Macroeconomics Without Equilibrium or Disequilibrium[1]

by

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Working Paper No. 205

August 1997

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ABSTRACT

This paper uses a simulation model to describe the role which bank money and bank loans must play when decisions by households and firms are taken under conditions of uncertainty and when production takes time. Its main purpose is to integrate the theory of money and finance into that of income determination, in what may broadly be called the Keynesian tradition. Stocks of bank money and cash are found to be irretrievably endogenous. Great importance is attached to the accounting framework which, though simplified, comprises a comprehensive system of stocks and flows which enables sequential solutions to be found. The simulation method makes it possible to pin down exactly why the model behaves as it does. The model suggests the basis for a way of looking at the world which is fundamentally different from that used in the neo-classical paradigm.

KEYWORDS: MACROECONOMICS, STOCKS & FLOWS, REAL TIME, BALANCE SHEETS, ENDOGENOUS MONEY, CREDIT, LOANS, BANKS, SIMULATION, PROFITS

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[1] I owe a special debt to George McCarthy who has helped and guided me throughout in all manner of ways. I am also indebted to Stephanie Clark, Anwar Shaikh and Malcolm Sawyer for extensive discussions; and to Robert Solow and Lance Taylor who both wrote careful critiques of an earlier draft.

INTRODUCTION

This paper uses a simulation model[2] to describe the role which banks have to play when decisions by households and firms are taken under conditions of uncertainty, and when production, distribution and investment all take time. The first objective of the study is to supplement the narrative method used perforce by Keynes and his followers before the computer age. But it also adumbrates an alternative way of looking at the world - alternative, that is, to the neo-classical paradigm which is used by "IS/LM" Keynesians, new Keynesians, monetarists of both kinds, quantity rationers and almost all writers of modern textbooks. Its title emulates Kaldor (1985) and its contents derive largely from Hicks (1989) and from Tobin's work read *seriatim*.

The neo-classical synthesis (NCS) is characterised in all its versions by three uncomfortable features. First, the concept of an exogenous money stock which can be "controlled by the Fed" is required if this class of models is to be capable of solution. The entire apparatus of IS-LM diagrams, which is still the workhorse of macro teaching, requires that the "money supply" is not merely exogenous but *fixed*[3]. Bank loans have no essential

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[2]All the simulations were carried out using MODLER software.

[3] Of course the IS-LM model can be re-solved using alternative assumptions about the money stock. But this is not the same thing as "increasing the money supply" as a process in time. The IS-LM diagrams make me think of childrens' "pop up" books which generate three dimensional images out of two dimensional space; you can get a series of images but only by closing the book and opening it at different pages!

role, if any, to play[4]. Second, the NCS takes it as axiomatic that prices send all the signals which govern action, even when the signalling system doesn't work well because of rigidities, imperfections, asymmetries in information flows etc. And expectations, which have become such an important part of economics in recent years, are invariably expectations about prices. Third, mainstream thinking, as Hicks pointed out with increasing emphasis in his later works, has no satisfactory way of handling real time. The theory of exchange, even when inter-temporal "trade" is assumed to occur, cannot characterise the Hicksian "traverse" - the whole sequence of events which carries the community, often chaotically, through history. These three uncomfortable features of the NCS constitute a syndrome which has its roots in a vision of the universe as consisting, in its essence, of a single market where individual maximising agents exchange goods, labour, money and "bonds" with *one another*. The NCS sponsors the belief that strong conclusions can be drawn about how the real world actually works (e.g. what determines the level of real output and employment) from assumptions about supposedly rational behaviour in advance of any empirical study.

In the model proposed here, there is literally no such thing as a "supply" of bank money, at least in the sense required for the solution of the IS-LM model - that is, a supply distinct from demand, with an equilibrium condition equating the two and thereby determining "the" rate of interest. Banks *accept* money

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[4] Surely the absence of the asset side of banks' balance sheets - the loans they make - is a lacuna of great significance in Patinkin (1956)

and undertake to exchange it in various ways. They respond to the fluctuating needs of firms for revolving finance and of households in the management of their transactions and the disposition of their wealth, while remaining profitable and solvent. Governments can no more "control" stocks of either bank money or cash than a gardener can control the direction of a hosepipe by grabbing at the water jet. Decisions by households, firms *and banks* are mainly based not on price but on quantity signals which often take the form of realised stocks of wealth or inventories. Expectations concern such diverse things as sales, income and wealth. Historical time is intrinsic because the past, in the form of state variables, is inherited by each period; then a transition to a new state takes place which becomes the inheritance of the subsequent period. Simulation is used because unruly sequences cannot be penetrated by static or equilibrium methods; the method makes it possible to pin down exactly why the sequences occur as they do. Nothing, it is maintained, can be known about the real world unless it is actually studied empirically, hence no greater claim is made for the model presented here than that it is an elementary schema laying out a rigorous space within which empirical macro-economics can proceed. The starting point we lay down is a realistic, if simplified, characterisation of the institutional framework within which all modern capitalist economies operate.

Our model, looked at one way, is the extreme antithesis of the Walrasian model. Yet agents' disparate plans, expectations and outcomes are all reconciled with one another in it - though obviously not by a heavenly auctioneer calling prices; the reconciliation occurs through the agency of banks when they allow loans and all kinds of money to expand and contract, without anyone even noticing, in response to the uncoordinated needs of firms and households. The model does have an important Walrasian feature however. It is based on a complete, if simplified, system of stock and flow accounts set in a double entry framework where every variable performs a different role according to the context in which it occurs e.g. according to whether it describes an asset or a liability. It then follows that there is always one variable which is determined by two different equations which must both give the same answer when the model is solved. Such completeness is perhaps a hallmark of any properly constructed model of a whole system.

The first section of the paper displays the accounting framework of the model, the second describes the behaviour of the four sectors which make it up, the third shows how the whole thing works using four numerical simulations and a concluding section draws some strands together. An appendix contains a glossary and lists the equations used to generate the simulations. The reader is invited to skip, first time round, to the simulation results which give a quick general idea of what is at issue.

THE ACCOUNTING FRAMEWORK

The following matrices set out the stock and flow accounts on which the model is based. The major simplifications are that the economy is closed, there is no fixed investment, no fixed capital and no equity: households do not borrow and firms do not hold money; all bonds are "bills" of which the capital value does not change when interest rates change; money wages and productivity are constant. While these assumptions make the model unrealistic as a representation of the real world, there remains enough to characterise precisely the main, very basic, features of a monetary economy. Although simplified, the model is not *arbitrary,* for it is complete in its own terms; everything visibly goes somewhere and comes from somewhere.

Table 1 Flow of Funds at Current Prices

	Households	Firms: Current	Firms: Capital	Banks: Current	Banks: Capital	Govt	Row Sum
Consumption	-C	+C					0
Gov't Expenditure		+G				-G	0
[Sales]		[S]					
Stockbuilding		+ΔI	-ΔI				0
Tax		-T				+T	0
Wages	+WB	-WB					0
Profits	+F	-Ff		-Fb			0
Interest on loans		$-rl.L_{-1}$		$+rl.L_{-1}$			0
Interest on money	$+rm.M_{-1}$			$-rm.M_{-1}$			0
Interest on bills	$+rb.Bp_{-1}$			$+rb.Bb_{-1}$		$-rb.B_{-1}$	0
[Disposable income]	[Yd]						
Δstock of cash	-ΔHp				-ΔHb	+ΔH	0
Δstock of current deposits	-ΔMn				+ΔMn		0
Δstock of demand deposits	-ΔM				+ΔM		0
Δstock of bills	-ΔBp				-ΔBb	+ΔB	0
Δstock of loans			+ΔL		-ΔL		0
Column Sum:	0	0	0	0	0	0	0

The flow matrix shows how the model comprises four sectors, households, firms, government and banks; it also defines most of the symbols to be used. Households receive all factor income plus interest payments on their assets. What they do not spend on consumption has an identical counterpart in changes in wealth, somehow allocated between four assets - cash, non-interest bearing money, interest bearing money and government bills. Firms produce and sell goods and services, accumulate inventories, borrow from banks, pay wages and distribute profits. Banks have credit money (both kinds) as liabilities and loans, bills and cash for assets. Their transactions in assets may all be looked on, reading horizontally, as residuals which makes the row in question sum to zero; they can be seen this way because, since every other column sums to zero, the banks' transactions must do so as well. Banks' profits are the excess of interest receipts over interest payments. The government spends, taxes, and pays interest on its debt. Any deficit has, as its counterpart, a change in cash plus bills in some combination.

Table 2 shows the stock (balance sheet) counterpart of the flow matrix. Every financial asset is matched by a financial liability. Total household wealth is equal to the sum of money plus bills (reading vertically) or equivalently (reading horizontally) to the stock of government debt plus the stock of inventories valued at cost - the only tangible asset in this model. It is transactions in assets in Table 1 which heave the stock variables in Table 2 from one period to another.

TABLE 2 BALANCE SHEETS

	Households	Firms	Banks	Government	Row
Inventories		+I			I
Cash	+Hp		+Hb	-H	0
Current Deposits	+Mn		-Mn		0
Demand Deposits	+M		-M		0
Bills	+Bp		+Bb	-B	0
Loans		-L	+L		0
Column Sum	V	0	0	DG	I

Where V = Household wealth

DG = Total government liabilities

SECTION 3 BEHAVIOURAL ASSUMPTIONS

In this section, the behaviour of the four sectors of the model will be described for the most part verbally, but equations will be used when precision calls for them. Moving from the world of accountancy to that of behaviour requires that each concept be given a different function according to the context in which it occurs and suffixes will be apportioned accordingly; for instance the suffix _e denotes an expected value, a star indicates a desired value and so on. Only those symbols which describe *ex post* realised values will have no suffix. The simulation model is given, as a complete system of about forty equations, in the appendix[5].

THE BEHAVIOUR OF FIRMS

The following schema describes the main decisions firms take[6] and shows why bank finance is required if normal business is to proceed.

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[5] The equations listed in the text only have an expository function and do not constitute a complete system. The appendix model has equations numbered A1, A2, etc.

[6] The schema is very spare, concentrating largely on accountancy. But even this is quite a big job! For instance, to bring enough precision to the model for numerical solutions to be obtained, ten equations were needed to describe firms, fifteen for households and eleven for banks. It was, in particular, an

"Firms" here comprise the distributive chain as well as producers narrowly defined. The manufacturing firm makes goods over a period of time which intermediary traders stock, advertise, guarantee and market, normally holding prices fixed - certainly in response to short run fluctuations in demand - and the whole chain of agents is in a state of uncertainty about what the value of sales and profits will actually be. It will be assumed that firms are operating within the normal range of outputs at which running costs per unit of output are constant and that they base their decisions about production and prices on the quantity they expect to sell at the price they choose plus any adjustment to inventory levels they wish to see[7].

Realised sales are determined by actual consumption plus government expenditure and realised inventories by planned inventories modified by the difference between expected and actual sales. Realised profits are then given by residual as shown in column 2 of the transactions matrix, Table 1, namely

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[7] This obviously contrasts with the neoclassical assumption that firms are all on their production frontiers producing at the spot where price equals marginal cost. As Hicks (1989 p.22) put it "There is no need to assume that there is a single optimum output for which the plant is designed; it is better, being more realistic, to think of it as having a *regular* range of outputs...which it is...fitted to produce [and] ...over that range marginal cost is simply running cost per unit of output...which could be considered constant..." The limit to production is a matter beyond the scope of this paper but we protest that this is not realistically described by a putative limit beyond which it is unprofitable to fulfil an additional order.

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

where Ff is profits of firms, S is final sales (consumption plus government expenditure), T is indirect taxes, WB is the wage bill, rl is the rate of interest on loans and I inventories valued at cost[8]. It will be assumed that profit margins are set like tax rates, as some proportion of the pre-tax value of sales - an assumption which is broadly consistent with the stylised facts, since the share of profits in total final sales, though cyclical and subject to trends, is a quite well behaved number. It will also be assumed that realised profits are all distributed to households. These assumptions have two very important logical implications. First, if profits are a constant share of sales, then it must also be the case that prices are a constant mark-up on the historic cost of production. Second, if profits are all distributed, it must also be the case that bank loans expand and contract, $ for $, with inventories.

To show this, note first that as, taking all firms together, wages are the only cost of production, the end period value of inventories is the proportion (σ)of the wage bill incurred each period which is not embodied in sales that period.

[8] The interest cost of holding inventories must be included among costs particularly if the definition of profits in Table 1 is to survive meaningfully when inflation is introduced into the model. The term $rl.I_{-1}$ is identical to stock appreciation (IVA) when the rate of interest equals the inflation rate. The universal convention used by national income accountants is simply to deduct stock appreciation from gross profits but that is a crude and often inappropriate adjustment e.g. when real interest rates are negative or fluctuate a great deal.

2) $I = \sigma . WB$

Putting 2) into 1) we get an alternative, more intuitive, way of describing profits which makes the time factor more explicit and intelligible.

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

In words, profits are equal, by definition, to the excess of receipts from ex-tax sales over what it cost, historically, to produce what was sold. The third term on the right hand side of 1a) describes the proportion of costs incurred this period which is embodied in sales this period; the fourth term describes the costs incurred last period which will be embodied in sales this period, including the interest cost which arises from the fact that production takes time.

Defining the last two terms in (1a) as historic cost (HC) we can write

1b) $S = T + Ff + HC$

or

1c) $S = (1 + \tau).(1 + \beta).HC$

where τ is the tax rate and β the rate of profit mark-up.
It can now be seen why, with historic cost pricing and full distribution of profits, changes in inventories valued at cost

must always be matched exactly, $ for $, by changes in loans from outside the production sector. This now follows directly from the definition of profits in equation 1, for if all profits are distributed, the cash flow derived from sales falls short of what is needed for taxes, wages and interest payments by exactly the amount of the increase in inventories. Injections of revolving finance from outside are thus essential if firms are to undertake production in advance of sales and also extract (and distribute) profits from the business as sales are made and profits realised.

How are firms' expectations about sales formed? The question probably doesn't have a good or general answer. The assumption underlying this paper is that we live in a contingent world about which economic theory cannot tell us very much and which can only be understood better as a result of laborious empirical study, with pattern recognition a key element in the type of cognition required. The important thing here is that we have a way of dealing with the fact that sales never turn out as expected. The signal to which firms respond is not a price signal but, typically, a quantity signal; it is in response to realised sales and therefore inventory levels that firms decide whether or not to increase or reduce production, change prices or, in a more complete model, invest. Meanwhile bank loans expand and contract buffer-wise to the extent that expectations are falsified.

BEHAVIOUR OF HOUSEHOLDS

Consumption is determined by the stock of wealth inherited from the previous period together with the expected flow of disposable income, ignoring, for the time being, consumer credit and asset price changes.

3) $C = C(Yd\_e, V_{-1})$ $\quad 0< C_1, C_2 <1$

This, given the accounting relationship describing wealth accumulation

4) $\Delta V = Yd - C$

necessarily implies a precise value for the desired long run wealth-income ratio.

As shown in Table 1, any addition to wealth must be allocated between four assets - cash (Hp), non-interest bearing money (Mn), interest bearing money (M) and bills (Bp) - and the way this happens in the model owes everything to James Tobin and his associates.

Households aim to apportion their wealth between the assets available to them, in proportions which depend on the rates of interest on offer subject to their having enough spendable money (current deposits and cash) for transactions and to take the strain when unexpected things happen. In order to understand (or model) the process it is absolutely essential to distinguish interest bearing from non-interest bearing money, the two being held for very different reasons[9].

In the model, since cash holdings are nowadays so unimportant, they are assumed to be some straightforward proportion of consumption which is unaffected by interest rates. Intended holdings of other assets are described by the following functions where the suffixes _e and _h denote that the variable in question, lifted out of the accounting matrix into the world of behaviour, denote what households "expect" or "hold". The word "hold" contrasts with the usual, perhaps prejudicial, expression "demand for" money or other assets.

$$5)\quad Mn\_h^{*}/Vn\_e = Mn(\overset{-}{rm},\ \overset{-}{rb},\ \overset{+}{Yd\_e/Vn\_e})$$

$$6)\quad M\_h/Vn\_e = M(\overset{+}{rm},\ \overset{-}{rb},\ \overset{-}{Yd\_e/Vn\_e})$$

$$7)\quad Bp\_d/Vn\_e = B(\overset{-}{rm},\ \overset{+}{rb},\ \overset{-}{Yd\_e/Vn\_e})$$

where rm, rb are the rates of interest on respectively money and bills and Vn is wealth net of cash holdings. Mn_h, holdings of non interest bearing money, has a star which means that the function describes an aspiration.

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[9] It often happens that the two are added together in neo-classical texts, notwithstanding that they are chalk and cheese, because together they constitute the liabilities of the banking system and are therefore the end product of the "money multiplier" on which so much is supposed to hang.

It is essential that the income terms in these equations be scaled by wealth, otherwise the share of Mn in wealth (at given interest rates) will rise through time with income[10]. The constraints and adding up properties hardly need emphasising; the sum of constants must be 1 since total wealth must equal the sum of its parts, the sum of coefficients on each interest rate (reading vertically) must be zero, and the sum of coefficients on the income term must be zero as well. The sum of coefficients on the interest rates in equations 6) and 7) reading horizontally must be approximately zero too because there can be no great difference between raising the own rate of interest and reducing the sum of all other interest rates.

It is assumed that the planned holdings described in 6) and 7) go through but that holdings of non interest bearing money perform a "buffer" role. The aspiration is given in equation 5) but the actual outcome modifies this to the extent that income expectations are falsified.

8) $Mn\_h = Mn\_h^{*} + Yd\_e - Yd$

As any two of the three equations 5) to 7)imply the third, we can

[10] Was it a slip in Brainard and Tobin (1968) to make this argument in income alone? This incomplete formulation has found its way into a number of texts.

represent holdings of interest bearing money as the residual between net wealth and total holdings of the other two assets.

9) $M_h = V_n - Mn_h - Bp_h$

In the simulation model, holdings of Mn are constrained to be non-negative. If actual income falls short of expectations by enough to eliminate holdings of Mn, equation 9) ensures that households delve into their demand deposits.

As with firms, we don't have a very strong view about how expectations are formed. Under certain circumstances expectations can be important, for instance if whole generations alter their savings patterns. But normally, as is the case with firms, households are kept on the rails by the regular information they receive about their stocks of wealth. Nothing guides people more remorselessly than the monthly bank statement.

THE BANKS

Banks may be said, without putting an excessive strain on language, to "supply" loans although it seems more natural to say that they "make" them. But they do not, in any sense recognisable to common parlance, "supply" money unless what is being referred to is a *loan*[11]. What they do is *exchange* assets for one another

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[11] For instance, one might perfectly well respond to the question "How could you afford it?" by saying "I got the money from a bank". But this response states that a bank *loan* has been granted which stands as a liability (i.e not money) in the books of the respondent.

or for loans. Presented with a valid cheque banks will make (it is part of what they undertake to do by taking you on as a client) the appropriate entries in whatever account is designated or hand cash over the counter without question; presented with cash, they will make a counterpart addition to a current or deposit account or reduce a loan. The making of these exchanges has nothing in common with the exchange of money for goods and services (say haircuts) where the business makes a profit by appropriating some proportion of what is sold. Banks make their profits in a completely different way - by receiving a higher rate of interest on their assets than what they pay on their liabilities. In what follows, the assumption that banks take a passive role with regard to this switching will be emphasised by using the suffix _x, denoting exchange, rather than the usual _s for supply. It has already been pointed out that if firms distribute all their profits, they must be getting finance from banks on a scale which matches the value (reckoned at cost) of inventories one for one, and it is an assumption of the model that this is what in fact happens.

To formalise, the banks' balance sheet constraint is

10) Bb_h = Mn_x + M_x - L_m - Hb_h

which says that their holdings of bills and cash plus the loans they have made must exactly equal the money they have exchanged into, or accepted as, deposits of bank money.

Banks' profits (Fb) are given by the excess of receipts of interest on their assets (loans and bills) over payments of interest on money.

11) $Fb = rl.L\_m_{-1} + rb.Bb\_h_{-1} - rm.M\_x_{-1}$

In the absence of equity capital, banks' profits all simply flow to the household sector.

We next assume that banks have to hold reserves, in the form of cash, in some fixed proportion to their liabilities.

12) $Hb\_h = Fr.(Mn\_x + M\_x)$

To guarantee that banks make profits, two conditions have to be met. The first is that the rate on loans exceeds the rate on money. In practise the rate on loans is higher than the rate on bills as well, otherwise banks would make higher profits by holding bills than by making loans. This is modelled by making the loan rate exceed the money rate by some mark up, but when this is insufficient to get the loan rate above the bill rate a trigger mechanism is introduced to make it do so.

This has been modelled, Heath Robinson style, as follows

13) $rl = rl1.X1 + rl2.X2$

where

13a) $rl1 = (1 + \phi_1).rm$

13b) $rl2 = (1 + \Phi_2).rb$

X1 and X2 take on the value 0 or 1 depending on whether rl1 is greater or smaller than the bill rate and Φ_1 & Φ_2 denote rates of mark-up.

The second condition necessary to ensure that banks make profits is that their bill holdings are normally positive - they do not have to borrow for long from the government at penal rates. We model this by making banks raise the money rate of interest in steps whenever their bill holdings fall below a certain level (relative to their liabilities) and reduce the rate on money whenever bonds are above this critical level.

More precisely,

14) Δrm = (Z1 - Z2) times some small number

where Z1 and Z2 take on the value 0 or 1 depending whether the banks' bill to asset ratio is above or below the critical level.

The remaining equations describing the dealings of the banks with households and firms are

15) Hp_x = Hp_h

16) Mn_x = Mn_h

17) M_x = M_h

18) $Bp\_x = Bp\_h$

19) $L\_m = L\_r$

It has already been pointed out, in section 2, that as every row in the transactions matrix sums to zero and every column excluding banks sums to zero, it follows that the column describing banks' transactions must sum to zero as well. This property of banks' balance sheets means that banks can exchange, with impunity, any one kind of asset for any other and simultaneously make loans, on any scale whatever. *None of the equations above is an equilibrium condition in the ordinary sense.* There are enough equations in the model for banks to be able to respond immediately and profitably to any configuration whatever of asset holdings desired by households and simultaneously the loan requirements of firms.

THE GOVERNMENT

The government's budget constraint is simple and traditional

20) $\Delta H + \Delta B = G + rb.B_{-1} - T$

The government has three policy instruments at its disposal; the flow of Government expenditure, the rate of tax, in our model all indirect, levied on all types of expenditure and the rate of interest on bills. The announcement of a bill rate of interest implies that the government will exchange any quantity of bills at that rate of interest for cash.

21) $B\_x = Bb\_h + Bp\_h$

And this, given that households' bill holdings are determined in 7), means we can write

22) $Bb\_x = Bs\_x - Bp\_h$

where the suffix x means that the asset has been passively exchanged for something else (cash in this case). The governments' bill liabilities are what is left over as a residual from all the government's other transactions.

We have at last completed the Walrasian circle! We have an equation both in banks' holdings of bills (equation 10, A25 in the appendix) and also in the government's exchange of them with banks (equation (22) above, A37 in the appendix). After much travail we have established a logical architecture such that the two are found, indeed, to be equal to one another when the model is solved. It is not immediately obvious that this should be so for the two equations come, as it were, from two quite different directions. From one direction banks' bill holdings are the residual of the relatively active components of the banks' balance sheet (all three kinds of money plus loans). From the other direction, banks' holdings of bills are the residual of all the government's other transactions. At each instant of time, the bills which the government finds that it has sold to banks is the same number as the bills which the banks find, for entirely different reasons, that they have needed to buy from the government. The two versions of Bb will only be equal if the accounting in all the rest of the model is complete and watertight. To achieve this is easier said than done.

In the neo-classical model it is habitual to use the same government budget constraint as here (equation 20) and then to declare any one of cash, bills or interest rates exogenous whereat the other two become endogenous (see, for instance, Modigliani (1963)). In the absence of historical time, there is nothing untoward about this. As pointed out in the footnote to the second paragraph of this paper, the neo-classical model in its market clearing version can be solved using alternative assumptions about the stock of money which will, yes, make no difference to any component of the model's solution except the "price level". Set in historical time, however, with banks providing loans, exchanging assets and keeping guard, with an inevitable time lag in their response, over any untoward changes in the structure of their balance sheets, the position is entirely different. The government's *ex post* deficit is a residual over which the government has no direct control and the banks' holdings of bonds are a residual over which the banks have no direct control. The total stock of cash is thus a residual made up of two other residuals, neither of which can be directly controlled! So much for the dogma contained in every modern textbook, on which the whole neo-classical edifice rests, which says that the stock of cash is "controlled by the Fed" with the stock of bank money (both kinds in an ugly lump) determined thence by the money multiplier. In our model, notwithstanding that there is a rigid fractional reserve rule in place, the entire chain of causality is reversed compared with this story!

Credit money holdings have two starkly different component parts, interest and non interest bearing; one is determined as part of households asset allocation decision, the other by households' fluctating needs which in any short period are bound to move in unexpected ways. The stock of cash (excluding that held by households) is then determined by the stock of bank money (both kinds together) via the fractional reserve ratio; banks must swap cash for bills until their reserve requirements are met.

LONG RUN PROPERTIES OF THE MODEL

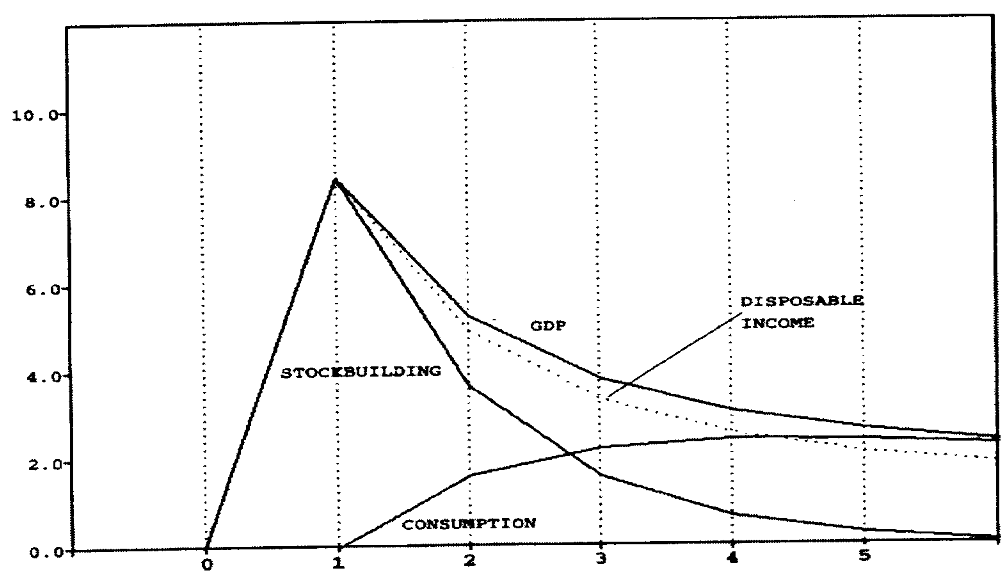
Before coming to the simulations, it remains to point out that, in accordance with the famous insight of Carl Christ (1967) subsequently embellished by Blinder and Solow (1975) and Tobin and Buiter (1976), the full steady state of any properly specified stock-flow model of a closed economy will be one in which (as all stock variables are then constant) the tax take exactly equals government outlays. Hence, if taxes are levied in some proportion to income (or sales), the steady state flow of GDP must be equal to government outlays times the reciprocal of the tax rate. The steady state stock of wealth is determined in the consumption function and the steady state stock of government liabilities will be equal to wealth less private sector loans.

SECTION 4 SIMULATIONS

In this section the model's properties are demonstrated using numerical simulations. Although the results are conditional on rather arbitrary values which have been attributed to variables and parameters, our conjecture is that, once a comprehensive system of stock and flow accounts has been designated, the behaviour of the model will be very broadly the same whatever parameters are chosen provided, of course, that they assume stock-flow norms - wealth-income ratios for households and inventory-sales ratios for firms. For all its shortcomings, the simulation method has the merit that it is always possible to track down exactly why the results are what they are. If, for instance, interest rates rise unexpectedly in response to a particular kind of shock, we can go back and see whether this is because the model has unacceptable features (in which case we have to change the model) or perhaps because we hadn't realised, when doing thought experiments, that once all the ramifications are made explicit, we get anomalous results which make us wish to change the model we were previously carrying in our minds.

SIMULATION 1: A STEP UP IN INVENTORY LEVELS

CHART 1A SIMULATION 1: EFFECT ON INCOME & EXPENDITURE FLOWS



The first simulation follows through the effects of a once for all rise in the desired ratio of inventories to production, the main purpose being to show what happens when loans generate income flows as well as money stocks. In the very short term, as Chart 1A shows, the rise in the level of inventories causes a blip to stockbuilding and hence to production. There is no simultaneous effect on consumption in period 1 because, it is assumed, the rise in income was unexpected by consumers[12]. However in period 2, consumption rises in response to the addition to wealth during period 1. Eventually a new steady state will be reached in which GDP, disposable income, consumption and

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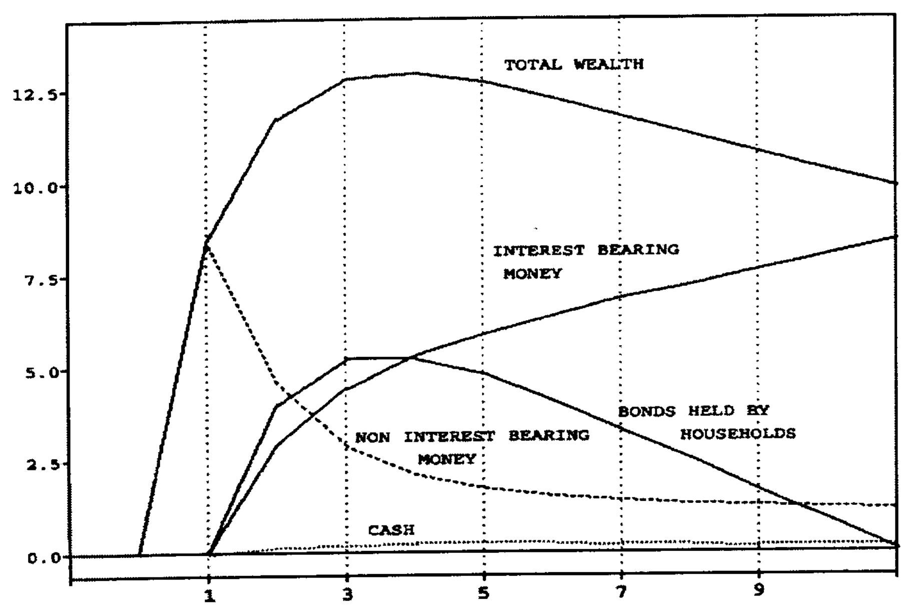
[12] For the present simulation we assume that expectations are "model consistent" that is, expected disposable income is the disposable income which the model would generate, given the exogenous variables, in a steady state.

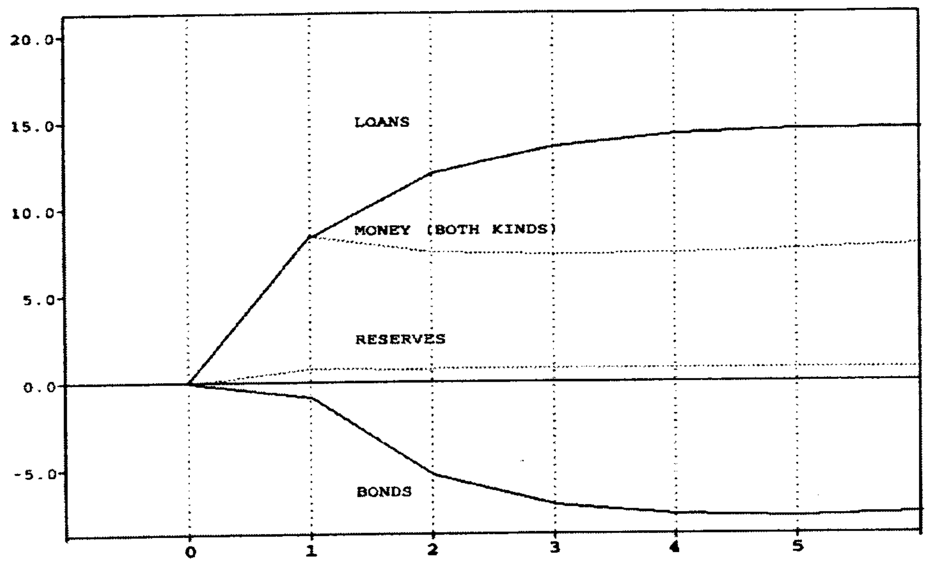
the stock of wealth all end up roughly where they started. Chart 1B shows the initial effect on households' balance sheets. The top line represents the addition to household wealth which

CHART 1B SIMULATION 1: EFFECT ON WEALTH & ITS COMPONENTS



has taken place as a consequence of the shock and is equal to the cumulative excess of disposable income over consumption in Chart 1A. The four lower lines show how wealth is allocated between the four financial assets. As the addition to income was unexpected, no active portfolio choice is immediately made and consequently the entire accretion fetches up, in period 1, as an addition to holdings of non interest bearing bank money. In the present instance the notion of the initial rise in money being a response to an increased "demand" for it is particularly wide of the mark;

CHART 1C SIMULATION 1: EFFECT ON BANKS' BALANCE SHEET



holdings of non interest bearing money have gone up by default[13] because income recipients have been caught napping.

In period 2 the process of asset allocation begins. There is a tiny addition to holdings of cash by households which is needed to finance the higher flow of consumption, but otherwise the initial accretion of non interest bearing money starts to be salted away into interest bearing deposits and bills in proportions which depend on relative interest rates. Holdings of non interest bearing money, although reduced in period 2, remain higher than they were before because of the continuing need to finance a higher flow of transactions.

Chart 1C shows the counterpart changes (always compared with what

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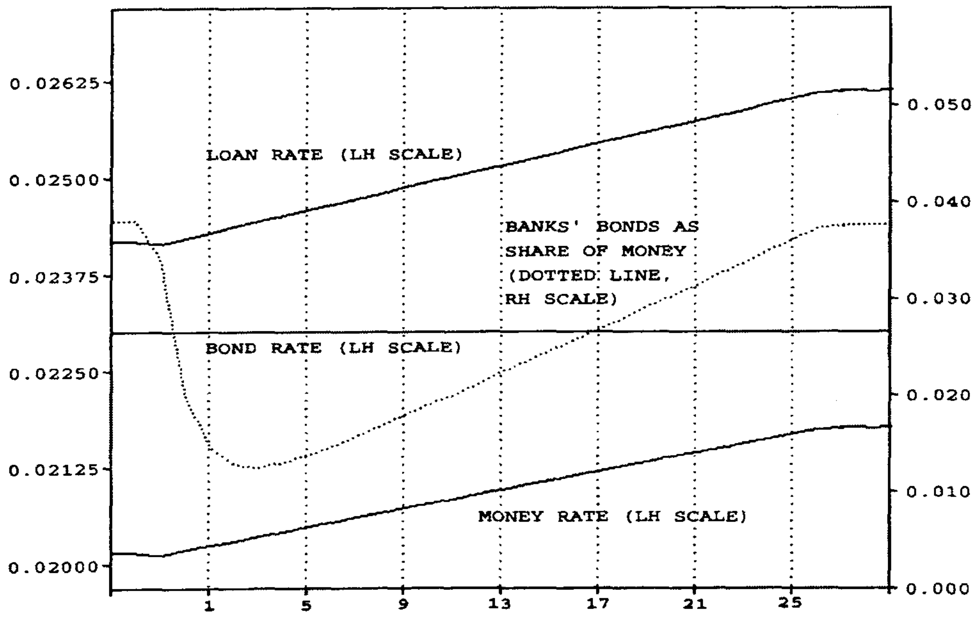
[13] This is surely what D.H.Robertson (1931) meant by "automatic lacking"!

would otherwise have happened) in the banks' consolidated balance sheet. The top line shows the (addition to the) stock of loans, assumed equal to the cumulative total of the addition to stockbuilding in Chart 1A; as the stock of inventories is higher for ever, so is the stock of loans. The second line gives the addition to deposits of both kinds taken together and the third line shows the addition to banks' reserves, assumed to be 10% of total deposits. The lower line then shows how, as a logical necessity given everything else, banks are initially obliged to

CHART 1D SIMULATION 1: EFFECT ON INTEREST RATES



reduce their holdings of bills; they have to do this to the extent that the rise in loans and reserve requirements exceeds the amount of bank money that households wish to hold[14].

Chart 1D shows (using the solid lines and the right hand scale)

[14] N.B. The bottom line says that bill holdings are lower than they otherwise would have been, not that they are negative!

the three interest rates on money, loans and bills, together with banks' holdings of bonds expressed as a proportion of their assets (the dotted line using the left hand scale). Banks will always set the loan rate of interest above the bill rate, otherwise it would be more profitable for them to hold bills rather than make loans; and the bond rate is always higher than the money rate otherwise households would never hold bills. This hierarchy will be satisfactory to banks because the rate on each category of their assets (excluding mandatory reserves) is higher than that on each category of their liabilities[15]. A crucial further assumption is that banks avoid being forced "into the bank" i.e having to borrow from the central bank at a penal rate; to do this they will keep their bills in some positive ratio to their liabilities - to be termed "the defensive asset ratio". They will respond to a decline in this ratio - a quantity signal- by getting households to switch out of bills into money by raising the money rate of interest.

In the simulation model it was assumed that banks raise or lower the rate they are prepared to pay on deposits to an extent which depends on the distance of the defensive asset ratio from the desired norm. To protect banks' profits when deposit rates are raised, loan rates must be raised simultaneously. Chart 1D shows how money and loan rates change relative to the bill rate until the defensive asset ratio is restored to its original level.

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[15] See Godley and Cripps (1982) pp. 161-162

CHART 1E SIMULATION 1: BONDS & MONEY AS SHARES OF WEALTH

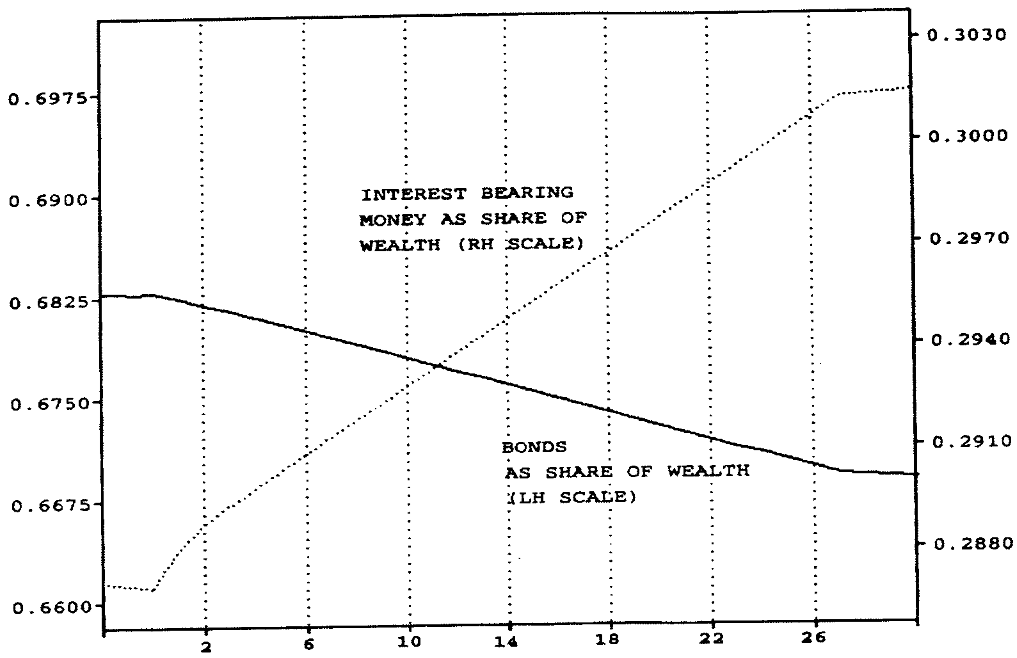
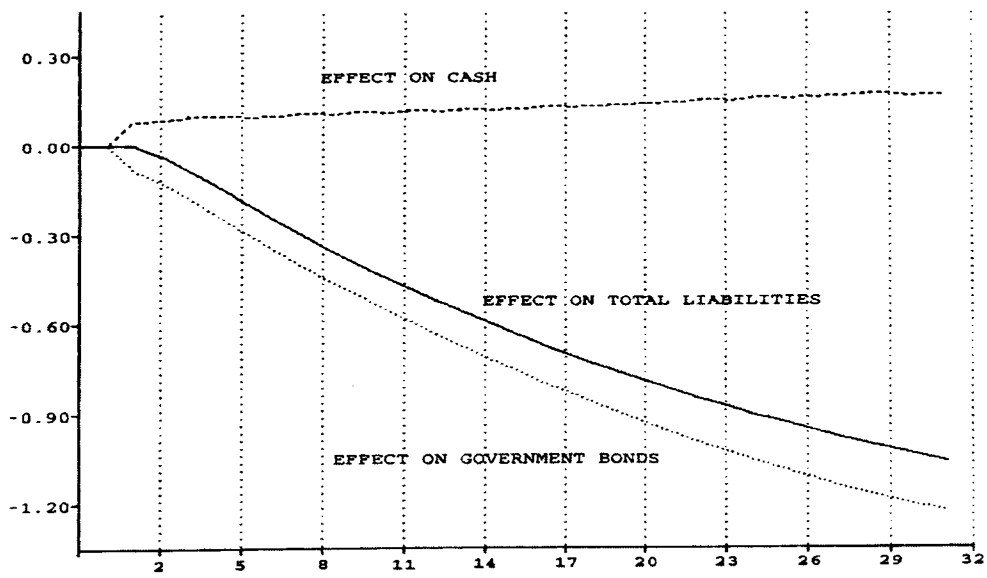


Chart 1E shows the counterpart of everything described so far in terms of changes to the two largest components of household wealth; because of the change in the pattern of interest rates, *with loan and money rates permanently higher than they were before*, there is permanent switch out of bills and into interest bearing money, each expressed as proportion of wealth. According to this way of thinking, by the way, it is only for the brief moment before households react to higher incomes by spending more or by investing actively, that it is true to say that "every loan creates a deposit".

In the new steady state, the ratio of wealth to income is restored to its original level. But since loans and inventories are higher than before, the total stock of government debt (cash plus bills) has to be lower by the amount of the increase in private debt; this can be read off the balance sheet matrix, Table 2. The dynamic intuition here is that between the two

CHART 1F SIMULATION 1: EFFECT ON GOVERNMENT LIABILITIES



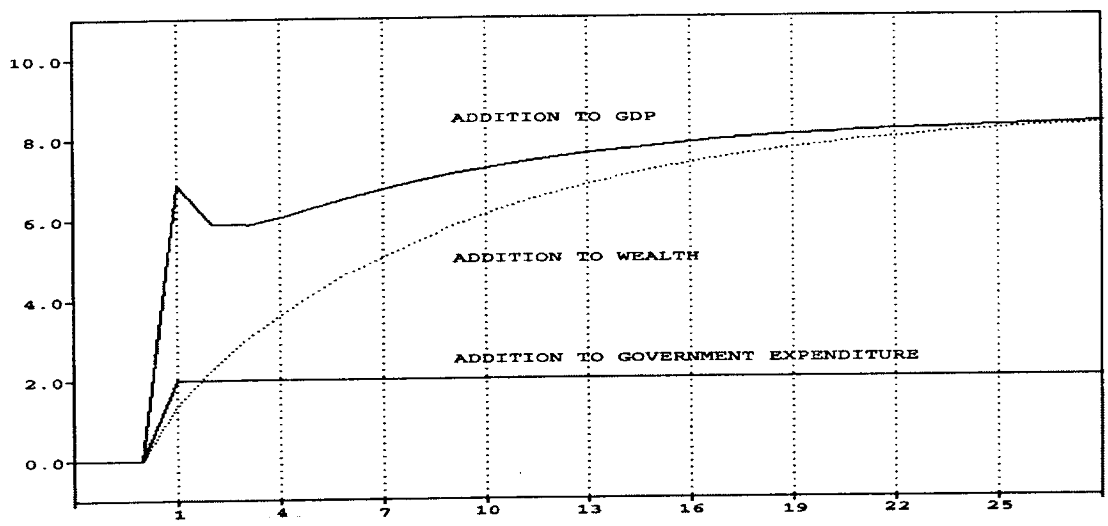
steady states, total income and output are all the time higher than they otherwise would have been. As government expenditure on goods and services and tax rates are unchanged, there has to be a reduction in government indebtedness throughout the period which is illustrated in Chart 1F. Yet the total stock of cash must be higher in the new steady state because banks' reserve requirements rise (Chart 1C) while households cash holdings fetch up (virtually) unchanged. Therefore (always assuming fixed bill rates of interest) more than all of the fall in government liabilities takes the form of lower bill holdings.

The story of simulation 1 is almost complete. It remains to point out that since government debt is lower in the new steady state, *the flow of government interest payments (given bill rates) will also be lower and therefore the flow of aggregate income will be slightly lower as well.* We shall defer discussion of whether and in what sense the total stock of base money could be "controlled" under these or other circumstances.

A question! How should we think about the limit to the loan making process? One answer is that an increase in the loan rate will, in reality though not in this model, choke off the demand for loans. The second is that as money rates nudge the bill rate, the government may be unable to sell bills at all except at a higher rate of interest. In other words, it may be unrealistic to suppose that the bill rate of interest can validly be treated as exogenous beyond a certain point; perhaps it has eventually to move up if the private demand for loans rises beyond a certain point.

SIMULATION 2: A STEP IN GOVERNMENT EXPENDITURE

CHART 2A SIMULATION 2: A STEP IN GOVERNMENT EXPENDITURE



The second simulation explores the consequences of lifting government expenditure on goods and services in a single step, everything else given. In this experiment, so as better to isolate the asset allocation decisions, perfect foresight on the part both of firms and households is assumed; expected sales and disposable income are assumed to be equal to the actual values generated by the model.

Chart 2A shows the addition to government expenditure and the consequential additions to GDP and wealth. There is a small overshoot in period 1 because of the relatively rapid adjustment of inventories towards their new level. Wealth, on the other hand, adjusts relatively slowly. Government debt (implied but not directly shown in the chart) and government interest payments rise throughout the transition period.

CHART 2B SIMULATION 2: CHANGES TO COMPONENTS OF THE BANKS' BALANCE SHEET

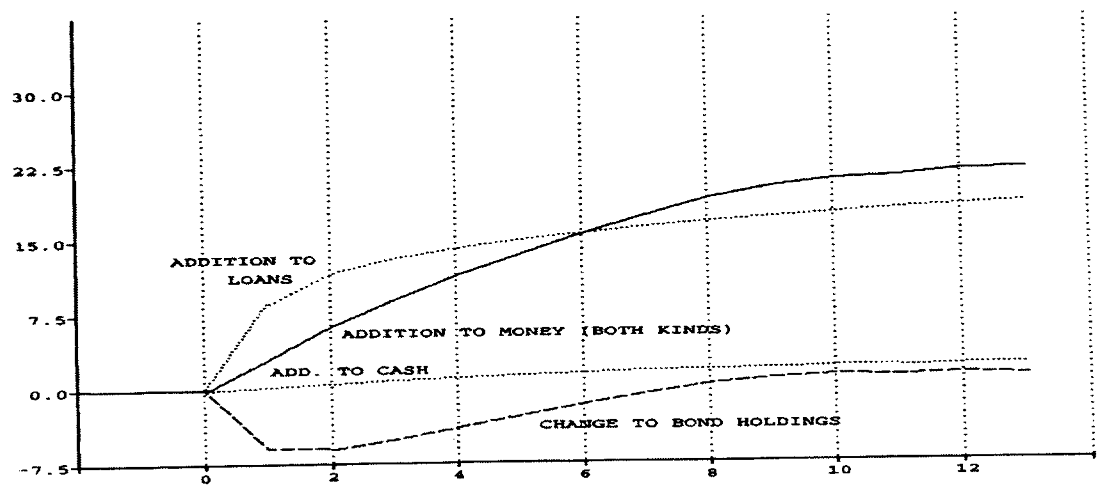
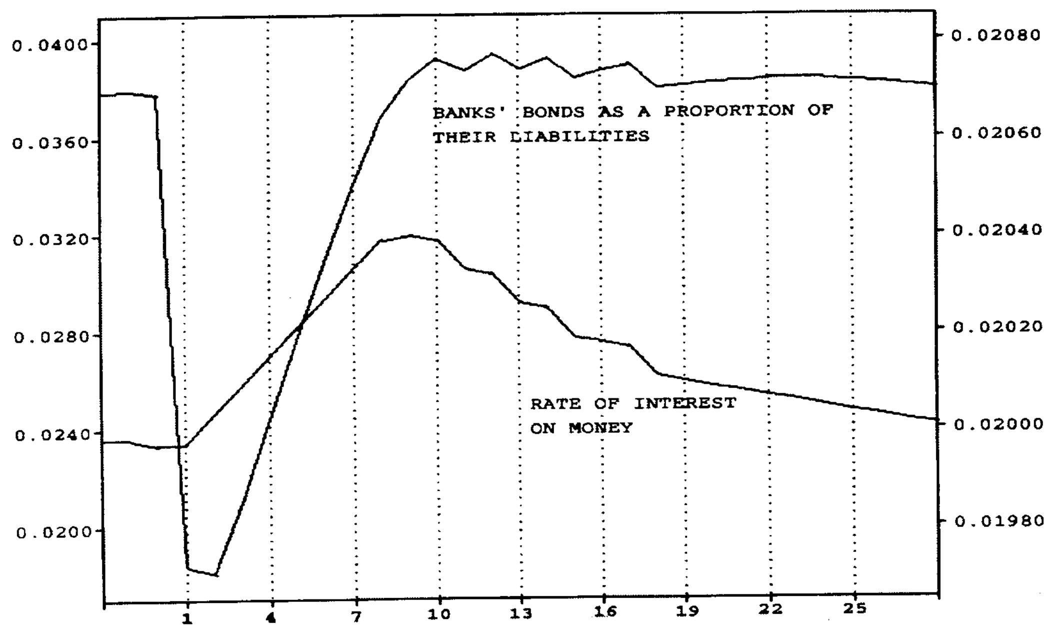


Chart 2B shows what happens to the components of the banks' balance sheet. The top dotted line shows the addition to loans - a rapid response occasioned by the need of industry for finance. The addition to the total stock of money (taking both kinds together) rises more slowly (along with wealth) and banks' reserves rise step by step with money. It then has to be the case that banks' holdings of bills, their defensive assets, initially fall by the difference between loans and reserves on the one hand and money on the other. The way banks respond to the fall in their bills holdings is shown in Chart 2C.

CHART 2C SIMULATION 2: BANKS' BONDS AND THE RATE OF INTEREST



The fall in the defensive asset ratio sparks off a rise in the money (and hence loan) rate of interest which starts to be reversed as soon as that ratio is restored. What brings interest rates down again? The answer is that after period 9 (by when the defensive asset ratio is restored) the flow of disposable income falls progressively relative to the stock of wealth - that this is happening is clearly implied in Chart 2A. The fall in disposable income relative to wealth means that *ex ante* holdings of money also fall progressively (see equations 5-7 in section 3) and this, in turn, means that the rate of interest on money falls without any further change in the banks' defensive asset ratio.

CHART 2D SIMULATION 2: COMPONENTS OF WEALTH

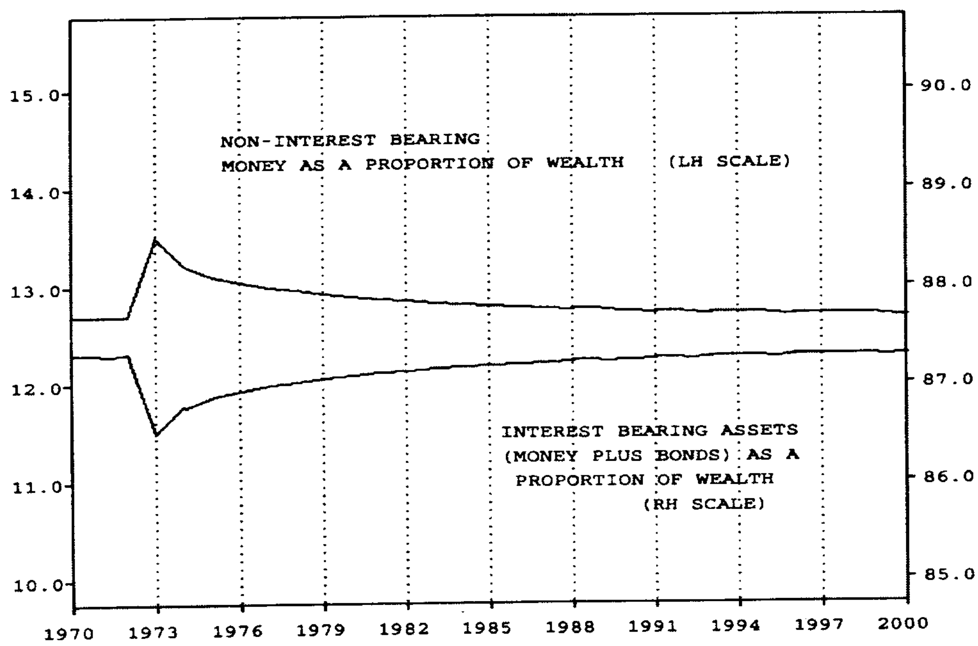
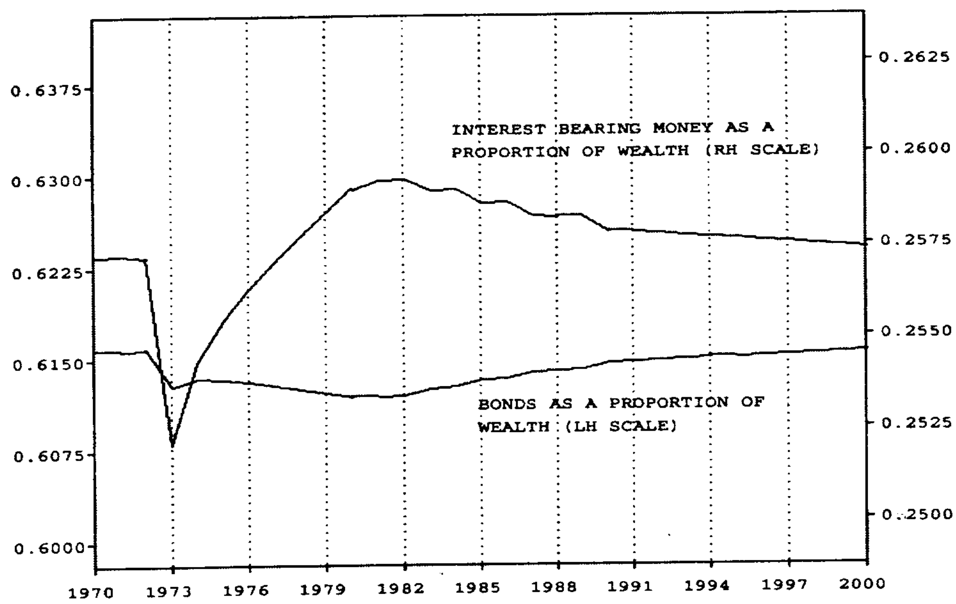


Chart 2D shows, using the left hand scale, how holdings of non interest bearing money immediately rise for transactions purposes; and there has to be a corresponding fall in interest bearing forms of wealth for "adding up" reasons. Holdings of non interest bearing money (as a share of wealth) gradually fall back to their original level as wealth rises.

CHART 2E SIMULATION 2: ALLOCATION OF INTEREST BEARING ASSETS OF HOUSEHOLDS



The next chart (2E) shows the response of households' holdings of interest bearing money bonds to the initial shock and to the subsequent changes in interest rates. There is an initial downwards blip in both series to accommodate the immediate need for non interest bearing money; thereafter the two series balloon in opposite directions, then subside again. With given bill rates of interest, the entire system settles down with income flows higher than before but with all stock flow ratios and relative interest rates exactly where they started.

SIMULATION 3: INTRODUCING RANDOM EXPECTATIONS

In this third simulation we put the whole system under severe strain by assuming that expectations of sales by firms and also expectations of disposable income by households are subject to violent random processes. No pretense is made that expectations are really formed in this way; the object of the exercise is to find out how banks would deal with such chaotic behaviour if they had to.

CHART 3A SIMULATION 3: RESPONSE OF MONEY TO INCOME SHOCKS

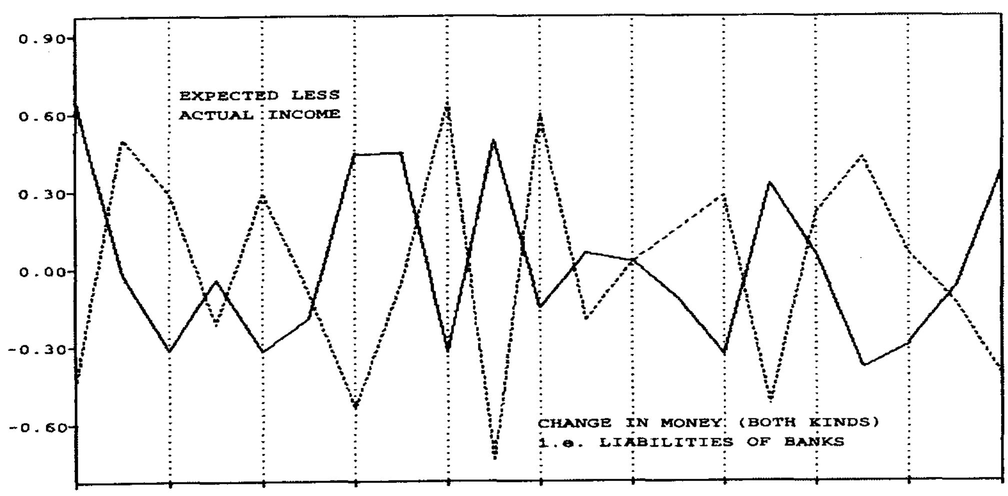
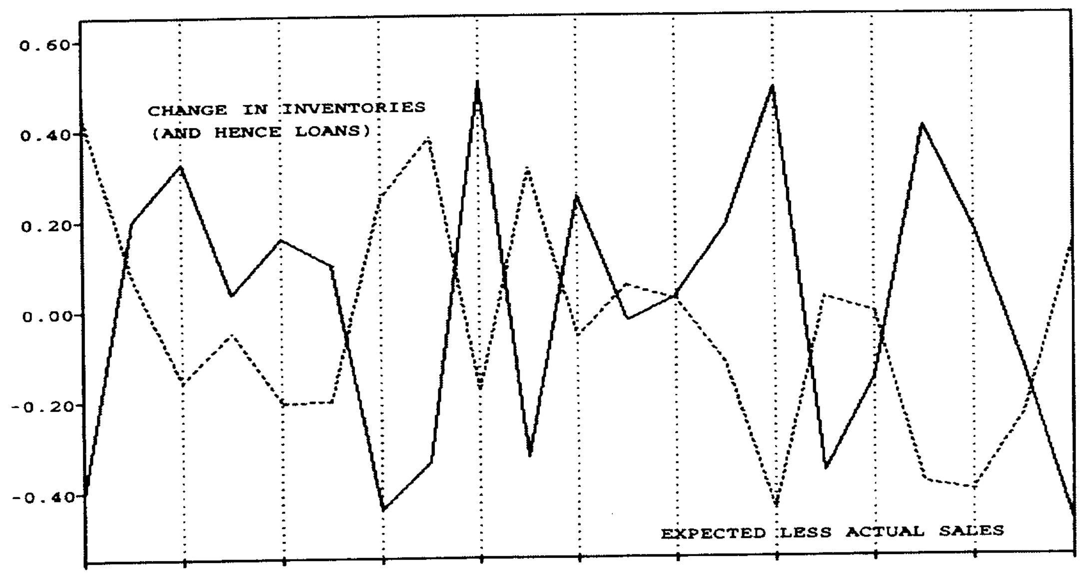


Chart 3A shows, for each period, the gap between actual and expected disposable income together with the change in deposits of non interest bearing money which act as buffers, moving each period in the opposite direction to the expectations gap. Chart 3B shows a similar divergence between actual and expected sales by firms, whose inventories fluctuate in a similarly shock absorbing way.

CHART 3B SIMULATION 3: RESPONSE OF INVENTORIES TO SALES SHOCKS



The banks have no difficulty accommodating the sharp and disparate series of shocks to these two components of their balance sheet, but they do have to move money rates (and therefore loan rates) about sharply in order to achieve this.

CHART 3C SIMULATION 3: RESPONSE OF MONEY RATES TO BANKS' BOND HOLDINGS

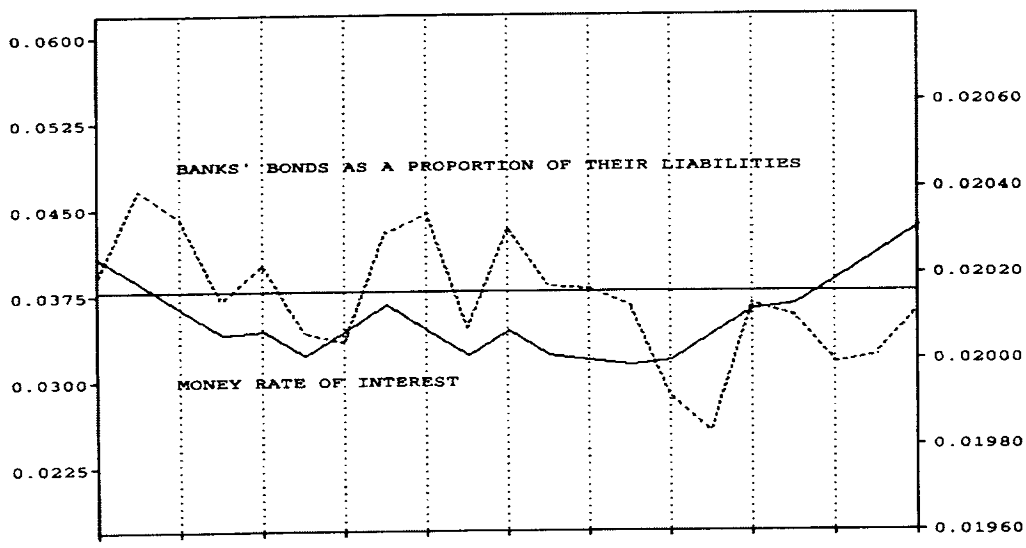


Chart 3C shows the defensive asset ratio with the money rate of interest and Chart 3D shows the consequential changes to holdings of interest bearing money and bills (expressed as a share of a wealth) which take place as a consequence.

CHART 3D SIMULATION 3: ALLOCATION OF HOUSEHOLD WEALTH

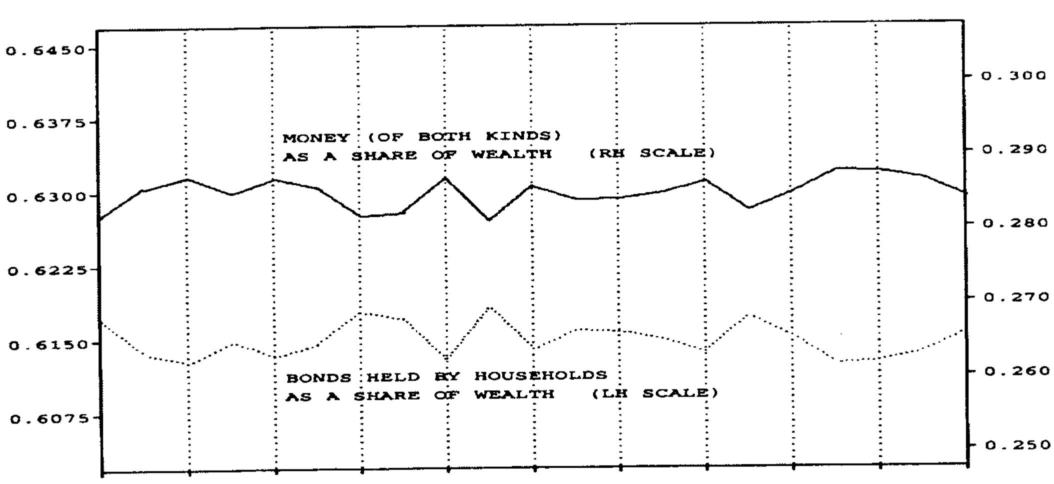
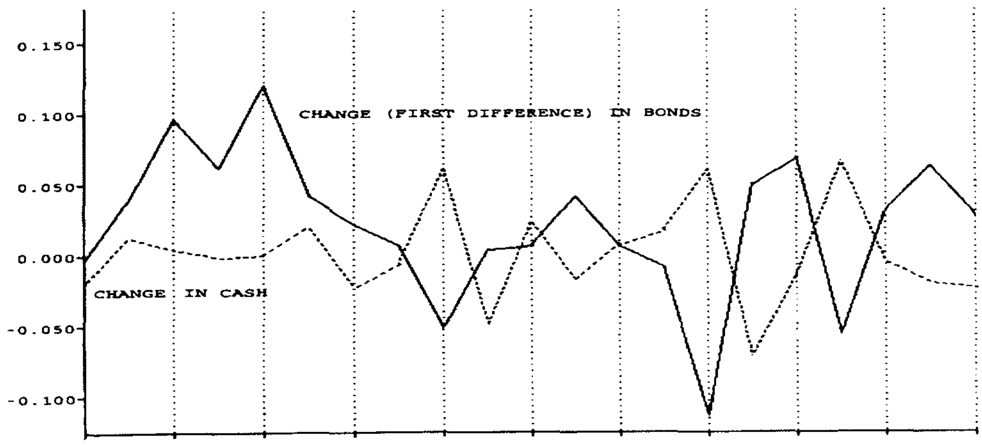


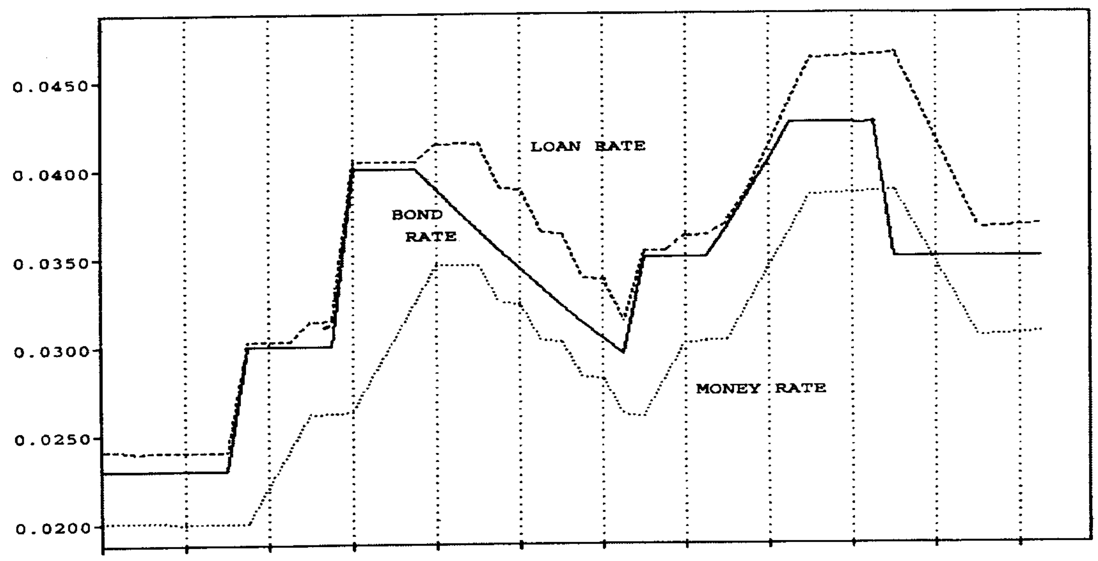
CHART 3E SIMULATION 3: RESPONSE OF GOVERNMENT LIABILITIES (BONDS & CASH)



The last chart (3E) shows what happens to changes in government liabilities - that is, total bill issues (the solid line) and total issues of high powered money (the dotted line). They have to move about in this wild way as a unique counterpart to the operations of households, firms and banks. The story is as follows. The government has a predetermined fiscal policy (public expenditure and tax rates are pre-determined) and has also determined the rate of interest on bills. Banks, in order to remain profitable, have to keep adjusting loan and money interest rates so as to keep their bill holdings in the right parish while households are continuously responding to relative interest rates by shifting between interest bearing money and bills. But households, firms and banks can only continue to function, in this chaotic world, if the government is continuously exchanging high powered money for bills on demand. There has to be an active frontier at the spot where the residuals pile up.

SIMULATION 4: CHANGING THE BOND RATE OF INTEREST

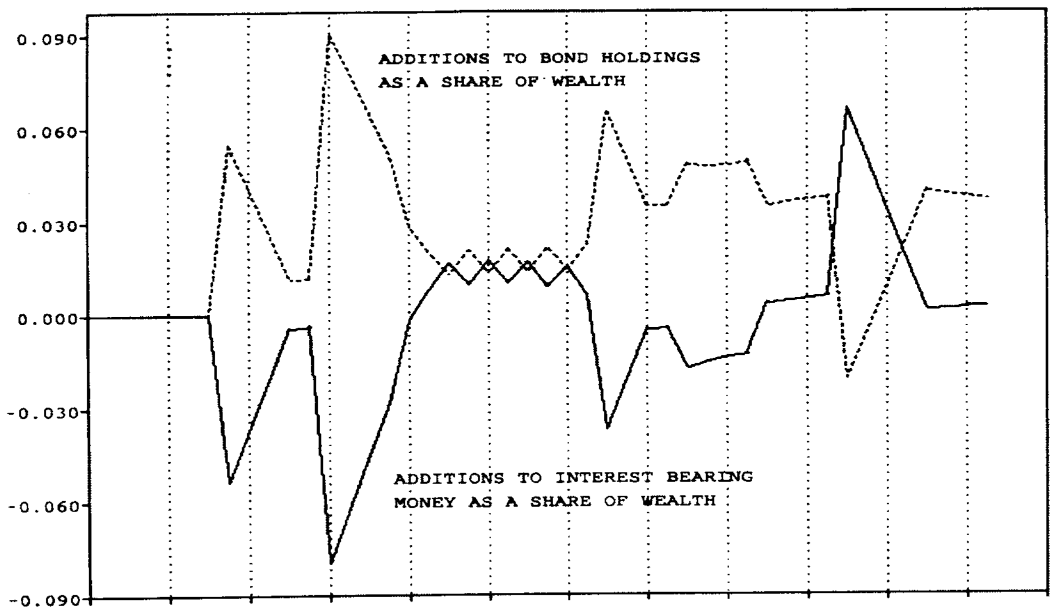
CHART 4A SIMULATION 4: INTEREST RATES



It is re-emphasised that the model, as it stands at present, generates no negative feedback from higher interest rates either to expenditure or to asset prices which makes this simulation particularly unrealistic. The model will only illustrate a limited set of responses and interactions, but this it does very precisely.

The purpose of the fourth simulation is to show how money and loan rates respond when the government changes the bill rate of interest. Chart 4A, which should be read with Chart 4B, shows what happens when bill rates are changed up and down in a rather wild way. When bill rates go up there is a tendency for households to move out of money into bills. This reduces the banks' defensive asset ratio, causing them to put up money rates of interest. Then, to preserve their profit margins, banks put up loan rates, normally by the same amount as money rates. But this

CHART 4B SIMULATION 4: HOUSEHOLDS' PORTFOLIO RESPONSES TO INTEREST RATE CHANGES



is not the end of the story, for there is nothing so far to prevent loan rates from falling, on occasion, below bill rates. For this reason it is assumed, in the model, that banks set loan rates slightly above bill rates when the normal margin over money rates is insufficient to generate the normal hierarchy of rates. According to simulation 4, there is a brief period towards the end of the period during which money rates exceed bond rates. This arises because the model only allows the money rate to adjust in stages towards any new desired level. But this may not be unrealistic? There will surely be at least some delay in the response of households to relative interest rate changes which could produce such an outcome.

CHART 4C SIMULATION 4: BANKS' HOLDINGS OF BONDS AND THE MONEY RATE OF INTEREST

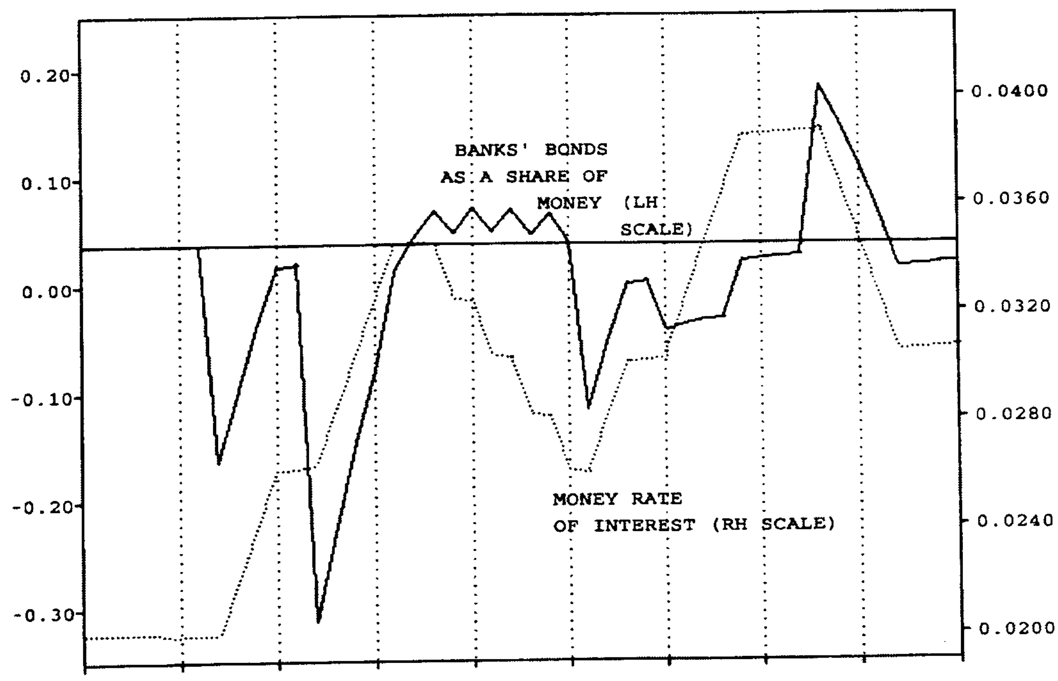


Chart 4C shows changes in holdings of interest bearing money and bills (expressed as shares of wealth) as a result of shifting relative interest rates.

CHART 4D SIMULATION 4: ADDITIONS TO GOVERNMENT LIABILITIES & THEIR MAKE-UP

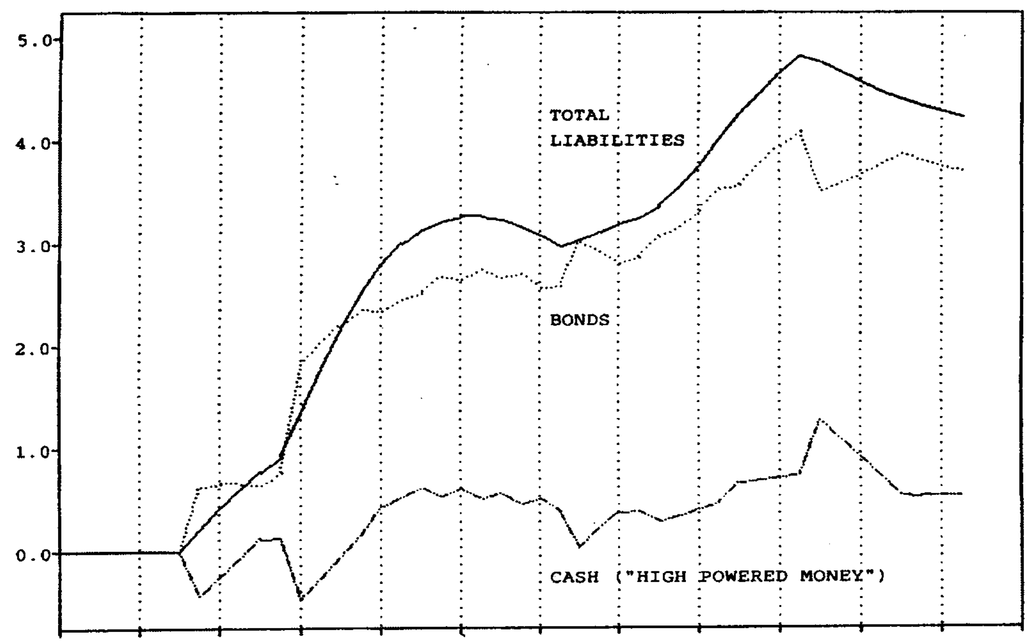


Chart 4D shows, in the top solid line, the total addition to the stock of government liabilities and, in the two lower lines, the breakdown of this into bills and high powered money. The rise in the total comes about because, as can be seen in Chart 4A, there is, by assumption, a progressive addition to interest rates and therefore to government interest payments; and no particular significance attaches to this.

CONCLUDING SECTION

There are many ways in which the model deployed here could be expanded, depending on which particular aspect of macroeconomics one wished to explore. It could, for instance, provide a framework for the study of fixed investment, the capital stock and equity; it could include another country, comprise foreign trade multipliers for each of them and establish a fraework for studying the determination of exchange rates; and it could represent productivity changes and wage and price inflation. A start with some of these points have already been made in two working papers (Godley (1996a) and (1996b)).

To come down to it, the present paper claims to have made, so far as I know for the first time, a rigorous synthesis of the theory of credit and money creation with that of income determination in the (Cambridge) Keynesian tradition. My belief is that nothing the paper contains would have been surprising or new to, say, Kaldor, Hicks, Joan Robinson or Kahn. I look forward to hearing what Goodhart says, particularly about the institutional aspects of the operations described; but what I have written has been informed in part by a careful reading of his work and I have no reason to suppose that we are in significant disagreement. The paper could not have been written without Tobin's monumental contribution to the subject. Yet, in the perception I at present

have, and which may turn out to be quite misguided, Tobin never makes the final step - essential to my story here - where bank loans are required to enable industry to function at all; the raison d'etre of Tobin's banks, *so far as I can see*, is to enlarge the asset choice of households and facilitate the agility with which it can be made.

APPENDIX

The following table defines the variables and parameters of the model and gives the numbers which have been attributed to each of them in order to obtain an initial steady state. The number of equations exceeds the number of endogenous variables listed below because the variables in the model describe values which are expected, desired, exchanged etc. The suffixes are

_e Expected

_h Held

_r Required

_m Made

_x Exchanged

** Long run steady state

* Short run aspiration

EXOGENOUS VARIABLES

BR = Banks' normal bill holdings as a proportion of money	0.0378
Fr = Fractional reserve ratio	0.1
G = Government expenditure	25
R1, R2 = Random variables with 0 mean and normal distribution	
rb = Rate of interest on bills	0.023
β = Profit mark-up	0.1
Φ_1 , Φ_2 = Mark-ups of the loan rates	0.02, .01
σ = Inventory-sales ratio	0.275
τ = Rate of indirect tax	0.25

ENDOGENOUS VARIABLES

B = Total bill issue	67.5
Bb = Bills held by banks	1.2
Bp = Bills held by households	66.4
C = Consumption	107.8
F = Total profits	9.8
Fb = Banks' profits	0.1
Ff = Firms' profits	9.7
H = Total Cash	13.8
Hb = Banks' cash	3.1
Hp = Households' cash	10.7
I = Inventories	26.4
L = Bank loans	26.4
M = Interest bearing money	27.7
Mn = Non interest bearing money	2.9
S = Total sales valued at market prices	132.8
SC = Total sales valued at cost	96.0
T = Yield of taxes	26.5
V = Wealth	107.8
WB = Wage bill	95.9
Y = GDP	132.8
p = Ratio of final sales to ditto at cost	1.38
rm = Rate of interest on money	0.02
rl = Rate of interest on loans	0.024

PARAMETERS

α_1, α_2		0.8	0.2	
γ		0.5		
λ	01 11 21 31	-0.07	0.005	0.005
	0.1			
	02 12 22 32	0.4	8.495	8.505
	0.09			
	03 13 23 33	0.67	8.5	8.5
	0.01			

THE EQUATIONS OF THE MODEL

(a) Firms

A1) $Ff \equiv S - T - WB + \Delta I - rl.I_{-1}$

A2) $S \equiv C + G$

A3) $WB = SC\_e + I^{*} - I_{-1}$

A4) $SC\_e = ??\ SC\ [+R1]$

A5) $S\_e = (1 + \tau)(1 + \beta)(WB - \Delta I^{*} + rl.I_{-1})$

A6) $p = \dfrac{S\_e}{SC\_e}$

A7) $SC = \dfrac{S}{p}$

A8) $\Delta I^{*} = \gamma(I^{**} - I_{-1})$

A9) $I^{**} = \sigma.WB$

A10) $\Delta I = \Delta I^{*} - (SC - SC\_e)$

A11) $\Delta L\_r = \Delta I$

(b) Households

A12) $Yd \equiv F + WB + rm.M\_h_{-1} + rb.Bp\_h_{-1}$

A13) $F \equiv Ff + Fb$

A14) $\Delta V \equiv Yd - C$

A15) $C = \alpha_1 Yd\_e + \alpha_2 V_{-1}$

A16) $Yd\_e = Yd^{**}\ [+R_2]$

A16a) $$Yd^{**} = \frac{G + rb.B_{-1}}{\tau/(1 + \tau)} - G$$

A17) $\Delta V\_e = Yd\_e - C$

A18) $Vn = V - Hp\_h$

A19) $Vn\_e = V\_e - Hp\_h$

A20) $Hp\_h = \propto_c . C$

A21) $$\frac{Mn\_h^*}{Vn\_e} = \lambda_{01} - \lambda_{11} rm - \lambda_{21} rb + \lambda_{31} \frac{Yd\_e}{V\_e}$$

[A22a) $$\frac{M\_h}{Vn\_e} = \lambda_{02} + \lambda_{12} rm - \lambda_{22} rb - \lambda_{32} \frac{Yde}{V\_e}$$]

A23) $$\frac{Bp\_n}{Vn\_e} = \lambda_{03} - \lambda_{13} rm + \lambda_{23} rb - \lambda_{33} \frac{Yd\_e}{V\_e}$$

A22) $M\_h \equiv Vn - Mn\_h - Bp\_h$

A24) $Mn\_h = Mn\_h^* + Yd - Yd\_e$

c) Banks

A25) $Bb\_h \equiv Mn\_x + M\_x - L\_m - Hb\_h$

A26) $Fb \equiv rl.L\_s_{-1} + rb.Bb\_h_{-1} - rm.M\_x_{-1}$

A27a) $rl1 = (1 + \phi_1).rm$

A27b) $rl2 = (1 + \phi_2).rb$

A27) $rl = rl1.x_1 + rl_2.x2$

$X1 = 1\ ,\ rl1 > rb\ ;\ 0\ ,\ rl < rb$

$X2 = 1\ ,\ rl1 > rb\ ;\ 0\ ,\ rl > rb$

A28) $\Delta rm = Z1.A1 - Z_2.A1$

$Z1 = 0\ ,\ BR < B1\ ;\ 1\ ,\ BR < B1$

$Z2 = 0\ ,\ BR > B1\ ;\ 1\ ,\ BR < B1$

$$BR \equiv \frac{Bb\_h}{Mn\_x + M\_x}$$

A29) $Hb\_h = Fr.(Mn\_x + M\_x)$

A30) $Mn\_x = Mn\_h$

A31) $M\_x = M\_h$

A32) $Hp\_x = Hp\_h$

A33) $L\_s = L\_r$

d) <u>Government</u>

A34) $\Delta B\_x \equiv G + rb.B\_x - T - \Delta H\_x$

A35) $T = S.\frac{\tau}{1+\tau}$

A36) $Hb\_x = Hb\_h$

A37) $Bb\_x = B\_x - Bp\_x$

A38) $H\_x = Hp\_x + Hb\_x$

[A39) $Bb\_x = Bb\_h$]

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