TOWARDS A RECONSTRUCTION OF MACROECONOMICS USING A STOCK FLOW CONSISTENT (SFC) MODEL[1]

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ABSTRACT

This paper aims to rehabilitate "stock flow consistent" (SFC) macroeconomics as a radical alternative to the neo-classical approach which has dominated the subject during the last thirty years. Commercial banks are reckoned to play a central role in the macro-economic process because they co-ordinate all the disparate aspirations, expectations and actions of the different sectors and this is one of many ways in which the model deployed here differs, not only from mainstream models, but also from "old fashioned" Keynesian models which have largely become extinct. A comprehensive system of stock and flow accounts, using four sectors and seven financial assets, will be deployed, followed by a narrative description of a theoretical model which can be numerically solved to yield sequences evolving in real time towards steady states. Details of the model's equations are not disclosed but the paper clearly indicates an alternative methodology, while the simulations lend plausibility to some distinctive conclusions.

KEYWORDS: MACROECONOMIC THEORY, STOCK FLOW MODELS, DOUBLE ENTRY ACCOUNTING, SIMULATION MODELS, REAL TIME SEQUENCES

JEL Classifications: A22 B52 D21 D31 E17 E27 E31 E44 E51

Introduction

In his major review of the course of macroeconomic theory ever since its inception, Lance Taylor (2004a) draws attention to the poverty of the postulated institutional context within which the mainstream subject has evolved. At the level of accounting there has commonly been a failure to integrate financial stocks and flows into the production-income-expenditure nexus. But, more generally, there has been a failure to fully characterise the way in which different sectors of the economy have distinctive objectives, functions and constraints, all of which must somehow be fully reconciled with one another however long or short the "run" under consideration. Taylor notes that alternative, more institutional, ways of thinking have already been adumbrated, in different ways, in particular by Stone (1966), Tobin (1980, 1982), Godley and Cripps (1983) and Godley (1996, 1999) as well as in his own work e.g Taylor (2004b). But no alternative synthesis has yet emerged such as could (for instance) form the basis of a textbook capable of giving students a decent notion of how the economic system as a whole actually functions.

The following paper takes one step forward by outlining a theoretical model of a fully "institutionalised" economy and bringing it to life by reporting numerical simulations of what happens when shocks of various kinds occur. To take a single instance, it will show that if the fractional reserve ratio of banks is increased the effect will *not* be to "reduce the money supply" in the way postulated by a multitude of textbooks including Mankiw (2003) which is in high favour at the moment. The model bears a superficial resemblance to the large "Keynesian" econometric models which were built, and largely became extinct, in the sixties and seventies. But so far as I know, those models never achieved, any more than frankly neo-classical theoretical models, a satisfactory incorporation of credit and finance into their accounts and this is one of the reasons why they fell victim to the monetarist counter-revolution. The co-ordinating role of banks is one of the main features of the model to be described here while the accounting framework is so rigorous and complete that, as in a Walrasian equilibrium, each individual stock or flow variable is logically implied by the sum of all the others.

The accounting framework

Begin by considering two matrices, the first of which describes an entire system of flow transactions measured at current prices while the second describes the underlying sectoral balance sheets. The variables are defined in the matrices except for: r, rm, rl rcb which are rates of interest on respectively bills, money, loans and commercial bills; e, BL which are titles to equity and bonds, and finally pe and pb which are prices of equity and bonds.

Transactions Matrix

	Households (1)	Firms (2) current	Firms (3) capital	Banks (4) current	Banks (5)capital	Govt. (6)	(7)	Σ
1. Consumption	-C	+C						0
2. Fixed investment		+INV	-INV					0
3. Gov. Expenditure		+ G				-G		0
4. Sales		[S]						
5. Δ in value of stocks		+ΔI	-ΔI					0
6. GDP inc. stock app.		[Y]						
7. Taxes		-T				+T		0
8. Wage Bill	+WB	-WB						0
9. Interest		$-rl.l_{t-1}$		$+rl.l_{t-1}$				0
10. Profits & allocation	$+FD +rcbCB_{t-1}$	-FF	+FU	$+rl(L_{t-1}-l_{t-1})$				0
11. Interest on money(*)	$+rm.MD_{t-1}$			$-rm.MD_{t-1}$				0
12. Interest on bills	$+r.BP_{t-1}$			$+r.BB_{t-1}$		$-r.B_{t-1}$		0
13. Interest on bonds	$+BL_{t-1}$					$-BL_{t-1}$		0
14. Bank profits	+FB			-FB				0
15. Financial Balances	**[BALh]**	**0**	**[BALf_cap]**	**0**		**[BALg]**		**0**
Flow of funds								
16. Cash	-ΔHP				-ΔHB	+ΔH		0
17. Current accounts	-ΔMC				+ΔMC			0
18. Deposit accounts	-ΔMD				+ΔMD			0
19. Bills	-ΔBP				-ΔBB	+ΔB		0
20. Bonds	-ΔBL.pb					+ΔBL.pb		0
21. Equities	-Δe.pe		+Δe.pe					0
22. Commercial Bills	-ΔCB		+ΔCB					0
23. Loans			+ΔL		-ΔL			0
24. Σ flows	0	0	0	0	0	0		

Balance Sheet Matrix

	Households (1)	Firms (2) current	Firms (3) capital	Banks (4) current	Banks (5)capital	Govt. (6)	Balancing item (7)	Σ
1. Inventories			+I				-I	0
2. Fixed capital			+K				-K	0
3. Cash	+HP				+HB	-H		0
4. Current accounts	+MC				-MC			0
5. Deposit accounts	+MD				-MD			0
6. Bills	+BP				+BB	-B		0
7. Bonds	+BL.pb					-BL.pb		0
8. Equities	+e.pe		-e.pe					0
9. Commercial Bills	+CB		-CB					0
10. Loans			-L		+L			0
11. Balancing item(**)	-V		+NW			+DG	+I +K	0
12. Σ stocks	0	0	0	0	0	0	0	0

(*) r, rm, rcb, rl are rates of interest on, respectively, bills, money, commercial bills and loans.
(**) V (wealth) = NW+DG+I+K ; NW=net worth of firms, DG=government debt, I=inventories, K=fixed capital stock

The national income identity, which equates the sum of expenditures with the sum of factor incomes, is given in column 2 in the form of the appropriation account of a

postulated production sector, which we may describe collectively as "firms"[2]. Each of the entries in lines 1) –10) of column 2 is a transaction which takes the form of a payment to or a receipt by the current account of firms from somewhere else, so that every row sums to zero. Investment in fixed and working capital (stockbuilding) is all paid for by firms themselves, hence under the double entry system of accounts we need to call into existence a capital account for firms, shown in the upper part of column 3, which describes how the sector makes these purchases from itself. Profits are defined equal to sales *less* indirect taxes *less* wages *plus* the change in inventories valued at historic cost *less* the interest cost of holding inventories, the latter cost being unavoidable if only because production and distribution take time. This definition of profits corresponds closely with that used in the national accounts[3].

There is little original or disputable about this matrix arrangement of the National Accounts, which is the recognizable world we live in. Yet it does contain one realistic feature which runs counter to the mainstream deployment of basic relationships - which invariably assumes that all the factor income generated by expenditure turns up instantaneously as income in the hands of households. This assumption is wildly incorrect as a matter of brute fact, for only a tiny fraction of profits (at least in the US and UK) is actually distributed, the great bulk being transferred to firms' capital account where it becomes a major source of funds for the finance of investment.

There remain, "above the line", the various flows of interest income between sectors including the receipts and payments which determine bank profits – a crucially important variable in this scheme of things. We reach, in line 15, the "financial balance" of each sector – its excess of total receipts over expenditures. As every row hitherto has summed to zero, the financial balances must sum to zero as well. But the existence of these balances, which individually will not, in general, be zero, points immediately to the incompleteness of the accounts so far. What form do these balances take in terms of asset and liability transactions?

An answer is provided in the lower, flow of funds, section of the transactions matrix. The acquisition of financial assets by households (defined to include pension and life funds) has to take one of the seven forms shown – three kinds of money, three kinds of fixed income security and equities. Transactions in equities and bonds (perpetuities) are defined as the number of titles purchased times their price. There is no positive or negative financial balance either in column 2 or column 4, since profits are in each case defined as

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[2] Five major simplifications have been made. All government expenditure consists of purchases from firms. The economy is closed. Households neither invest nor borrow. Firms do not hold cash. All taxes are indirect and paid by firms.

[3] The only difference is that in the official figures the interest cost of holding inventories is approximated by "stock appreciation" which has the convenient property that it makes total factor income exactly equal to total production of goods and services. The national accountants' approximation is exact only when the loan rate of interest is equal to the rate of cost inflation.

the residual between inflows and outflows. But the capital account of firms must show, in the lower part of the matrix, exactly how any investment in excess of retained profits is to be financed, namely by borrowing from banks or by issuing either equity or some other security. The other columns follow very simply. Banks earn profits by receiving higher interest receipts on their assets than they pay on their liabilities. As shown in the lower half of the matrix, banks have, as liabilities, two kinds of credit money and equity while for assets, they have loans, bills and cash. The government, here aggregating the Central Bank with the Treasury, finances any deficit with the issue, in some mixture, of bills, bonds and cash. The) sign describes a change in a stock variable between the beginning and end of the period under consideration, so time has an explicit representation in the system of concepts and we are furnished *ab initio* with the intrinsic means to relate what happens in each period to what happened in each previous period.

We may point to a bonus straightaway. We do at last (with no originality on the part of the author who is just exploiting the official systems of accounts already produced in the US, the UK and all countries who use the SNA) have a systematic way of incorporating credit money and financial variables into what has been called the production-income-expenditure nexus. Such integration simply does not exist in the textbook literature (c.f Mankiw op.cit. once again for a recent instance).

We only have, so far, a complete system of accounts measured in money terms. But some of the most important decisions, for instance, the decision of firms regarding how much they will produce, and of households as to how much they will consume, are made in terms of real physical quantities. The reader is asked therefore to imagine a supplementary system of real quantities, with an accounting relationship, outlined in the final section of this paper, between prices, quantities and the distribution of income which also describes how nominal and real wage rates fit into the story.

A change in any one variable in the transactions matrix must have counterparts in a theoretical minimum of three other entries. Suppose that an individual makes an impulse purchase at a supermarket and pays using a debit card. In this case there must be changes to at least *eight* variables in the matrix. There will be an increased outflow in column 1 under the heading consumption and there must be an equivalent and simultaneous reduction in the household sector's stock of current account money which (now reading laterally) generates a counterpart change in banks' liabilities. Reading laterally from line 1, the increase in consumption causes an equivalent increase in sales by firms which, in the very short term we are considering, has counterparts (columns 2 and 3) in the form of higher profits – all of them undistributed and reduced inventories valued at cost. Reading further down column 3, there will be an equivalent reduction in bank loans to firms (who are assumed not to hold cash in this simplified system). Finally, reading laterally to column 4, there is an equivalent reduction in banks' assets in the form of loans (so banks' assets and liabilities both fall by exactly the amount of the impulse purchase). We may leave the story at this point though it should be pointed out that a whole range of quasi-

disequilibrium phenomena may have been created as a result of the impulse purchase. In subsequent periods households may seek to restore checking account money stocks, firms to replace depleted inventories and banks to repair (the implied) contravention of reserve ratios which has taken place.

The following sections consider in turn the aspirations of each sector and the constraints under which it operates. It will be argued that there will always be at least one component of the operations of a sector over which that sector has no direct control. Each sector is perforce operating under conditions of uncertainty and hence must take decisions on the basis of what it expects will happen, so there must be at least one flexible component in each sector's list of options which acts as a buffer and over which it has no control in the very short run. *There is, in this model, neither a short nor a long term market clearing mechanism which brings (or which fails to bring) supplies into equivalence with demands* with the important exception that prices do clear the market for equities and bonds.

The Household Sector.

The accounts are set up so that, by definition, the change in the real stock of households' wealth is equal, in each period, to the difference between real disposable income and consumption – so the expected change in wealth is equal to the gap between expected real income and actual consumption. Formally, using the convention that the lower case represents real quantities,

1) $\Delta v_e \equiv yd_e - c$ where v is real wealth, yd is real, inflation accounted, disposable income including real capital gains, c is real consumption and the subscript e denotes an expected value.

A target for wealth relative to income is postulated

2) $v^* = \alpha 3 yd$

and a wealth adjustment function

3)) $\Delta v_e = \alpha 2(\alpha 3 yd_e - v_{-1})$,

from which a consumption function adequate for present purposes can be derived

4) $c = \alpha 1\ yd_e + \alpha 2 v_{-1}$

where $\alpha 1 \equiv (1 - \alpha 3)/\alpha\ 2$

The household sector is thus assumed to take a decision about consumption (and expected wealth) based on its actual wealth at the beginning of the period and expected income during the period. This consumption function implies there can exist a full stationary steady state, when there is no change in the real stock of wealth ($\Delta v = 0$), and therefore wealth is in its desired ratio to income It is easy to show that the mean lag in the response of consumption to income is equal to $\alpha 3$ (Godley and Cripps op.cit pp 36-39) while the parameters in 4) determine the lag profile precisely.

Apart from the consumption decision, households make portfolio decisions regarding the allocation of their expected wealth between the various assets available to them, which they do according to Tobinesque principles. More precisely, the demand for each asset expressed as a proportion of expected wealth is assumed to be a positive function of its (expected) own rate of interest and a negative function of all other rates of interest, while in the array of functions the sum of constants is equal to one and the sum of coefficients on any one interest rate is zero. As households do not know, and cannot directly control, what their income is going to be, there has to be a flexible element among their transactions and the obvious choice is current account money. It is assumed that changes in current account money act as a buffer to the extent that expectations are falsified and these are, in consequence, modelled as a residual. But the constraints in all the other asset demand functions ensure that the "demand" for current account money does indeed correspond with a coherently formulated demand function. The demand for cash is assumed not to be part of the wealth allocation process but is rather a transactions demand related to the flow of consumption.

The Firm Sector

It is assumed that firms (facing constant or increasing returns to labour input[4]) decide how much they are going to produce, how many people they will employ and how much investment they will undertake. They must also set prices such as they expect will enable them to achieve sales which have a value sufficient to pay for all their outgoings and also generate enough profit to satisfy shareholders and pay for some considerable proportion of investment. But firms have no direct control over their sales in the short run, so this highly complex set of decisions must be taken on the basis of expected sales – a risky business. In this particular model a simple stock adjustment model for both kinds of investment has been used. As firms do not know what their sales will be, there must once again be a flexible element, assumed in the model to be changes in inventories, which act as a buffer. But any increase in inventories requires additional finance, assumed to be readily available in the form of additional bank loans.

Banks

It is the role and *modus operandi* of banks in the macro-economic process which constitutes the main distinguishing feature of the present approach. We are attributing to banks a different and more important role for banks than did (for instance) Tobin, who generally modelled them as nothing more than financial intermediaries who exercise and facilitate portfolio choices [Tobin and Golub (1998) chapter 7]. *Pace* Tobin, one of banks' main *raisons d'etre* is to provide initial finance for fixed investment and revolving finance

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[4] C.f Hicks (1989 p22) "There is no need to assume that there is a single optimum output for which the firm 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".

for inventories. But the need for bank loans will be erratic and unpredictable both because of failed expectations by firms regarding sales and because of their need to fund unforeseen investment opportunities. Banks are able to provide loans because the act of lending creates (credit) money which constitutes a means of payment and a store of value. To make money acceptable for these purposes, banks must be willing to exchange any deposit in the possession of one pair of hands for a deposit in any other pair, or for cash or government securities as the counterpart of any purchases of securities or payment of taxes by non-banks[5]. At the same time, as argued above, households' holdings of money, while partly determined by an allocation decision similar in that used for other assets, is subject to an erratic and unpredictable outcome because expectations about incomes and asset prices are continuously being falsified. But there is no reason why the erratic demand for money should bear any relationship to the erratic demand for loans. As banks are assumed to be subject to a minimum reserve requirement, their flexible element, which acts as a buffer when lending changes unexpectedly relative to the stock of credit money, has to be their stock of government bills or, in the last resort should this stock be exhausted, direct advances from the authorities. And it is this flexibility in the ratio of bills to liabilities which enables banks to exercise their crucial co-ordinating function.

While the banks have no direct control over the stock of credit money and in practise little direct control over the level of loans, they can and do determine the rates of interest they charge on loans and pay on deposits. So given that the bill rate is exogenously fixed by the government, banks can, by changing the money rate of interest, eventually alter households' portfolio preference in favour of (or against) money as compared with other assets. Banks set interest rates in a way that ensures that they make profits – that is, (always taking into account the risk of default) the sum of their interest receipts (including receipts arising from the ownership of government bills) must exceed the sum of interest payments by some amount that satisfies shareholders and also ensures that they generate the capital adequacy ratios which are required by the regulatory authority. So when banks change interest rates on money they must also change them on loans. Thus the co-ordinating role of banks, essential to the functioning of the system as a whole, depends on there being a continuous adjustment of money rates of interest relative to loan rates and of both relative to the bill rate.

The Government (amalgamating Treasury with Central Bank for present purposes)

The government is assumed to be able to determine its own real expenditure on goods and services (although this is not always the case in the real world). Otherwise the government sets tax and benefit rates but has no direct control over tax receipts measured *ex post* and hence no direct control over its own deficit. It is assumed that the government sets the short term interest rate exogenously, implying that a supply of bills takes place on any

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[5] A story such as this makes the whole notion of an exogenous "money supply" chimerical, although the concept is essential for the solution of the neo-classical model.

scale that matches demand as determined in households' asset demand array. It is further assumed that the government aims to achieve some desired maturity structure in its liabilities which (given the bill supply) will determine the supply of bonds to the market. Equivalence between demand and supply of bonds is determined by the price of bonds and, thereby, the long term rate of interest in a market clearing process. This leaves the total supply of cash as a residual over which the government has no direct control with the supply of cash to the household sector by commercial banks being 100% demand determined. Accordingly, the supply of cash by the government to the banks has to be the ultimate residual of the supply of government liabilities (all the others having now been determined), over which (once again) it has no control.

We have here reached a point of fundamental importance. The demand for cash by banks is determined by the credit money stock in combination with the reserve requirement. The supply of cash to banks, as we have just seen, is the residual between total government liabilities and the supply of bills, bonds and households' cash. What is going to make the demand for cash by banks' equal to the supply of cash to banks? There is no room for an equation to make demand equal to supply because we already have equations in each variable so for a moment the model seems to be over-determined. The answer is to be found in a feature of the accounting system which inevitably becomes important as soon as one attempts to model such a comprehensive organism as a whole. As every column as well as every row sums to zero, any one row (or any one column) is necessarily implied (item by item) by the sum of all the other rows (or columns). And any single variable is necessarily implied by the sum of all other current price variables – of which there are some forty. This will imply that one equation has to be dropped if the model is to be capable of solution. In the particular model described here, it is the equation describing the equivalence between the demand and supply for banks' cash that can, indeed must, be dropped. And when we come to solve the model numerically it is found that this equivalence is always found to exist. Any discrepancy, in a numerical solution, between the demand and supply for banks' cash denotes that an error has somehow crept into the accounting equations.

THE MODEL ITSELF AND SOLUTIONS TO IT

The model itself has 130 equations, and it would not serve my purpose to go through it in detail in this paper[6] nor would there be room for such an exegesis. The model only has, for exogenous variables, real government expenditure, the tax rate, the bill rate of interest, the banks' reserve requirement and labour productivity; in addition it has 30 odd parameters[7].

Note too that (as hinted earlier) by virtue of the "buffering" available to each sector, we have been able to dispense totally with the notion of a market clearing equilibrium for goods or labour[8] – and, indeed, with disequilibrium in the sense used by Malinvaud (1977). Wage rates and the price of goods distribute the national income, they neither clear markets nor do they fail to clear them.

This model finds a solution corresponding to any (non-outlandish) set of assumptions about the formation of expectations. Moreover given its exogenous variables, it will move (so long as the inflation rate stabilises) towards a determinate steady state whatever happens to expectations, so long as these are not downright perverse as would be the case if, when falsified, they were always altered so that previous errors are compounded on an ever increasing scale (people learning less than nothing from their mistakes).

So we come at last to the main purpose of the paper, which is to report some simulation results accompanied by a narrative which, it is hoped, will lend plausibility to each experiment as well as, eventually, to a whole system of thought. In each case the results illustrated below are variables selected from a solution of the whole model. This last point is made lest anyone should suppose that the numbers presented are arbitrarily chosen, in isolation from all other considerations, just to illustrate particular mechanisms in a way that corresponds vacuously with the author's imagination.

## EXPERIMENT 1 THE BANKS'RESERVE RATIO IS RAISED

In order to isolate the particular effects which this experiment is designed to illustrate, it has been assumed that there is no inflation and that there is perfect foresight.

Chart 1 simply shows the ratio of banks' stock of cash to their liabilities – their reserve ratio - which is assumed to rise in a step from 3% to 8%.
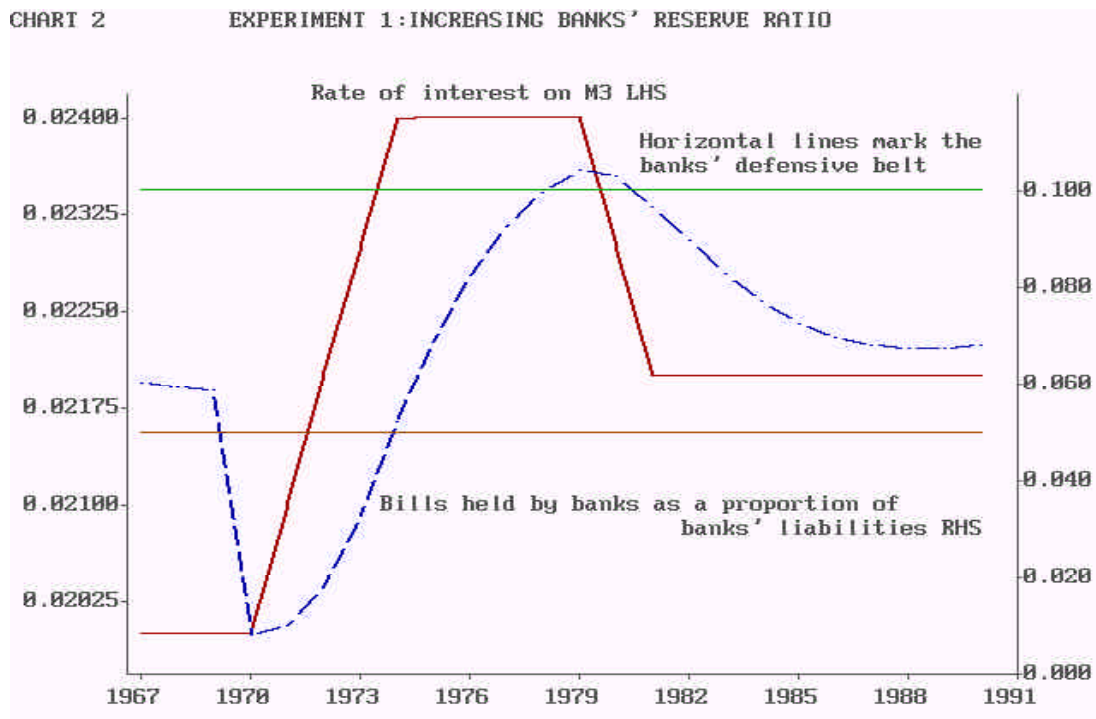
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[6] A full list of equations with a description of how they were derived will be found in Godley and Lavoie (forthcoming).

[7] But the "parameters" (eg the desired capital/output ratio or the wealth/disposable income ratio) may change spontaneously and discontinuously causing cyclical variations.

[8] As already mentioned, there are three local exceptions. The price of equity, the price of long bonds and the rate of interest on commercial paper are all determined by a market process which turns on demand being brought into equivalence with supply. In our main open economy models the exchange rate is also determined by a market process.

CHART 1   EXPERIMENT 1:INCREASING BANKS' RESERVE RATIO

Ratio of bank reserves to M1 + M3
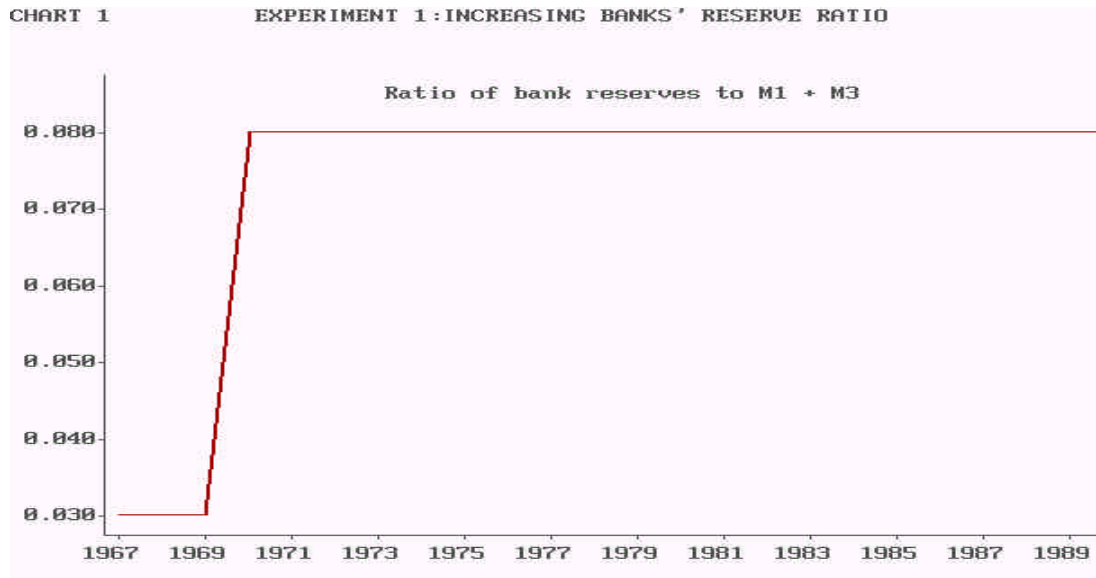
When banks suddenly have to raise their reserve ratios they do not, indeed *cannot*, immediately reduce their loans, still less the total quantity of credit money, by an equivalent amount if at all.

CHART 2   EXPERIMENT 1:INCREASING BANKS' RESERVE RATIO

Rate of interest on M3 LHS

Horizontal lines mark the banks' defensive belt

Bills held by banks as a proportion of banks' liabilities RHS

What they do immediately, as Chart 2 shows, is reduce (what Tobin called) their "defensive belt" of bills, which they can sell without hindrance to the government. But this has the effect of reducing the ratio of banks' bills to their liabilities almost to zero – far below the safety level. It has been assumed that banks have a desired band for the bill

ratio within which they feel comfortable; below it they run the risk of being forced to borrow from the central bank at a penal rate of interest while above it they are foregoing interest income unnecessarily. So banks raise the interest rate they pay on deposit accounts which has the effect of gradually raising the bill ratio so that it sits once more inside its desired range. Why does it have that effect?
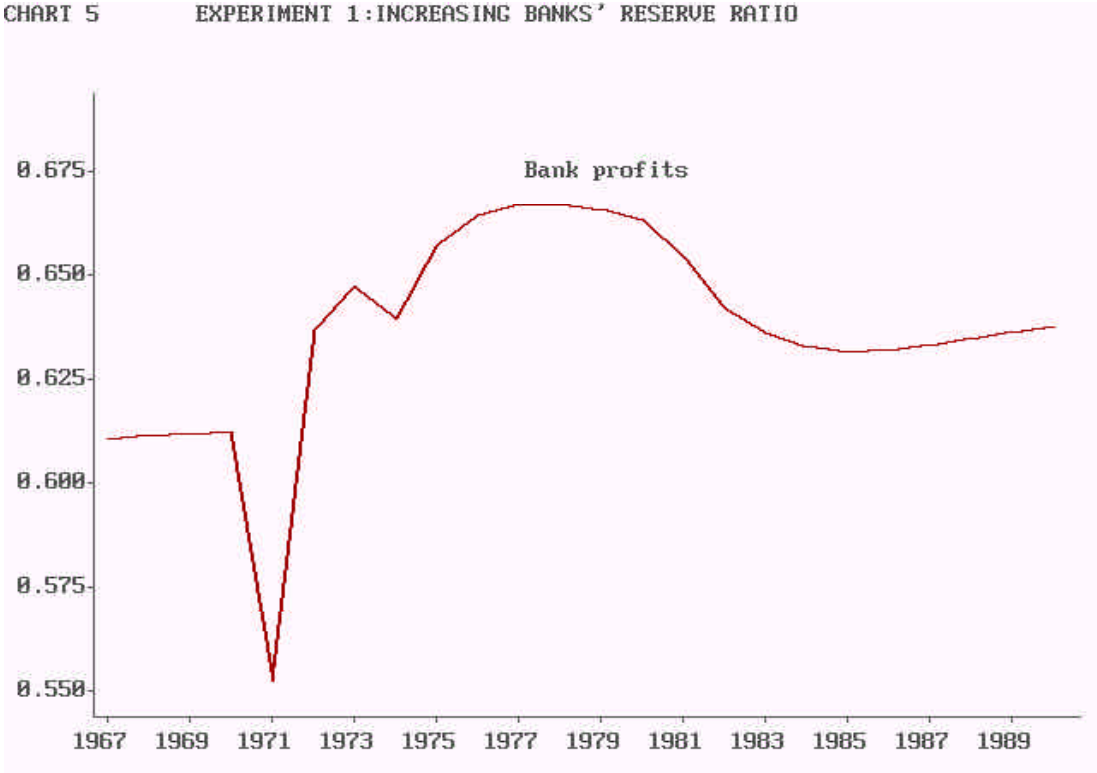
CHART 3   EXPERIMENT 1:INCREASING BANKS' RESERVE RATIO
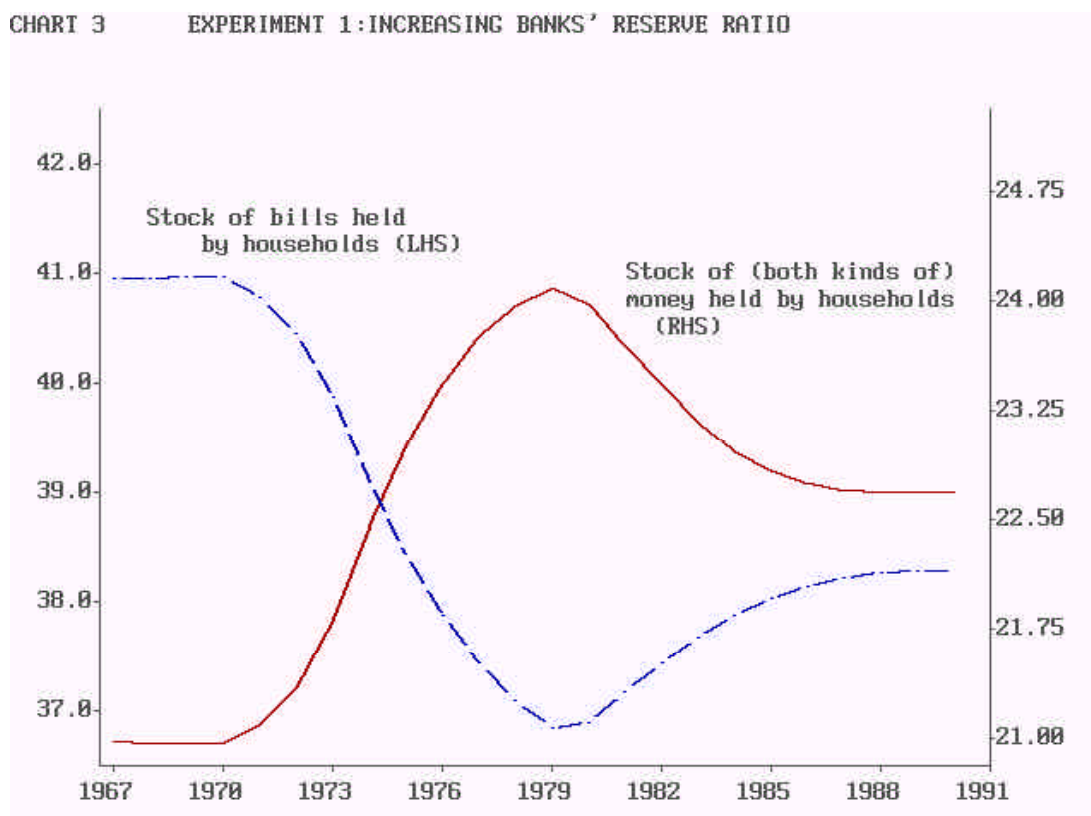
It has that effect because, with the money rate of interest higher relative to the bill rate people adjust their portfolios so that they hold more money and fewer bills – that is, the household sector as a whole exchanges bills for money, as shown in Chart 3. The net effect is not to reduce the quantity of money at all but to increase it. The banks, for their part, have increased their liabilities (credit money) and their bills by roughly equal amounts. As the banks' stock of bills is normally very small relative to the stock of money, the net effect is to raise the bill ratio so that the defensive belt is restored.

But banks have to preserve their profits, so when the money rate is raised they also raise the loan rate by whatever is the appropriate amount to keep profits more or less steady. The whole configuration of short term rates is shown in Chart 4 with the necessary hierarchy intact all the time – there must be at least three interest rates in a properly articulated account of banks in a macro model - though this is not part of the usual textbook story. The loan rate must be above the bill rate and the bill rate must be above above the money rate.. And unless interest payments as well as interest rates are

12

introduced, it is impossible to model banks' profits without which a solution to whole model would be impossible to derive.

CHART 4   EXPERIMENT 1:RAISING THE BANKS' RESERVE RATIO
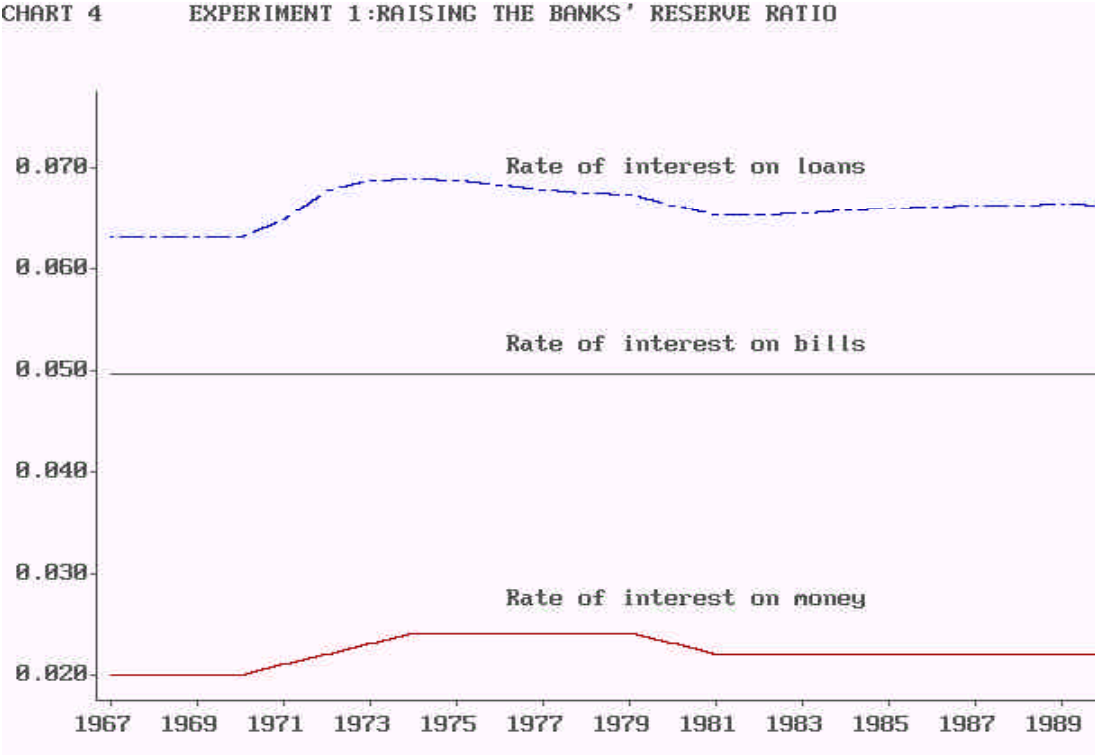
Finally, Chart 5 shows how, after a brief hiccup, bank profits are indeed maintained.

CHART 5   EXPERIMENT 1:INCREASING BANKS' RESERVE RATIO

In the next experiment it will be assumed that the level of sales expected by firms is equal to actual sales plus or minus a large random variable, while households' expectations about incomes are similarly generated by actual income plus or minus a (different) random variable. There is no suggestion here that expectations are really formed in this way; the purpose is to show how banks might cope under extreme conditions.

It is assumed that firms base their production decision on expected sales and their desired level of inventories. But their expectations about sales will in general be falsified. Chart 6 plots the course of actual less expected sales volumes together with the consequential change in (the volume of) inventories. It shows how inventories fluctuate inversely with the expectational errors.

CHART 6   EXPERIMENT 2: RANDOM EXPECTATIONS

The firm line is actual less expected sales
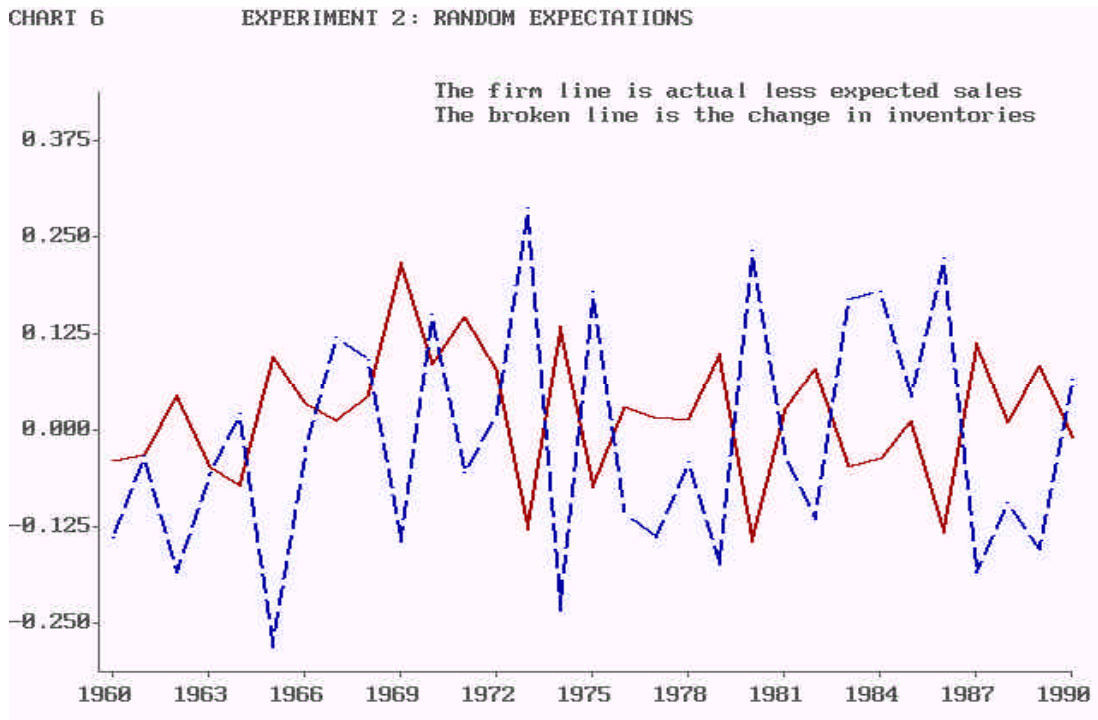The broken line is the change in inventories

Chart 7 below shows the implied changes in the *value* of inventories (inventories, that is, valued at actual historic cost) together with the borrowing from banks which firms need to undertake as a consequence. The equivalence is not exact because bank loans are taken out for purposes other than the finance of inventories.
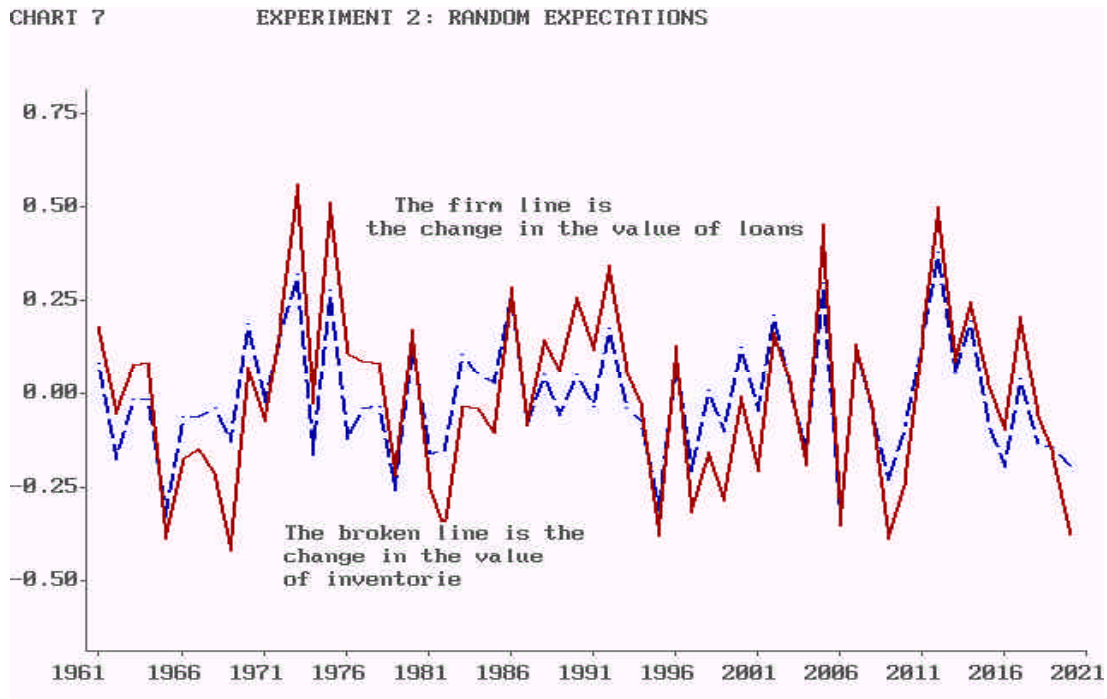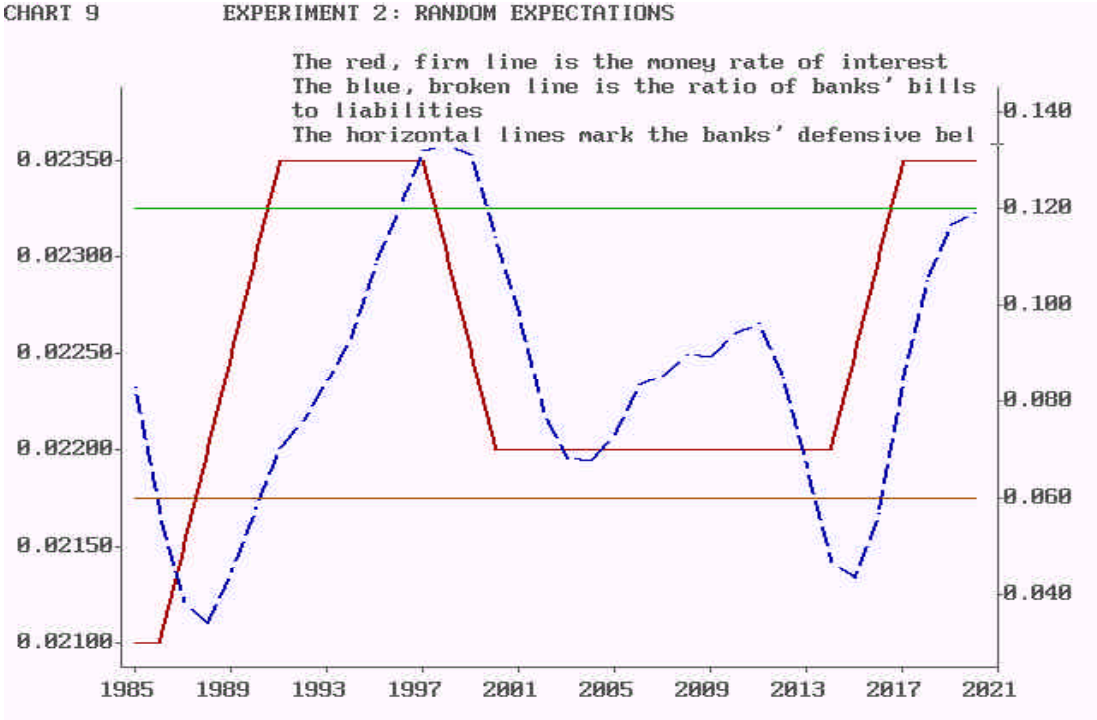
CHART 7   EXPERIMENT 2: RANDOM EXPECTATIONS

Chart 8 shows how the gap between actual and expected income moves, together with changes in current account money. The relationship between the two series is far less clear than was the case with inventories although regression analysis shows a significant positive coefficient. The relationship is weaker because there are so many factors influencing the demand for money; for instance the transactions need for cash fluctuates with consumption and this has a direct effect on the demand for (current account) money, which is a residual between total wealth and every other individual financial asset.

CHART 8   EXPERIMENT 2:RANDOM EXPECTATIONS
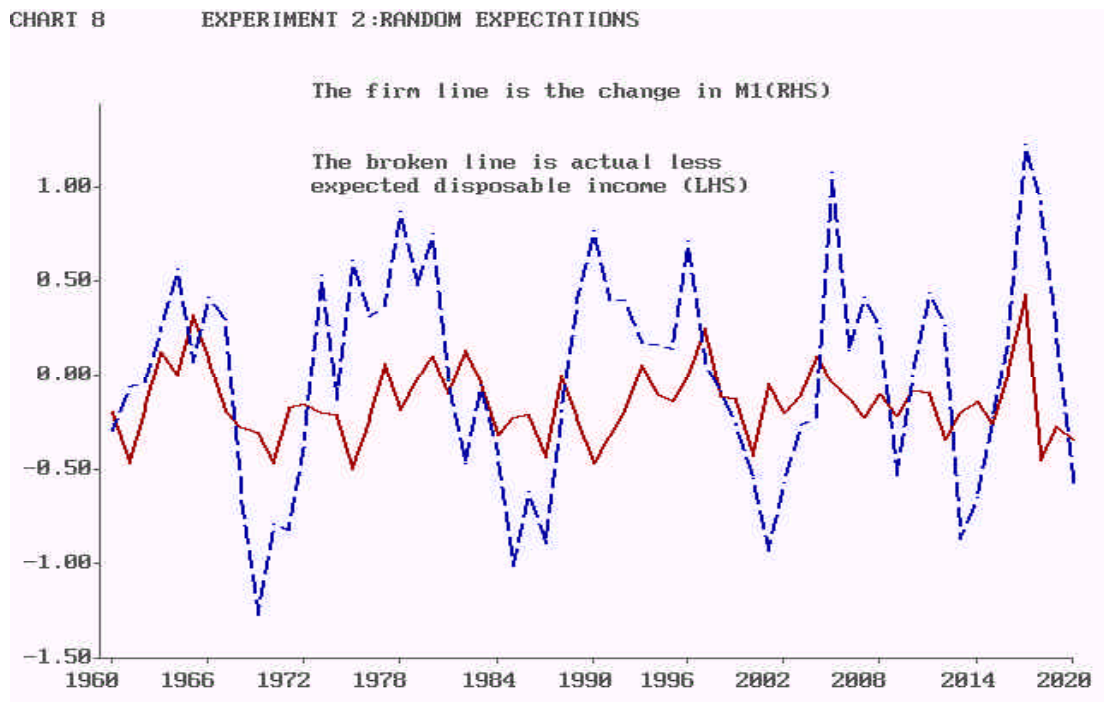
How do banks handle these fluctuations in their assets and liabilities (loans and money) over which they have virtually no short term control, and still remain profitable?

CHART 9   EXPERIMENT 2: RANDOM EXPECTATIONS

The red, firm line is the money rate of interest
The blue, broken line is the ratio of banks' bills to liabilities
The horizontal lines mark the banks' defensive bel

As Chart 9 shows, banks respond in a way that is directly comparable to their response to a changed reserve requirement, that is, they change the rate of interest they pay on deposits as soon as their bills move out of the target range. And to keep their profits intact they have to keep changing the rate of interest they receive on loans.

CHART 10   EXPERIMENT 2: RANDOM EXPECTATIONS

Loan rate of interest
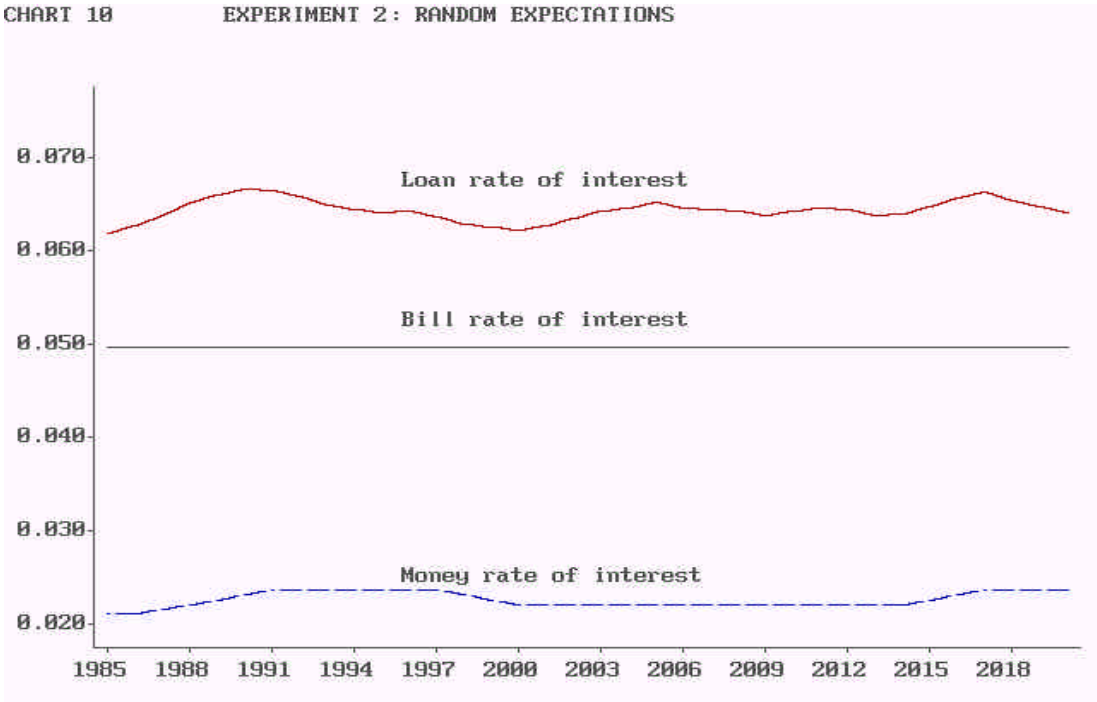
Bill rate of interest

Money rate of interest

Chart 10 shows the whole configuration of banks' interest rates – on loans, money and bills – the latter assumed exogenous and fixed throughout. The model is constructed so as to ensure that this particular hierarchy is always preserved. Loan rates exceed bill rates otherwise banks would have no incentive to lend. And bill rates must exceed money rates because otherwise neither banks nor households would buy bills (Godley and Cripps (op.cit. p 160).

EXPERIMENT 3:
'ANIMAL SPIRITS' DISCONTINUOUSLY RAISE THE DESIRED CAPITAL STOCK
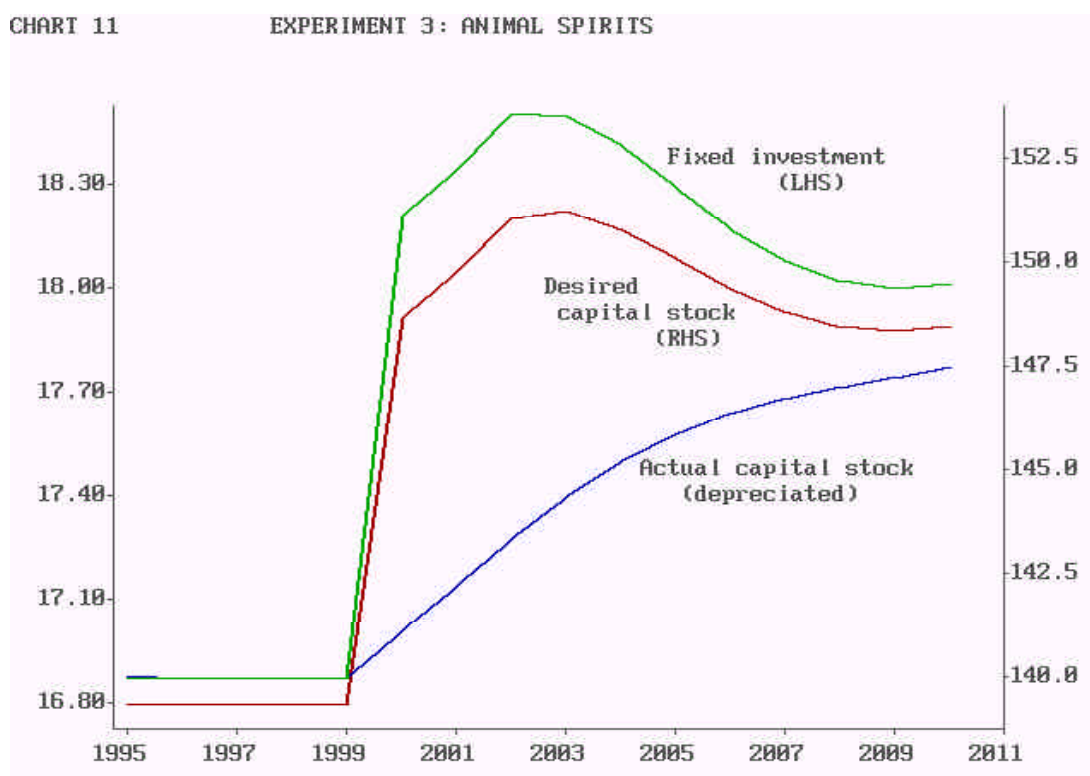

CHART 11   EXPERIMENT 3: ANIMAL SPIRITS

Chart 11 shows a discontinuous (exogenously determined) rise in the desired capital stock together with the consequential adjustment of the actual (depreciated) capital stock towards its new level. The chart also shows, using a different scale, the implications (mechanically derived) for gross fixed investment. Fixed investment remains at a higher level in the new steady state because depreciation is higher.

How exactly is this investment financed? This is a question which is seldom if ever asked in the mainstream macro story, though it is a continuous theme in the Cambridge Keynesian literature, and with the accounting framework deployed here it is a question that demands a precise answer. The answer built into the present model, which is consistent with a large amount of empirical evidence, is that in general investment is financed by retained profits. However, as the investment must be undertaken before profits can be increased, initial finance is provided by bank loans.

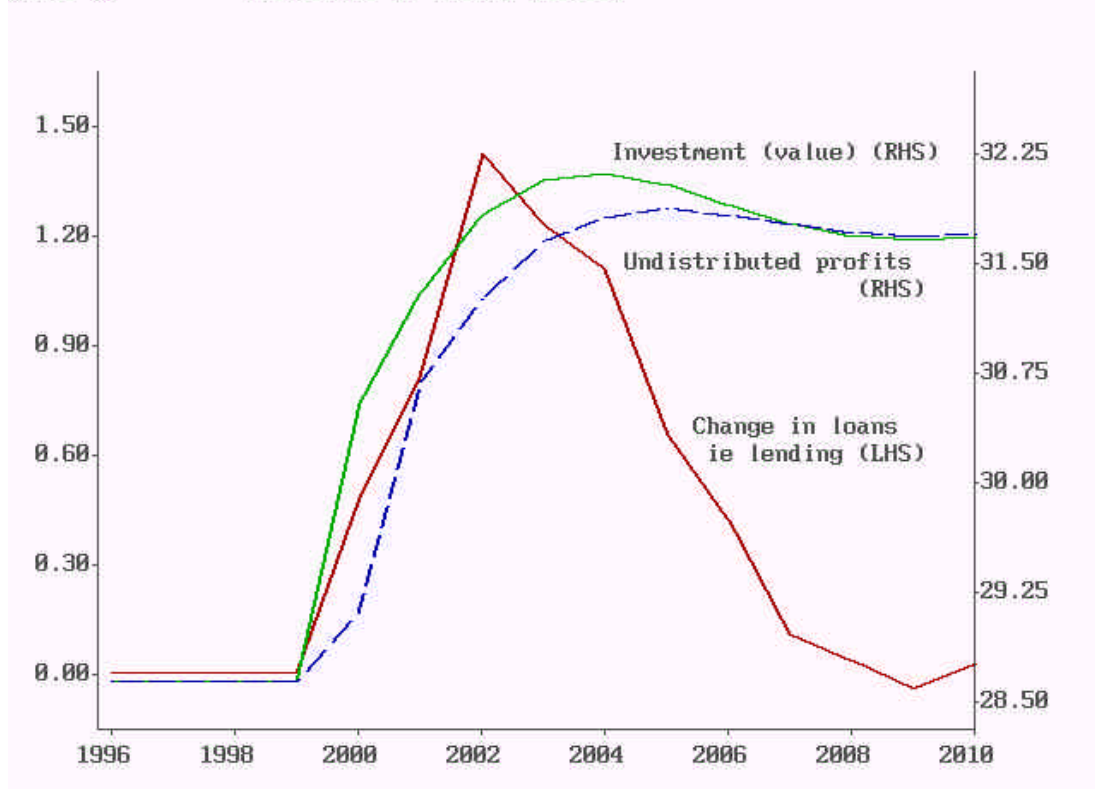CHART 12   EXPERIMENT 3: ANIMAL SPIRITS

Chart 12 shows the value of investment together with undistributed profits, which eventually finance the whole of it. However in the period until undistributed profits can do their work, fixed investment is financed by an addition to bank lending which falls away as profits take over.

And what in, turn, is the mechanism by which profits are raised? Until we are clever enough to introduce changed productivity into the analysis, the answer can only be that the profit mark-up on historic unit costs is raised.

Chart 13 shows what happens to the price level and also what happens to the share of profits in the value of sales. To translate the mark-up on historic costs into the specific sum of money generated each period required to finance investment involves a particularly intricate sequence of accounting manoeuvres which was originally set out in Godley and Cripps (1983) and will be summarised in the final section of this paper.

CHART 13   EXPERIMENT 3: ANIMAL SPIRITS
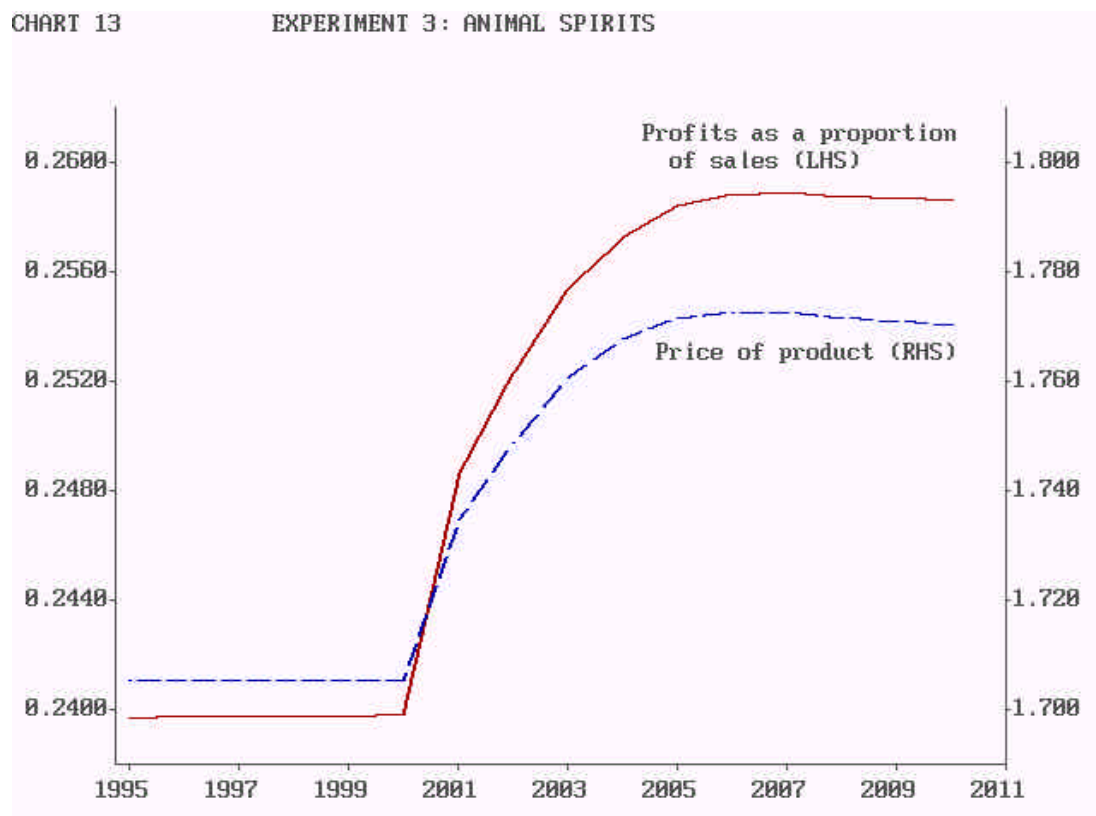
EXPERIMENT 4:
HOW THE SYSTEM AS A WHOLE RESPONDS TO A FISCAL SHOCK

About thirty years ago, some important articles were written about the long run effect of fiscal policy on output, of which the most well known is probably that by Blinder and Solow[9] (1973). The central point made in all this work was that a properly specified stock-flow model, on the assumption that all exogenous variables are held constant, should find a full (stationary) steady state when output is equal to government outlays divided by the (average) tax rate. As all stock variables (wealth, capital, inventories and government debt) and all flows are constant in the steady state, it must also be the case that the budget balance is zero and that government outlays are equal to receipts. To put it simply, if G = T where G is government outlays and T is the flow of taxes,. and if T= θY where θ is the tax rate and Y is output, it is obviously the case that Y* = G/θ. Notwithstanding that we have a model which is quite large and complex, it ought to retain this same property.

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[9] Others include Ott and Ott (1965) and also Tobin and Buiter (1976)

CHART 14   EXPERIMENT 4:EFFECT OF A STEP INCREASE IN REAL GOVT.EXPENDITURE

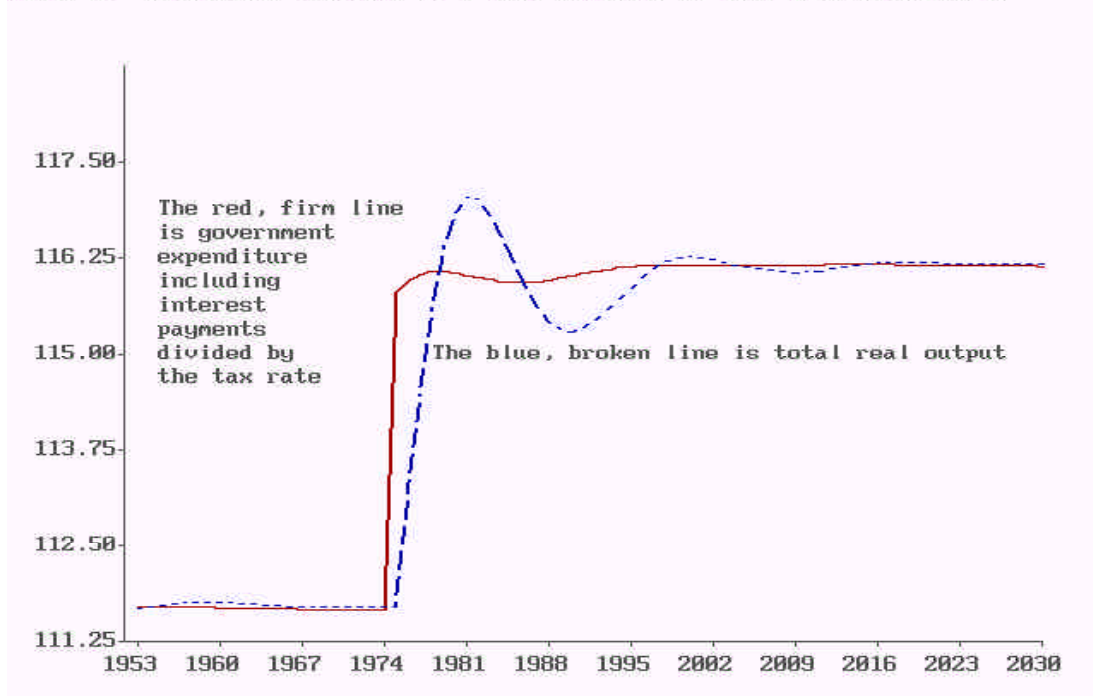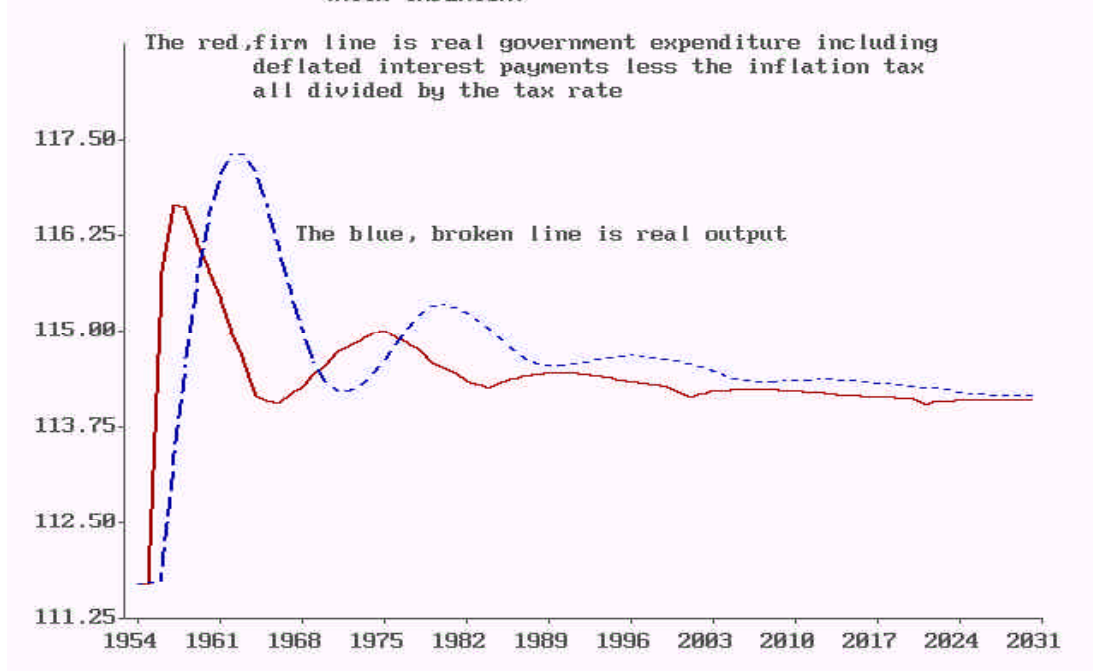The red, firm line is government expenditure including interest payments divided by the tax rate

The blue, broken line is total real output

CHART 15 EXPERIMENT 4:EFFECT OF A STEP INCREASE IN REAL GOVT.EXPENDITURE
(WITH INFLATON)

The red,firm line is real government expenditure including deflated interest payments less the inflation tax all divided by the tax rate

The blue, broken line is real output

Mercifully we find that it does indeed do so. In Chart 14 the inflation equations have been suppressed. We start from a full steady state and administer a shock in the form of a step up in government expenditure. The chart shows, on the one hand, the path of government expenditure including interest payments divided by the average tax rate and, on the other, the path of total output. The two series converge in a satisfactory way.

20

In Chart 15 we conduct the same experiment but allow wages and prices to rise when output rises above its first steady state level. The forcing variable has become real government expenditure *plus* the deflated flow of interest payments *less* the "inflation tax[10]" all divided by the tax rate. Again we have a satisfactory change in output towards what theoretically should be its steady state but inflation makes the new steady state output much lower than that in Chart 14. Too much should not be read into this, however, because nominal interest rates have been held constant, and this has reduced the flow of government outlays measured in real terms.

Inflation Processes

There has been an explosion of literature about the genesis of inflation during the last twenty five years, of which Layard et al (1991) is a good example. Conventional inflation models are all (so far as I know) deployed in terms of the proportional response of nominal wage changes to price changes and of price changes to wage changes without their being specific about what the target real wage actually is. Moreover, as the accounting framework of these models is so scanty, they ignore certain possible outcomes and do not do not fully characterise inflationary processes as sequences in time.

The starting point for the analysis of inflationary processes in the model described here is the identity in column 2 of the transactions matrix, which defines the income components of final sales

5) $S \equiv T + FF - WB + I - (1 - rl).I_{-1}$

where S is the value of sales at market prices, T is taxes, FF is firms' profits, WB is the wage bill, I is inventories valued at cost and rl is the loan rate of interest.

Following Godley and Cripps (op.cit pp 186-195) an expression may now be derived which defines a four way split of real production in any given unit of time between taxes, profits, wages and the banks which have financed the production process. The steps are as follows.

Of the physical objects sold in any period, s, a (variable) proportion, 1 - **F**, was manufactured in that same period, and hence the proportion **F** was manufactured in the previous period.

6) $s \equiv (1 - \sigma).s + \sigma.s$

The actual costs incurred in producing what was sold, HC, including the interest cost of holding inventories, was

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[10] The inflation tax is defined as $\gamma.dg_{-1}$ where γ is $\rangle p/p$ (p being the price level) and dg is total government debt deflated by the price index.

7) $HC \equiv (1 - \sigma).s.UC + \sigma.(1 + rl).s\,UC_{-1}$

where the unit wage cost, UC, is given by the nominal wage rate, W, times employment, N, divided by real output measured as numbers of physical objects.

8) $UC \equiv W.N/y$

Equation 7) says that the production cost of something both made and sold this period is given by valuing it at this period's unit cost; what was sold this period but made last period is valued at last period's unit cost.

Defining a tax rate, τ, and the profit mark-up measured ex post, ρ,

we may write 5) as

9) $S \equiv (1+ \tau).(1 + \rho)[(1 - \sigma).s.UC + \sigma.(1 + rl).s\,UC_{-1}]$

The real rate of interest with respect to cost inflation, rc, is

10) $rc \equiv (1 + rl)/(1 +\pi c) - 1$

where

11) $\pi c \equiv UC/UC_{-1} -1$

To obtain the identity which links prices (measured as dollars per object) to costs, first divide 9) through by s, the number of objects sold, to obtain the price level, p.

12) $p \equiv (1+ \tau).(1 + \rho)[(1 - \sigma).UC + \sigma.(1 + rl).\,UC_{-1}]$

Equations 9) and 12) carry the useful, and possibly surprising, implication that if prices are a constant mark-up on historic cost, profits will be a constant share of the value of ex-tax sales.

Next substitute 10) and 11) into 12) to obtain

13) $p \equiv (1+ \tau).(1 + \rho)(1 +\sigma.rc).UC$

Finally, dividing 13) by p and multiplying by y we have an expression which exhaustively describes the four way split of real output in each period between rival claimants.

14) $y \equiv (1+ \tau).(1 + \rho)(1 + \sigma.rc).w.N$

where w is the real wage rate.

In this model it is assumed that nominal wage rates are set at discrete intervals of time. Wage rates are the outcome of a bargaining process which determines the real value of the nominal settlement at the instant the bargain is struck; and which will largely depend, quite conventionally, on the pressure of demand for labour. Any inflation which subsequently takes place, and the effect on income distribution which this has, will depend on resource availability and on the extent to which the various shares described in

14) can protect themselves. Normally, but by no means always, the tax and profit shares will be pretty inviolate. The share of creditors may be vulnerable, particularly at the onset of inflation - when their share can become negative. It will normally be the case that it is the real value of nominal wage settlements which gives way, eroded by inflation, when there are insufficient resources to meet all claims. Inflation will accelerate if increasingly unrealistic claims on real resources are made or if the interval between wage settlements shortens. If the interval between settlements shortens to the point where nominal wages are indexed (as started to happen in the UK in 1974-5) inflation becomes explosive. Equations 13) and 14) may be used to derive the level of real wages which is consistent with stable inflation, if tax, profit and real interest rates are given.

Apart from resolving potentially conflicting claims on the flow of production, rapid inflation will, according to the equations of this model, have a devastating effect on the real value of wealth if there are matching increases in nominal interest rates, with strongly adverse effects on aggregate real demand.

Conclusion

The strength of this paper resides in the rigour and completeness of the double entry accounting framework used, which shows (largely following Tobin) how money and finance should be integrated into the analysis of income, expenditure and production flows. The paper has also described, at the level of accounting, how the pricing behaviour of firms, the tax mark up and the real interest rate determine the distribution of the national income between the four sectors which make up the economy. The paper has informally described a model of the way in which the whole system of stocks and flows can move in more or less determinate sequences, generally towards steady states, and numerical simulations were used to illustrate how parts of it work. But the whole exercise, though rigorous with regard to its accounting, is still no more than a sketch, the parameters and behavioural functions being based on nothing more than stylised facts and guesses. In contrast to the standard textbook methodology, which starts by making very strong behavioural assumptions based on no empirical evidence at all (for example regarding the shape and role of an aggregate neo-classical production function), indicating a different paradigm is indicated in which knowledge is gradually built up by empirical study, within the formidable constraints imposed by double entry accounting.

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