate and the final term is the erosion of real wealth stocks as a consequence of inflation.

SOME MACROECONOMICS

[Note to readers of the first draft of this paper. The main purposes of what follows are to show how the whole system fits together and cast the banks in a realistic role. The parts dealing with consumption and investment are very scanty; but the framework would survive alternative treatments of these functions.

A) BEHAVIOUR OF FIRMS

Firms have to make decisions regarding how much to invest, what prices to charge, how much to produce and how many people to employ - based on their expectations regarding sales and the extent to which they wish to change the inventories with which they open the period. In what immediately follows we follow line for line the operations described in Hicks (1974)

The production decision may be written

27) $\bar{y} = \bar{s}\_e + i\_p - i_{-1}$

where $\bar{y}$, $\bar{s}$ e are respectively real production and expected sales where the bar means that these variables are measured in the same units as real inventories, that is, at constant factor cost, excluding profits and indirect taxes. Equation 27) says that firms decide to produce what they expect to sell plus the change in inventories they wish to bring about.

Firms' desired inventories are described by the following partial adjustment process

28) $i\_p = i_{-1} + \omega . (i^* - i_{-1})$

that is, firms intend to move them some distance towards a normal stock/sales ratio described by

29) $i^* = \zeta . \bar{s}\_e$

Actual inventories are then determined by the extent to which sales expectations are falsified

30) $i = i\_p + (\bar{s} - \bar{s}\_e)$

For simulation purposes we assume that sales expectations are formed adaptively, subject to random shocks

31) $\bar{s}\_e = \bar{s}_{-1} + R1$

where R1 is a random variable.

Labour productivity is initially assumed not to change, so if average wages (W) are scaled to unity in the base year

32) $WB = W.N$

Employment (N) is related to output and we shall assume to start with that productivity is constant

33) $\ln(N) = \eta_0 + \eta_1 \ln(y)$

For investment I assumed a crude accelerator based on expected sales

34) $k^* = \beta_0 . \bar{s}\_e$

35) $in = \beta_1 . (k^* - (1 - dep) . k_{-1})$

where dep is the rate of capital consumption. So the end-period stock of capital measured at constant prices is

36) $k = (1 - dep) . k_{-1} + in$

and the stock of fixed capital "at replacement cost" is

37) $K = k.p$

For simulation purposes it has been assumed that all of fixed investment is financed, with a lag, out of undistributed profits

38) $FU = \Delta K_{-1}$

Note that this equation, by virtue of 19) and 26), describes the way firms determine the flow of profits through the size of the mark-up.

In addition firms have some resort to new equity issues whenever the level of equity prices makes Tobin's q exceed unity

39) $\Delta e\_s = \phi(q - 1)$

40) $q = \frac{pe.e\_s}{K}$

while stocks of cash held by firms follow some trivial rule

41) $Hf\_d = \psi.S$

We are left with bank loans - the indispensable residual component of finance which covers inventories as they take up the slack between actual and expected sales and provide initial finance for fixed investment which gets repaid when undistributed profits rise, by 38), to pay for it in a later period.

42) $\Delta L\_d = IN + \Delta I - De\_s.pe + \Delta Hf\_d$

There remains, so far as firms' behaviour goes, the distribution of dividends, which is assumed to follow some simple rule e.g.

43) $FD = \delta.K_{-1}$

B) BEHAVIOUR OF HOUSEHOLDS

The conventional (elementary) assumption that consumption is some proportion, less than one, of disposable income obviously cannot describe a steady state since it implies, by 26) above that the real stock of wealth is increasing without limit.

We assume, fairly conventionally, that real consumption is some proportion (less than one) of expected real income plus another proportion of the opening real wealth stock

44) $c = \alpha_1.yd\_e + \alpha_2.v_{-1}$

This consumption function implies (bearing in mind the definition of real disposable income in 26) that, in a full steady (stationary) state where Δv must be zero, the consumption flow exactly equals the income fiow so, in an <u>ex post</u> sense, the average propensity to consume is then one although the marginal propensity to consume out of income obviously remains less than one.

Note that this consumption function can be alternatively written, substituting 26) and collecting terms, as a wealth adjustment function

45) $$\Delta v\_e = \alpha_2 \left(\frac{1-\alpha_1}{\alpha_2} .yd\_e - v_{-1} \right)$$

or, solving out lagged wealth recursively, consumption can be written as a function of current and lagged income with the coefficients constrained in a particular way, to sum to unity

45a) $c = \alpha 1.yd\_e + \alpha_2.\ (1-\alpha_1)yd_{-1} + \alpha_2(1-\alpha_1).(1-\alpha_2)yd_{-2}\ .\ .\ .$

We shall assume, analogously with our treatment of firms' expectations of sales, that expectations about real income are determined adaptively, with a random component

46) $yd\_e = yd_{-1} + R_2$

where R_2 is another random variable.

Expected end-period wealth is determined by opening wealth, capital gains, expected income and consumption. Any addition to wealth has to be exactly allocated between the six assets shown in Table 1 and described by 11).

It is assumed that the decision about how much cash to hold *is,* these days, completely unimportant and dependent entirely on the value of transactions carried out

47) $Hp\_d = \mu.C$

So asset choice proper is concerned with expected total wealth excluding cash, a variable termed VN

48) $VN\_e = V\_e - Hp\_d$

The asset demand functions may be arrayed, a la Tobin, as follows, with arguments covering all real rates of return, including that on cash - the negative of the inflation rate - in every one of them

49) $$\frac{M1^*\_d}{VN\_e} = \lambda_0 - \lambda_1 rrbb - \lambda_2 rrb - \lambda_3 rrm - \lambda_4 rrk - \lambda_5 \pi r + \lambda_6 \frac{YP\_e}{V\_e}$$

50) $$\frac{Bsp\_d}{VN\_e} = \lambda_{30} + \lambda_{31} rrbb - \lambda_{32} rrb - \lambda_{33} rrm - \lambda_{34} rrk + \lambda_{35} \pi r - \lambda_{36} \frac{YP\_e}{V\_e}$$

51) $$\frac{Bpd\_d.pb}{VN\_e} = \lambda_{10} - \lambda_{11} rrbb + \lambda_{12} rrb - \lambda_{13} rrm - \lambda_{14} rrk + \lambda_{15} \pi r - \lambda_{16} \frac{YP\_e}{V\_e}$$

52) $$\frac{e\_d.pe}{VN\_e} = \lambda_{20} - \lambda_{21} rrbb - \lambda_{22} rrb - \lambda_{23} rrm + \lambda_{24} rrk + \lambda_{25} \pi r - \lambda_{26} \frac{YP\_e}{V\_e}$$

where rrbb, rrb, rrm and rrk are all real rates of interest, derived using the Fisher formula for discrete time.

The demand for M3 is given by residual

53) $M3\_d = VN\_e - M1\_d - Bsp\_d - Bp\_d.pb - e\_d.pe$

but the full Tobinesque specifications which I have used ensure that the constant in the implied function is positive and the coefficients have the right signs, that is, a positive sign on the money rate of interest and negative signs on all other arguments.

It is assumed that mistaken expectations about disposable income turn up as differences in holdings of Ml compared with what was targeted in equation 49) above. Thus

53) $M1\_d = Ml^* + VN - VN\_e$

The demand for Ml (again a la Tobin) must be given a non-negativity constraint, which implies that, if households are very badly mistaken with regard to their expectations about income, their demand for M3, by 53) above will take any residual strain.

Note that while income as a share of wealth has been included in ail the asset demand functions in deference to the idea adopted by Tobin that there is a transactions demand for Ml, we have not allowed, in the simulation model, for any adjustment lags between desired and actual asset structures. This is yet another of the model's weaknesses!

Note however that the constraints on the coefficients are somewhat more elaborate than those proposed by Tobin, at least in Brainard and Tobin (1968). For surely the effect on the demand for any asset as resuit of a given rise in the rate of return on that asset ~~cet. par.~~ will not be different from that of a fall (of the same size) in the rates on all other assets, the own rate held constant. Accordingly it has been assumed in the simulation model that, reading each function horizontally, the sum of all coefficients on other rates of return will equal that on the own rate, and that the coefficient of each individual rate is roughly proportionate to the share of the asset in question in the total wealth stock.

What did we mean by rk, the rate of return on equity? Define the rate of (distributed) profit

55) $rr = \frac{FD}{K_{-1}}$

Once again following Tobin, we define the rate of return on equity

56) $rk = \frac{rr}{q}$

where q is the ratio of the total value of equity to the stock of physical capital valued at replacement cost described in 40).

If we now postulate an equilibrium condition

57) $ed = es$

then equation 52) determines the price of equity.

C) BEHAVIOUR OF THE GOVERNMENT

The government has four policy instruments at its disposal government expenditure, the tax rate, the short term (bill) rate of interest (which it announces) and the outstanding stock of long bonds, which it determines by open market operations. To say that the bill rate is an exogenous policy instrument is also to say that bills are supplied on demand (i.e. at the declared rate of interest) to whoever pays for them, households or banks

58) $Bsb\_s = Bsb\_d$

59) $Bsp\_s = Bsp\_d$

This is obvious enough in a way. But note that banks can only get more bills, cet. par. if they exchange them for reserves and households, to get more bills must exchange them for some other asset, typically the closest substitute - M3. But households will only be motivated to do this, in the model, if relative interest rates change in favour of bills and against M3.

The assumption that the government engages in open market operations with regard to bonds means that the equation equating demand and supply for long bonds

60) $Bp\_d = Bp\_s$

is an equilibrium condition which determines the long bond rate via the price of bonds in equation 51)

BEHAVIOUR OF BANKS

[Note to readers of the first draft. While I feel very confident about my accounting I am particularly uncertain about the section which follows although I believe it to be more important than anything else in this paper. So I am particularly anxious to get comments on this. The modern literature has very little, so far as I know, on the role of commercial banks in a macroeconomic model. In fact, the only piece of real stature that I know is Tobin (1969). However banks in Tobin's paper are essentially agents operating in financial markets who do nothing but make an asset choice exactly like the asset choice of households and conducted according to the same principles. The role of banks is thus nothing more than to extend the range of asset and liability choice open to households and firms. I am proposing something completely different from this which although not new has never so far as I know been formalised before. I am saying that (within strict limits e.g. concerning credit-worthiness) banks respond passively to the needs of business for loans and to the asset allocation activities of households (as well as providing the means of payment). They make profits not by deciding where to invest but by setting prices (i.e loan and money rates of interest) in response to quantity signals. Loans are not (negative) assets but factors of production which imply a cost of production as much as the employment of labour]

We come at last to the core of what this paper is designed to show as regards systemic behaviour (as opposed to systemic accounting). On the one hand we have the demand for cash from households and businesses and the demand for the two kinds of credit money from households which together make up the liability side of banks' balance sheets. And all these demands fluctuate at short notice in response to household income, expenditure and asset allocation as expectations are falsified or as expectations themselves shift. At the same time the demand for bank loans, being the residual source of finance for business, fluctuates in response to "the needs of trade" as demand and output evolves and as diverse expectations are formed and always to some extent falsified. The fluctuations in the demand for loans are the outcome of set of influences quite distinct from those determining the demand for money. Yet the banks have no difficulty (at least in the model) in fulfilling all the functions required of them, gassivelv. By this I mean that they will always "accept" a deposit made with them whether Ml or M3 (which means that they will always exchange one deposit for another or for cash or bills); and they will always make loans to finance certain types of expenditure, subject to security being satisfactory, which means that the loanee makes a draft on an account which has nothing in it, which turns up as someone else's deposit. And banks can do all this and stay continuously solvent and profitable.

How? The key resides in the fact, already pointed out, that as all other rows and columns in the flow of funds matrix sum to zero, the banks' balance sheet must always do the same thing - it is literally impossible for any configuration of demands for *money,* cash or loans whatever to disturb the equality between banks' assets and their liabilities so long as there is no default.

But this is not (yet) to say that the banks' activities will always be profitable. One threat to banks' profitability resides in the possibility that for one reason or another (for instance if non-banks' holdings of money fall at the expense of their holdings of government securities) banks' holdings of bills falls towards zero and threatens to become negative. At that point the profitability of banks' operations becomes threatened because the government (central bank) may not issue negative bills i.e. lend, except at penai rates of interest. Accordingly, it is assumed in the model that banks, if their holdings of bills threaten to become negative, will raise the money rate of interest, thereby inducing households to exchange government securities for holdings of M3. I have modelled this response, admittedly very crudely, by introducing a logical function which says that the rate of interest on money will be raised whenever banks' holdings of bills approach zero and reduced whenever they are above some low number.

61) $\Delta rm > 0,\ Bsb < 0;\ \Delta rm < 0,\ Bsb > 0.1$

Banks' freedom (in this model) to offer whatever rate they like on M3 will ensure that, except in some very short term, they do not have to borrow from the government.

The profitability of banks' operations as a whole can now be guaranteed because they can set the loan rate of interest at whatever rate ensures such an outcome. The condition which guarantees zero profits is that the loan rate is set such that[9]

62) $rl.L_{-1} = rm.M3_{-1} - rb.Bsb_{-1}$

We can now write in the remaining equations which describe, formally, the functions of banks.

It is assumed that, whether by law or custom, banks operate a fractional reserve system which keeps their liabilities as some multiple of their reserves

63) $Hb\_d = \rho\,(M1 + M3)$

For the rest, we now have enough degrees of freedom to write down the following equalities

64) $M1\_s = M1\_d$

65) $M3\_s = M3\_d$

66) $L\_s = L\_d$

The meaning of these equations is that once money rates have been set such that banks do not have to borrow from the central bank and loan rates such as will guarantee the profitability of their operations as a whole, banks <u>can profitably match any configuration whatever</u> of demand for money on the part of households and, determined quite separately, demand for loans on the part of firms.

If this account of banks' operations is correct in very broad outline, it makes no sense to attribute unidirectional causality to any part of their operations - to say, for instance, that "every loan creates a deposit". For we are looking at a completely interdependent system in which the final outcome, looked at *ex post*, is the resolution of a huge number of diverse impulses. It may sometimes be the case that an additional loan,

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[9] This equation has already appeared in the accounting section as 15)

for some period of time, can clearly be said to create a deposit. But it may equally be the case that a holding of money is used in such a way that it extinguishes a loan (as well as itself). Whatever else may be the case, it can never make any sense whatever to say of the stock of credit money that it is "exogenous" or that it can be "treated" as exogenous.

GATHERING SOME THREADS TOGETHER

Barring a few bits of accounting[10] too trivial to be worth a line in the text, I have now described a complete model. It has about eighty equations, and therefore eighty endogenous variables, which comprise all expenditures at constant and current prices, the national income and its distribution between wages and profits, stocks of real capital and inventories and six different financial assets, the price of goods, equity prices and several interest rates. The main exogenous variables, counting the way normally used by macro-economists, are the policy variables (government expenditure, the tax rate, the short interest rate, the stock of long bonds and banks' reserve ratio) plus nominal wage rates. However in my very strong view, those concepts which enter the functions in the form of "parameters" should be thought of as themselves being variables. It is, I believe, a crazy aspect of the econometric study of time series that it seeks to discover stable parameters where stability is obviously not there to be found[11]. For instance, there is every reason to suppose that in the real world the demand for Ml, and therefore the demand for all other financial assets as well, will be dominated by continuously changing expectations and by uncertainty with regard to a wide range of imponderables - the political outlook, the prospects for inflation, the exchange rate, and equity and other asset prices, as well as by self-generated and self-reinforcing swings in confidence.

The two most important things which a model of this kind does are first, simply to show with precision how all the concepts - a comprehensive system of stocks and flows at constant and current prices - fit together. Then, with numerical solutions easy to obtain, we can gain insights into how the system as a whole functions, by first obtaining a base solution and then changing one exogenous variable at a time to see what difference is made. It might seem as though any particular model "run" depends so much on the particular numbers used that the results are completely arbitrary and have no general application at all. However, it is my experience that repeated simulation, combined with iterative modification of the model itself, does progressively lead to improved understanding, for instance of what the stability of the system turns on, what combinations of parameters are plausible and how the whole thing responds

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[10] These were a few accounting equations too trivial to merit discussion in the text but which were necessary to complete the model. All the equations are gathered in a reasonably organised sequence in the appendix.

[11] See Hendry's attempt (in Baba _et. al._ 1992 to find a stable demand for money function for a good example of this.)

when subjected to shocks. So finally I note some general properties of the model and describe what happened when it was shocked in one or two ways.

The model solves easily and is stable. For reasons well known ever since the famous (1967) paper of Christ (further developed by Blinder and Solow (1975) and also by Tobin and Buiter (1976), a stock flow model (of a closed economy) of this kind has a theoretical full steady state in which the real output flow is equal to real government expenditure (defined to include the flow of interest payments) times the reciprocal of the tax rate. However the existence of a financial system may involve a very substantial degree of disturbance to the economy's evolutionary path. The most striking disturbance arises when wage inflation (which I have so far treated as exogenous) occurs. The important thing to say about inflation is that there is no way to prevent it from destroying large quantities of financial wealth which has a deflationary impact on real demand. (This has already been pointed out by Tobin (1982). If real interest rates are kept constant the (adverse) impact effect on real wealth stocks is even greater. However, it is also the case that if the government adopts a neutral fiscal stance, the economy does, after a long time, return to the same steady state. During the recovery period - and helping to generate the recovery - the government must be held to be running a deficit and therefore shelling out financial assets which eventually restore the depleted wealth stock.

Now for a few experiments. Compared with some given "alternative" position, try assuming that the government reduces short term interest rates and, by implication, simultaneously increases the stock of cash and reduces the stock of bills. What happens? The net effect is to reduce all interest rates, increase the price of equity and stimulate demand sure enough. Moreover, as we have assumed a fractional reserve banking system, the total stock of credit money goes up in proportion to the rise in banks' reserves (not the same thing, incidentally as the rise in total cash because households change their cash holdings too). <u>But the mechanism by which the stock of money goes up is entirely different from that in the textbooks</u>. For loans increase only by some second order amount to cater for the needs of trade. The main counterpart of the increase in the stock of money is a reduction in non-bank holdings of government securities, which comes about because banks' change the money interest rate relative to the bill rate in order to satisfy the zero profit condition.

Another interesting simulation result is that with mark-up pricing, even if one makes the assumption that money wages follow a random walk, a regression of wage inflation on price inflation invariably turns up with a coefficient in the region of unity. If one adds employment this takes on a positive coefficient and lagged real wage rates takes on a negative coefficient. So although as Creator we know that wages behave randomly the regression is telling us that we have a vertical Phillips curve!

I have read speculations in the post-Keynesian literature about what may happen if (other things being equal) there is a collapse in confidence which increases the demand for cash. One might say (I have seen it said) that this will reduce activity because it implies a reduction in the demand for other assets which will reduce their price, thereby giving rise to a wealth effect on consumption.

The model presented here, even in its present very undeveloped form, makes it possible to think about a proposition of this kind with increased precision. Thus, one's first impulse might be to shock the solution by entering a higher constant in the demand for Ml equation (λ in equation 49). However if that is all one does, the structure of the model is such that (ex an-) the whole of the increased demand for Ml has its counterpart in reduced demand for M3 - clearly an extreme assumption. So (as we discover) the only sensible way to do the experiment is to specify just where the money is to come from by adding to λ_0 but simultaneously deducting appropriate amounts from λ_{10} and λ_{20} - the constants in the other asset demand functions. When I actually did shock the system in this way, I found that initially there was, indeed, a fall in the price of equity, which had the effect of reducing total real demand. However, this effect was not necessarily enduring, depending on the extent to which the rise in holdings of Ml was offset by a fall in holdings of M3 (as compared with other assets). Thus any switch from M3 to Ml increases banks' *ex ante* profits (for their total liabilities cost them less at given individual interest rates) and this puts a downward pressure on money and loan rates which (by equation 5.2) has the effect of *raising* equity prices again.

Equations of the model

The equations are exactly the ones used in the computer model and differ slightly from those in the text because of the exigencies of computer logic. For this reason the following equations have a different numbering system. Note that the endogenous variable determined in each equation is always placed on the extreme LHS, e.g. equations X43 and X44 determine, respectively, bond and equity prices

X1 $S = C + G + IN$

X2 $Y = S + \Delta I - IVA$

x3 $C = c.p$

x4 $G = g.p$

x5 $IN = in.p$

X6 $I = i.UC$

x7 $WB = W.N$

X8 $UC = WB/\bar{y}$

x9 $IVA = \Delta UC.i_{-1}$

X10 $\bar{y} = \bar{s} + \Delta i$

X11 $\bar{s} = \epsilon.s$

x12 $s = c + g + in$

X13 $y = s + \Delta i$

x14 $p = (1 + \tau)(1 + \gamma) HC/s$

x15 $HC = WB - \Delta I + rl.Ld_{-1}$

X16 $T = S.\tau/(1 + \tau)$

x17 $\gamma = FN/HC$

X18 $i^* = \zeta.\bar{s}\_e$

x19 $i\_p = i_{-1} + \omega.(i^* - i_{-1})$

x20 $i = i\_p - (\bar{s} - \bar{s}\_e)$

x21 $\bar{s}\_e = \bar{s}_{-1} + R1$

x22 $FN = FU + FD$

X23 $FU = IN\_,$

X24 $FD = \delta.K_{-1}$

X25 $in = \beta_1 (k^* - (1 - dep)\, k_{-1})$

X26 $k^* = \beta_0\, \bar{s}\_e$

X27 $k = (1 - dep)\, .\, k_{-1} + in$

x28 $K = k.p$

x29 $rr = FD/K_{-1}$

x30 $rk = rr/q$

x31 $q = pe.e\_d/K$

x32 $\Delta e\_s = \phi\, (q_{-1} - 1)$

x33 $\Delta L\_d = IN + \Delta I - FU - \Delta e\_s.pe$

x34 $\ln(N) = \eta_0 + \eta_1 \ln(y)$

x35 $YD = WB + FD + rm.m3\_d_{-1} + rb.Bsp\_d_{-1}$
$+Bp\_d_{-1}$

X36 $yd = YD/p$

x37 $\Delta V = YD - C + \Delta pb.Bp\_d_{-1} + \Delta pe.e\_d_{-1}$

X38 $v = v/p$

x39 $c = \alpha_1\, yd\_e + \alpha_2 .v_{-1}$

x40 $Hp\_d = \mu C$

x41 $M1^*\_d = VNe.\_ \quad + \lambda_1\, rrbb - \lambda_2\, rrb - \lambda_3 .\, rrm$
$-\lambda_4\, rrk - \lambda_5\, \pi r + \lambda_6\, YD\_e/VN\_e)$

X42 $Bsp\_d = VN\_e(\lambda_{00} + \lambda_{01}\, rrbb - \lambda_{02}\, rrb - \lambda_{03}\, rrm$
$- \lambda_{04}\, rrk + \lambda_{05}\, \pi r - A,,\ YD\_e/VN\_e)$

x43 $pb.Bp\_d = VN\_e\, (\lambda_{10} - \lambda_{11}\, rrbb + \lambda_{12}\, rrb = \lambda_{13}\, rrm$
$- \lambda_{14}\, rrk + \lambda_{15} .\pi r - \lambda_{16}\, YD\_e/VN\_e)$

x44 $pe.e\_d = VN\_e\, (\lambda_{20} - \lambda_{21}\, rrbb - \lambda_{22}\, rrb - \lambda_{23}\, rrm$
$+ \lambda_{24}\, rrk + \lambda_{25}\, \pi r - \lambda_{26}\, YD\_e/VN\_e)$

x45 Ml_d = Ml'_d + (VN - VN_e).Z

X46 Z = Ml*_d.GT.0

x47 M3_d = V - Hp_d - Ml_d - Bsp_d - Bp_d.pb - e_d.pe

X48 VN_e = V_e -Hp_d

x49 Vn = V - Hp_d

x50 V_e = V_{-1} + YD_e - C

x51 YD_e = YD_{-1} + R_2

x52 yd_e = YD_e/p

x53 π = Δp/p_{-1}

x54 nr = π/(1 + π)

x55 pb = 1/rbb

X56 rrm = (rm - π)/(1 + π)

x57 rrbb = (rbb - π)/(1 + π)

X58 rrb = (rb - π)/(1 + π)

x59 rrk = (rk - π)/(1 + π)

x60 Hp_d = μC

x61 AH_s = G + Bp_s_{-1} + rb.Bs_s_{-1} - T - ΔBs_s - ΔBp_s.pb

X62 Bsb_d = Ml_s + M3_s - L_s - Hb_d

X63 Hb_d = ρ(M1_s + M3_s)

X64 rl.L_s_{-1} = rm. M3_s_{-1} - rb.Bsb_d_{-1}

X65 Δrm = ZED. .005 - EX. .005

X66 EX = Bsb_d_{-1}.GT. .01

X67 ZED = Bsb_d_{-1}.LT. 0

X68 Hp_s = H_s - Hb_s

X69 Bs_s = Bsb_s - Bsp_s

x70 L_s = L_d

x71 Ml_s = Ml_d

X72 M3_s = M3_d

X73 e_d = e_s

x74 Bsp_s = Bsp_d

x75 Bp_d = Bp_s

X76 Bsbs = Bsbd

x77 Hb_s = Hb_d

LIST OF VARIABLES

N.B. When variables are given in two versions, UC and LC, the former refers to current prices, the latter to constant prices

Bp = Bonds
Bsb = Bills held by banks
Bsp = Bills held by households
Bs = Total bills
C,c = Consumption
dep = Rate of capital consumption
e = stock of equity
EX = 1 or 0 (as ZED below)
FG = Gross profits
FD = Distributed profits
fr = Reserve ratio
FU = Undistributed profits
G,g = Government expenditure
H = Total cash
HC = Historic costs
Hb = Cash held by banks
Hp = Cash held by households
I,i = The stock of inventories
IVA = Stack appreciation ("inventory valuation adjustment" in American English)
K,k = The stock of fixed capital
L = Bank loans
Ml = Non interest bearing credit money
M3 = Interest bearing money
N = Employment
p = price of goods
pb = price of bonds
pe = price of equity
pi = inflation rate
pir = ditto expressed as a rate of return
q = Tobin's q
Ral, Ra2 etc = A random variable
rb, rbb, rl, rm, rk, rr = nominal rates of interest on bonds, bills, loans, money, equity, capital
rrb, rrb, rrl, rrm, rrk = real rates of interest ditto
S,s = Total final sales
sbar = Ditto valued at cost
T = Tax flow
tau = The rate of indirect tax
UC = Unit wage costs
V,v = Wealth stock
VN,vn = Wealth excluding cash
WB = Wage bill
W = Wage rate
Y,y = GDP
ybar = Ditto valued at cost
YD,yd = Household disposable income

ZED, ZED1 = 1 or 0 These are variables to operate the logical function which imposes non-negativity (or other) constraints

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