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Working Paper

Circuit theory extended: The role of speculation in crises

Economics Discussion Papers, No. 2012-30

Provided in Cooperation with:

Kiel Institute for the World Economy – Leibniz Center for Research on Global Economic Challenges

Suggested Citation: Lancastle, Neil (2012) : Circuit theory extended: The role of speculation in crises, Economics Discussion Papers, No. 2012-30, Kiel Institute for the World Economy (IfW), Kiel

This Version is available at:

<https://hdl.handle.net/10419/59590>

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Circuit Theory Extended: The Role of Speculation in Crises

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Abstract This paper asks why modern finance theory and the efficient market hypothesis have failed to explain long-term carry trades; persistent asset bubbles or zero lower bounds; and financial crises. It extends Keen (*Solving the Paradox of Monetary Profits*, 2010) and the Theory of the Monetary Circuit to give a mathematical representation of Minsky's Financial Instability Hypothesis. In the extended model, the central bank rate is not neutral and the path is non-ergodic. The extended circuit has survival constraints that include a living wage, a zero interest rate and an upper interest rate. Inflation is everywhere. The possibility of a high interest rate, hedge economy emerges, where powerful banks invest surplus loan interest. With speculation, banks lobby to enter investment markets and the system is precariously liquid/illiquid. The paradox of a Ponzi economy, where loans never get repaid, is that private banks must speculate to increase reserves and rely on systemic crises to rebuild their balance sheets. Estimating model parameters for the US gives a scissor-graph like the The Financial Crisis Inquiry Commission (*The Financial Crisis Inquiry Report*, 2011) with other nuances, namely i) a 'heart attack' in 1973–1974 that corresponds to the collapse of Bretton Woods ii) an accelerated decoupling of household wages and loans after the repeal of Glass-Steagall. Simulating bank bailouts, household bailouts and a Keynesian boost suggests that bank bailouts are the least effective intervention, with downward pressure on wages and household spending. Bailing out hedge households is a form of monetary contraction, and boosting hedge business loans is a form of monetary expansion. The appropriate policy choice would seem to depend on the external balance and inflation concerns. The paper concludes that, with international Ponzi sectors, viable resolution mechanisms include reparations ($d_L < 0$), turning Ponzi debt into equity or 'junk' debt ($d_L \rightarrow \infty$), household bailouts and a Keynesian boost.

JEL E10, E27, E43, E58, E60

Keywords Circuit theory; macroeconomic simulation; carry trade; banking regulation; interest rate policy

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The author wishes to thank the Alumni of Leicester University, who are providing generous financial support to him and his family through the Alumni Scholarship scheme.

Circuit Theory extended: the role of speculation in crises

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The Rise of Modern Finance

As Mehrling says ‘the world of the new modern finance theory was a world in which both expectations hypothesis (EH) and uncovered interest parity (UIP) were expected to hold’ (Mehrling, 2011:86). Under EH, the long-term interest rate is defined in terms of the short-term rate and a constant risk premium. Under UIP, a low interest rate currency is expected to appreciate, and a high interest rate currency to depreciate. For efficient market hypothesis (EMH) theorists, these anomalies were short-lived phenomena that would be arbitrated when sufficient capital was drawn in, and global imbalances would be resolved through price adjustments via free-floating exchange rates (Friedman, 1953, Fama, 1991). There is no explanation for long-term carry trades, persistent asset bubbles or zero lower bounds, and no theory to explain financial crises.

Provided the central bank maintains a liquid payments system, private banks can exploit EH and UIP through carry trades that ‘borrow in low-interest rate currencies and lend in high-interest-rate currencies, borrow in short-term markets and lend in long-term markets, borrow at the risk-free rate

and invest in risky bonds... significantly, all of these arbitrage trades depended on the availability of funding liquidity' (Mehrling, 2011:86). The central bank maintains liquidity by stepping in as 'dealer of last resort' when capital markets diverge from expected behaviour. Hence the central bank provides an implicit guarantee for speculators should EH and UIP fail, both providing liquidity and underpinning debt markets.

This world of modern finance saw the birth of New Consensus Macroeconomics (NCM) 'after the collapse of the Grand Neoclassical Synthesis in the 1970s' (Arestis, 2009:2), of Bretton Woods, and of the gold standard. Instead, the US Dollar became the world's reserve currency. Under NCM, international capital markets did not need to be regulated because a floating exchange rate would adjust prices and clear markets. Economists needed to solve a different problem: to forecast price inflation. The Bank of England (BoE), in describing their inflation forecast model, expressed this quite clearly when they said 'as the economy is completely small and open in capital markets, UIP is a standard no-arbitrage condition that prices the exchange rate to equalise the return on riskless domestic and foreign bonds' (Harrison *et al.*, 2005:43).

Yet despite theory, evidence against UIP had been building for years. Froot and Thaler found evidence of a negative correlation of -0.88, where high interest rate currencies tended to appreciate (Froot and Thaler, 1990). Economists (Balassa, 1964; Samuelson, 1964; Fischer, 2002; Karadi and Koren, 2008) sought explanations in productivity and real-world factors, and behavioural finance theory sought explanation in irrational trends (Schulmeister, 2006). UIP is a central anomaly in finance, because it questions whether international capital markets are efficient.

Some economists have since argued that a long-term asset price bubble is sustainable '(provided) the interest rate is sufficiently low to provide repayment incentives' (Hellwig and Lorenzoni, 2009:1156). Hellwig uses liquidity constrained actors in his model, rather than assuming liquidity is a 'public good'. In his model, real world actors have no incentive to default, because they lose the ability to borrow in future periods. Instead, 'interest rates adjust downwards to provide repayment incentives to all the potential borrowing parties. As a result, 'low interest rates emerge in equilibrium' and asset prices remain inflated. 'The circulation of [self-enforcing private debt] requires that an intrinsically useless asset (a rational bubble) is traded at a positive price' (Hellwig and Lorenzoni, 2009:1157).

Neither does EMH take account of the business cycle or banking regulation. Outside EMH, Minsky's 'financial instability hypothesis' (FIH) had proposed that capitalist economies move from hedge finance towards speculative and (ultimately) Ponzi finance. This would be a falsifiable hypothesis if there were public information on the flows, assets/liabilities, and financial obligations of all of the actors in an economy. Minsky hinted at how this might be done. 'It can be shown that if hedge financing dominates, then the economy may well be an equilibrium seeking and containing system. In contrast, the greater the weight of speculative and Ponzi finance, the greater the likelihood that the economy is a deviation amplifying system' (Minsky, 1992:7).

This paper proceeds by extending the Theory of the Monetary Circuit to give a mathematical representation of FIH, without assuming any causality. It uses the extended circuit to gain insights into banking regulation, interest rate policy and the possibility of stable high (and low) interest rate economies. While not directly attacking the theory of loanable funds, the Ponzi economy presents a scenario where demand for loans outstrips supply. If the central bank maintains liquidity by lending freely, a persistent, low interest rate asset bubble is possible.

They saw it coming: the Theory of the Monetary Circuit

There were economists and analysts who 'saw this (crisis) coming' (Bezemer,2009:3) by considering the stocks and flows between different sectors of the economy. They share a belief in accounting models that analyse the 'flow of funds for crisis potential... without avoiding a discussion of the elephant in the room (debt build-up)' (Bezemer, 2011:30). For this group, economics cannot be reduced to 'methodological individualism' (Passarella, 2012:3) because different economic sectors have different roles.

Bezemer refers to the post-Keynesian tradition as a theoretical backdrop, such as the models developed by Godley and Lavoie (G&L) where 'everything comes from somewhere and everything goes somewhere' (Godley and Lavoie, 2007:6). As a minimum, the G&L models have three sectors: banks, households and businesses, where there 'cannot be any *black hole*.... the fact that money stocks and flows must satisfy accounting identities in individual budgets and in an economy as a whole provides a fundamental law of macroeconomics analogous to the principle of conservation of energy in physics' (Godley and Lavoie, 2007:14).

Godley and Lavoie argue that long-run, global imbalances are possible between economies, provided the central bank of the surplus country is able (and willing) to buy the debts of the deficit country. In

a model which they liken to China and the US, there is 'no intrinsic limit to (the) processes' where 'Chinese exporters receive, for their increased sales abroad, an additional flow of dollars which they exchange with their central bank for their own currency... the Chinese central bank ... exchanges these for US Treasury bills. Beyond these two exchanges, the People's Bank of China neither needs nor wants to do anything at all' (Godley and Lavoie, 2007:470).

Godley and Lavoie do not explain how the People's Bank of China can make a profit from these trades. As an alternative starting point, this paper extends Keen's Monetary Circuit, which shows how banks make a profit and, like Godley and Lavoie, is grounded in Graziani.

Graziani argued that the banking sector took on a new role after the collapse of Bretton Woods. Token money could no longer be exchanged for gold at the central bank, making private, non-commodity money acceptable in final settlement. Non-commodity money creates a third agent, the bank, through whom payment occurs. This role of a third agent, says Graziani, emphasises why 'in any model of a monetary economy, banks and firms cannot be aggregated into one single sector' (Graziani, 1989:519). According to Graziani and the Theory of the Monetary Circuit (TMC), stocks of non-commodity money are increased or decreased by the debt and credit operations taking place between the Central Bank and private banks.

In his model, Graziani considers four agents i) a central bank ii) private banks ii) firms and iv) wage-earners or households. The circuit begins with banks lending to businesses. Businesses use this *initial finance* to buy labour. The initial circuit closes when households spend their wages, either on consumption or to purchase financial assets that have been issued by businesses. In subsequent circuits, businesses only borrow the additional money they need to finance production. With a single bank, Graziani saw 'an unlimited credit potential, and ... no risk of insolvency' (Graziani, 1989:524). With more than one bank, 'there is (still) no limit to the amount of bank-money which the banks can safely create, provided that they move forward in step' (Keynes, 'A Treatise on Money', Chapter 2:26 quoted in (Graziani, 1989:524)).

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Keen revises this circuit, to show how banks can generate monetary profits indefinitely, 'even if their ventures are 100% debt-financed' (Keen, 2010:4). He has three agents: banks, household and businesses. Businesses have loan and deposit accounts, the bank maintains reserves (the bank

vault), and households place their wages on deposit prior to consumption. With realistic assumptions about the rate of interests on each type of account, Keen models the impact of an exogenous injection of money into either i) the bank vault or ii) household deposit accounts:

Figure 1: Keen's Core Model

	Transaction	Type	Bank vault	Bank transaction	Firm loan	Firm deposit	Worker deposit
1	Lend money	Flow	$-a$			a	
2	Record loan	Account			a		
3	Compound debt	Account			b		
4	Pay interest	Flow		c		$-c$	
5	Record payment	Account			$-c$		
6	Deposit interest	Flow		$-d$		d	
7	Wages	Flow				$-e$	e
8	Deposit interest	Flow		$-f$			f
9	Consumption	Flow		$-g$		$g + h$	$-h$
10	Repay loan	Flow	i			$-i$	
11	Record payment	Account			$-i$		
12	Government policy	Exogenous injection into either B_v or W_D					$+I$
			$+I$				
	Σ		$i - a + I$	$c - d - f - g$	$a + b - c - i$	$a - c + d - e + g + h - i$	$e + f - h + I$

Adapted from (Keen, 2010:6-7)

Following the principle that 'everything comes from somewhere and everything goes somewhere', each of the flows ($a-i$) results in a debit or credit on one or more accounts. The system is dynamic and the sequence is indicated by the first column. Notes flow to firms from the bank vault, firms pay wages and interest, workers receive wages and interest. Critically, both firms and households consume ($g + h$). This consumption allows firms to repay their loans and close the circuit.

Keen uses realistic parameters for i) the rate of outflow of notes, ii) the rates of interest on loans and deposits, and iii) the rate at which wages are paid. He shows that banks can earn a monetary profit from the circuit, and then simulates the effects of injecting government money into either bank vaults or worker deposits. Keen concludes that injecting money into worker deposits 'go early, go hard, go households', ((Gruen, N., 2008) would have a more immediate and substantial effect during

crises. As well as extending Keen, this paper re-runs those simulations, and also asks what the impact might be of a third intervention: increasing business loans.

Circuit Theory Revised

Keen's model did not take account of household lending, whether secured against rising property prices or to make up for a decline in wages. Yet the US Financial Crisis Inquiry Commission (2011:62) showed how financial sector wages outstripped non-financial, starting in the 1980s. This combination of a relative fall in wages, rising asset prices, and rising household loans, was also apparent in the UK. A member of the Monetary Policy Committee, Wadhwani, criticised the Bank of England (BOE) for using interest rates to rein in a house price bubble (Wadhwani, 2000). He argued that high interest rates were making things worse. With open capital markets, international capital was attracted in search of carry, boosting household lending.

Angeriz and Arestis make a similar argument. The UK current account had been 'in deficit for nearly 20 years and for most of the last 30 years, more or less since the breakdown of the Bretton Woods' (Select Committee on Economic Affairs, 2004:26). Not only had exchange rates failed to adjust to reduce these imbalances, but inflation targeting had failed spectacularly in the past: price stability had preceded the 1930s Great Depression in the USA, the problems in Japan in the early 1990s, and the bursting of the dotCom bubble in March 2001 (Angeriz and Arestis, 2007:870).

The revised model (below) adds *a second, household circuit* where banks lend to households, and households invest in property. Household investment gains are used to support consumption in the speculative and Ponzi models. The models show the impact of different levels of investment gain in additional markets. There is no limit to the further disaggregation of sectors, or investment markets.

Keen's model has already introduced the possibility of modelling exogenous shocks, because it includes wages. An extreme wage shock might be a natural disaster or epidemic that wipes out households or business assets, impacting the ability of firms to produce and sell goods. As a consequence, loans do not get repaid and the circuit does not close. Predictable events can also be modelled: demographic trends from ageing and improving healthcare, and perhaps even migration due to climate change. The revised model extends these concepts.

In a general sense, by including wages Keen introduces the possibility of taxes on flows. As well as taxes (on wages, investment and lending), sectors might change their behaviour (such as household spending based on wealth, rather than wages). In the revised model, the role of government is an intermediate state: funded by both loans and the taxing of stocks and flows. Those loans and taxes flow into wages, property, spending and loan payments to the banking sector. Lastly, the revised model considers the impact of inflation in asset prices, wages, commodity prices and consumer goods.

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The revised model has three sectors (households, banks and businesses) that can make hedge, speculative and Ponzi investments, where:

- i. The hedge borrowers repay their loans from realised investment cash flows
- ii. The speculative borrowers repay their loans from realised investment cash flows. However, they roll over their debts regularly, re-investing capital gains to either produce (businesses) or consume (households)
- iii. The Ponzi borrowers rely on their investments being profitable. In doing so, they do not wait until profits are realised. In a simple, accounting sense, they use unrealised cash flows to increase production (businesses) or consumption (households)
- iv. Inflation is everywhere

The models assume that investment markets do not clear fully, and that each sector has different motives for investment. The household sector mainly borrows to invest in property. In the 'real' world, some households will invest in financial assets as a form of deferred spending (pensions).

If households are hedging, their spending *across the sector* is less than wages. If households are spending more than they receive in wages, then spending is being supported by unrealised investment gains (so the house or pension assets have not been sold): the model defines this as Ponzi household spending. In practice, this Ponzi spending is both voluntary (households who cash in on investment gains without selling assets) and involuntary (household forced to borrow on credit cards, to miss mortgage payments or run up an overdraft, to avoid their spending dropping below a living wage).

Following Graziani, businesses require *initial finance* to pay wages and begin production. In subsequent phases, businesses raise capital by issuing financial assets, and use loans to invest in

Where Δres = reserves, $-\Delta a$ = loans, r_L = loan payment rate, w_r = wage rate (the ratio of wages: business loans), hs_r = household spending rate, (the ratio of household spending to household loans), bs_r = bankers' spending rate, (the ratio of bankers' spending to loans).

For simplicity, households and businesses are assumed to borrow the same *initial finance*. The ratio of household to business loans is an important variable, but this assumption leads to some stylised facts about the loan payment preferences of households, banks and businesses.

In the tradition of stock-flow modelling, all of the rows and columns sum to zero. As a consequence, one of the equations can be treated as redundant. Giving this treatment to spending gives insight into the behaviour of banks and households, as follows:

Figure 3: Spending in Hedge Model

Transaction	Banks		Households		Businesses		Σ
	Current	Capital	Current	Loan	Current	Loan	
Create loan	$-\Delta res$	$+\Delta res$	$-\Delta a$	$+\Delta a$	$-\Delta a$	$+\Delta a$	0
Loan payment	$+2\Delta a \cdot r_L$		$-\Delta a \cdot r_L$		$-\Delta a \cdot r_L$		0
Wages			$+\Delta a \cdot w_r$		$-\Delta a \cdot w_r$		0
Spending	$-2\Delta a \cdot r_L$		$-\Delta a \cdot (w_r - r_L)$		$+\Delta a \cdot (w_r + r_L)$		0
Repay principal	$+\Delta res$	$-\Delta res$	$+\Delta a$	$-\Delta a$	$+\Delta a$	$-\Delta a$	0
Σ	0	0	0	0	0	0	0

Provided households and businesses meet their loan repayment schedules, banks sustain their spending from loan payments. In a model without asset price inflation, households and businesses do not make investment gains and the model has no investment or inflation risk.

There is no need for banks to hold reserves, provided bank spending remains within the limits set by the circuit, namely that banks' spending $bs_r < 2\Delta a \cdot r_L$.

As the loan payment rate (r_L) approaches zero, bank spending also approaches zero. On the other hand, household spending $hs_r = \Delta a \cdot (w_r - r_L)$, increases as the loan payment rate approaches zero. In other words, banks lobby for higher loan payment rates, whereas households are interested in lower loan payment rates and higher wages.

However, the loan payment rate is itself determined by central bank policy and regulation, in particular the central bank rate (cb_r). As rates rise, some businesses, households and governments will be unable to repay their loans. This is represented in the model as a default rate (dr_L). Since

the model has no investment risk, banks can recoup capital losses by selling assets, but they cannot recoup missed loan (interest) payments.

Finally, the duration of loans to households and businesses (d_L) can increase or decrease. As loan duration decreases, loan payments increase (and vice-versa). In summary:

$$\text{Bank spending} = 2r_L = f \frac{cb_r(1-dr_L)}{d_L}$$

What is the impact of inflation on the model? Since each term is a function of Δa or Δres ***inflation is everywhere***. Different levels of inflation in asset prices, wages, commodity prices and consumer goods make the model non-ergodic. If inflation is zero, loans get repaid and the circuit closes. With asset price deflation, loan payments increase in proportion to loans and banks become more liquid. With asset price inflation, banks need to increase loans (Δa) to maintain their spending. With hyperinflation, loans never get repaid and banks become illiquid. Assuming *inflation is everywhere and constant*, the impact of inflation is through loan durations (d_L) where:

hyperinflation: $d_L \rightarrow \infty$

deflation: $d_L \rightarrow 0$

The equations for household and bank spending create an obvious upper and lower bound where i) the central bank rate (cb_r) must be greater than 0% for bank spending to be positive ii) the loan payment rate (r_L) must be less than the wage rate (w_r) for household spending to be positive. In the 'real' world, without a living wage constraint (w_{lv}) such that $((w_r - r_L) > w_{lv})$, households will be forced into speculative and Ponzi behaviour.

The model has two other interesting features. Businesses seeking to increase total spending ($\Delta a \cdot (w_r + r_L)$) are split between raising wages (to increase workers spending) and lobbying for higher loan payment rate (r_L). The latter increases bank spending, but also increase their loan payments.

Secondly, businesses and households share a preference for increased lending to businesses. This is illustrated by separating household and business loans in the spending formulae, which yields this result:

Figure 4: Preferences in Hedge Model

Transaction	Banks	Households	Businesses	Σ
Spending	$-\Delta a_h \cdot r_L - \Delta a_b \cdot r_L$	$-\Delta a_b \cdot w_r + \Delta a_h \cdot r_L$	$+\Delta a_b (w_r + r_L)$	0

Where $a_h = \text{household lending}$ and $a_b = \text{business lending}$.

An expansion of business lending boosts the business circuit, which can boost household spending through wages. So households and businesses lobby for higher business loans. Banks are neutral. In summary:

Figure 5: Preferences by Sector

		Banks	Households	Businesses
Loan payment rate $2r_L = f \frac{cb_r(1-dr_L)}{d_L}$	Central bank rate (cb_r)	Higher	Lower	Split between support for banks, and support for households
	Loan duration (dr_L) and inflation	Lower	Higher	
	Repayment default rate (dr_L)	Lower	Higher	
Ratio of household to business loans		Neutral	Preference for higher business lending	

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The hedge economy model shows that the central bank rate is not politically neutral. Hedge banks, which do not borrow from the central bank, prefer higher loan payment rates to increase their spending. Hedge households prefer lower loan payment rates, to minimise their borrowing costs. Businesses are split. Lower loan payment rates mean they can pay higher wages to boost household spending, but higher rates also mean higher bank spending.

A stable hedge economy might have occupational pensions, stable healthcare, wages and demographics, consistent inflation, and good banking regulation (with steady default rates and loan durations). To close the business circuit, external spending would need to neutral or negative across the production cycle. With these characteristics, a hedge economy could sustain a wide range of central bank rates, **including a stable, high interest rate economy** should the household sector have less political influence than the banks.

The model also suggests that credit easing/rationing and wage policies are necessary macroeconomic tools. The wage rate (w_t) varies between different economies and sectors. A capital-intensive sector, such as manufacturing, might have a lower wage rate. On the other hand, where sectors rely heavily on labour, such as education and government services, if the wage ratio is too low then household spending is reduced.

Of course, in the new world of modern finance, loanable funds are not solely distributed by the banking system, and the model needs extending to take account of resource allocation through investment markets. This is the traditional Arrow-Debreu model, and the next section introduces speculative investment.

Speculative Economy

In this speculative economy model, loans are invested in assets. Following the definition given by Minsky, speculative households do not spend investment gains until they have been realised. They continue to make loan payments and to fund spending from wages, but they also roll over their loans regularly by selling their assets and spending the realised investment gains. This revision allows borrowers to speculate on their capital accounts. Investment gains (r_1 and r_2) can be positive or negative, and investment gains make no distinction between capital gains (losses) from asset price inflation, and investment returns such as dividends on equities, or coupon payments on bonds.

Speculative businesses also invest their loans in assets, which might include commodities or other businesses in their supply chain. They use these productive investments to produce goods and services, and pay wages and loans. They can also buy and sell investments, and spend realised investment gains.

Initially, banks are not speculating in this model and *inflation is everywhere*, as before. This yields the following result.

Figure 6: Speculative Model

Transaction	Banks		Households		Businesses		Σ
	Current	Capital	Current	Investment	Current	Investment	
Create loan	$-\Delta res$	$+\Delta res$	$-\Delta a$	$+\Delta a$	$-\Delta a$	$+\Delta a$	0
Loan payment	$+2\Delta a. r_L$		$-\Delta a. r_L$		$-\Delta a. r_L$		0
Investment gain		$-\Delta a. (r_1 + r_2)$		$+\Delta a. r_1$		$+\Delta a. r_2$	0
Wages			$+\Delta a. w_r$		$-\Delta a. w_r$		0
Spending	$-\Delta a. bs_r$		$-\Delta a. hs_r$		$+\Delta a. hs_r$ $+\Delta a. bs_r$		0
Re-finance	$-\Delta a. (r_1 + r_2)$	$+\Delta a. (r_1 + r_2)$	$+\Delta a. r_1$	$-\Delta a. r_1$	$-\Delta a. r_2$	$-\Delta a. r_2$	0
Repay principal	$+\Delta res$	$-\Delta res$	$+\Delta a$	$-\Delta a$	$+\Delta a$	$-\Delta a$	0
Σ	0	0	0	0	0	0	0

Since we are interested in bank spending, that row is treated as the redundant equation.

Figure 7: Spending in Speculative Model

Transaction	Banks		Households		Businesses		Σ
	Current	Capital	Current	Investment	Current	Investment	
Create loan	$-\Delta res$	$+\Delta res$	$-\Delta a$	$+\Delta a$	$-\Delta a$	$+\Delta a$	0
Loan payment	$+2\Delta a. r_L$		$-\Delta a. r_L$		$-\Delta a. r_L$		0
Investment gain		$-\Delta a. (r_1 + r_2)$		$+\Delta a. r_1$		$+\Delta a. r_2$	0
Wages			$+\Delta a. w_r$		$-\Delta a. w_r$		0
Refinance	$-\Delta a. (r_1 + r_2)$	$+\Delta a. (r_1 + r_2)$	$+\Delta a. r_1$	$-\Delta a. r_1$	$+\Delta a. r_2$	$-\Delta a. r_2$	
Spending	$-\Delta a. (2r_L - r_1 - r_2)$		$-\Delta a. (w_r - r_L + r_1)$		$+\Delta a. (w_r + r_L - r_2)$		0
Repay principal	$+\Delta res$	$-\Delta res$	$+\Delta a$	$-\Delta a$	$+\Delta a$	$-\Delta a$	0
Σ	0	0	0	0	0	0	0

With speculative household and businesses, a number of survival constraints become apparent.

The loan payment rate at which the banking sector does not become illiquid (r_L), is now a function of the loan size (Δa) and investment gains (r_1) in all investment markets:

$$\sum_1^n \Delta a_n. r_L > \Sigma(a_1 r_1 + a_2 r_2 + a_3 r_3 + \dots a_n r_n)/n$$

In the simple example above, where households and businesses borrow the same amount, bank spending is positive as long as $2r_L > (r_1 + r_2)$. As before, hedge banks are likely to lobby for higher central bank rates, lower defaults and shorter durations.

Additionally, private banks will lobby to enter investment markets, where they expect to achieve investment gains that are higher than their cost of borrowing from the central bank. Since private banks have information on capital flows to (and from) investment markets, they are well-placed to benefit from such speculation.

Banks also need to defer spending to ensure they have enough capital to pay realised gains to households and businesses. In other words, banks need to hold suitable levels of reserves. Businesses and households also need to defer spending until they have realised their investment gains. If they do not, some businesses and households will become insolvent.

Figure 8: Preferences in Speculative Model

Transaction	Banks	Households	Businesses	Σ
Spending	$-\Delta a_h \cdot (r_L - r_1)$ $-\Delta a_b \cdot (r_L - r_2)$	$-\Delta a_b \cdot w_r + \Delta a_h \cdot (r_L - r_1)$	$+\Delta a_b (w_r + r_L - r_2)$	0

Where $a_h = \text{household lending}$, $a_b = \text{business lending}$,

$r_1 = \text{return on household investments}$ and $r_2 = \text{return on business investments}$.

Households continue to lobby for an increase in w_r , a reduction in r_L , and banks continue to lobby for an increase in r_L . As before, households and businesses have a preference for higher business lending, whereas banks are neutral. There are three main differences from the hedge economy, however:

- 1) Banks lobby to enter investment markets, where they expect to achieve investment gains that are higher than the cost of borrowing from the central bank
- 2) Banks prefer to lend in sectors where returns are low, and to invest in sectors where returns are high: **the carry trade**
- 3) Total spending is *permanently reduced* by $+\Delta a_b \cdot r_2$. Speculative businesses can still close their circuit, because this reduction is the same as their investment gain. The effect of speculation is therefore i) a reduction (or deferment) of wages and spending, ii) the

possibility of zero bank spending, with hedge banks that are precariously liquid/illiquid, and
 iii) the more plausible possibility that speculation increases liquidity problems.

Ponzi Economy

In the third model, sectors do not wait until investment markets clear before spending their gains. For households, this might be voluntary (cashing in on investment gains) or involuntary (due to a living wage constraint $(w_r - r_L) > w_{lv}$).

Ponzi businesses increase borrowing on the strength of unrealised investment gains. In practice, the line between loan and investment accounts is blurred, but the important factors are that i) investment gains are unpredictable and not contractual ii) non-productive investments include a range of financial assets, where there is no delivery or consumption of the physical asset. So a speculative business might invest in commodity futures and forwards, but only a Ponzi business would invest in commodity options or derivatives.

For simplicity, the model assumes two extremes with a defined relationship between r_1, r_2 and r_L . As the bubbles form, $\frac{r_1+r_2}{2} > r_L$ and as the bubbles collapse, $\frac{r_1+r_2}{2} < r_L$. If we define $x = \text{excess gain/loss}$ then $r_1 = (r_L + x_1)$ and $r_2 = (r_L + x_2)$. For simplicity, x is either positive or negative across all markets.

Figure 9: Ponzi Model

Transaction	Banks		Households		Businesses		Σ
	Current	Capital	Current	Investment	Current	Investment	
Create loan	$-\Delta res$	$+\Delta res$	$-\Delta a$	$+\Delta a$	$-\Delta a$	$+\Delta a$	0
Loan payment	$+2\Delta a \cdot r_L$		$-\Delta a \cdot r_L$		$-\Delta a \cdot r_L$		0
Investment gain	$-\Delta a \cdot (2r_L + x_1 + x_2)$		$+\Delta a \cdot (r_L + x_1)$		$+\Delta a \cdot (r_L + x_2)$		0
Wages			$+\Delta a \cdot w_r$		$-\Delta a \cdot w_r$		0
Spending	$-\Delta a \cdot bs_r$		$-\Delta a \cdot hs_r$		$+\Delta a \cdot hs_r$ $+\Delta a \cdot bs_r$		0
Σ	$-\Delta res$	$-\Delta a \cdot (2r_L + x_1 + x_2)$	$-\Delta a$	$-\Delta a \cdot (r_L + x_1)$	$-\Delta a$	$-\Delta a \cdot (r_L + x_2)$	0

Technically, bank spending now relies on their ability to manage reserves. Since banks, businesses and household spend their unrealised gains, there is no longer an accounting identity in the bottom

row. The circuit never closes and households and bank capital reduces by $\Delta a.(2r_L + x_1 + x_2)$ in each cycle.

Banks can continue to lend provided they remain liquid and solvent, which includes the new constraint that:

$$\Delta res > \Delta a.(2r_L + x_1 + x_2)$$

Since Δres is largely comprised of government debt (and can no longer be exchanged for gold), a solvent Ponzi circuit is perfectly plausible. Liquidity is a balance between increasing Δres , reducing loan payment rates (r_L) and low (or negative) excess gains ($x_1 + x_2$). Hence, the possibility of **a stable, low interest rate economy** emerges.

Since we are interested in bank spending, this is treated as the redundant equation.

Figure 10: Spending in Ponzi Model

Transaction	Banks	Households	Businesses	Σ
Spending	$+\Delta a.(x_1 + x_2)$	$-\Delta a.(w_r + x_1)$	$+\Delta a.(w_r + x_2)$	0

For there to be any bank spending (where banks themselves are not speculative or Ponzi):

$$x_1 + x_2 < 0$$

As in the speculative economy, banks lobby to enter investment markets and must run down or create new reserves as the bubble forms, when $(x_1 + x_2) > 0$.

During a systemic crisis, when the bubble collapses and $(x_1 + x_2) < 0$, Ponzi households and businesses become insolvent. Households need to increase spending above wages, otherwise the business circuit collapses (x_1 is negative in the term $-\Delta a.(w_r + x_1)$). Without debt-fuelled consumption, businesses are unable to meet their loan and wage obligations. Similarly, businesses need to increase their loans to make up for investment losses.

Total spending ($\Delta a.(w_r + x_2)$) is a function of wages and excess business gains. So, in addition to the findings from the speculative model, businesses have a preference that x_2 is positive. In other words, Ponzi businesses must pay higher investment gains than r_L .

Paradoxically, hedge banks are able to spend and rebuild reserves during systemic crises. Since investment gains become negative ($(x_1 + x_2) < 0$), banks can spend and even survive negative loan payments. This balance sheet paradox, where loans never get repaid, is expressed as:

$$\Delta res > \Delta a. (2r_L + x_1 + x_2)$$

To remain liquid and solvent, private banks in a Ponzi economy must i) speculate to increase reserves ii) rely on systemic crises to rebuild their balance sheets.

Simulations

The following sections estimate parameters for the hedge economy model, and then simulate a range of bailout tests.

The model parameters are estimated as follows:

- i. Δres (total bank reserves). For the sake of convention, bank reserves are set at 10%, although in a hedge economy reserves are not necessary.
- ii. $\Delta a_1/\Delta a_2$ (the ratio of household loans to business loans). With a single loan payment rate, r_L , and no 'frictions' on other flows, a long-run equilibrium is possible where:

$$\Delta a_1 = \Delta a_2$$

Or, if r_{L1} = loan payment rate for household loans and r_{L2} = loan payment rate for business loans, then in the long-run:

$$\frac{\Delta a_1}{\Delta a_2} = \frac{r_{L1}}{r_{L2}}$$

To avoid model effects from equilibrating flows, a single loan payment rate (r_L) is used with $\Delta a_1 = \Delta a_2$. The actual ratio of household to business loans is estimated and discussed (below).

- iii. *Taxes*. To model the government sector, the model would benefit from adding taxes to both flows and stocks. This exercise is beyond this paper, but it is important to note that in the UK and US, liability (loan) flows have some of the lowest tax rates, and different tax rates will distort any equilibria.
- iv. r_L (loan payment rate). This is a function of the central bank rate (cb_r), loan duration (dr_L) and repayment default rate (dr_L). Although UK and US household mortgages tend to be long duration, banks were increasingly using securitization to originate and distribute. In the

simulations, a loan payment rate of 4% is used. This is close to the average UK and US central bank rate (1970-2010). It is also the rate at which a principal is repaid over 25 years in a hedge model without inflation.

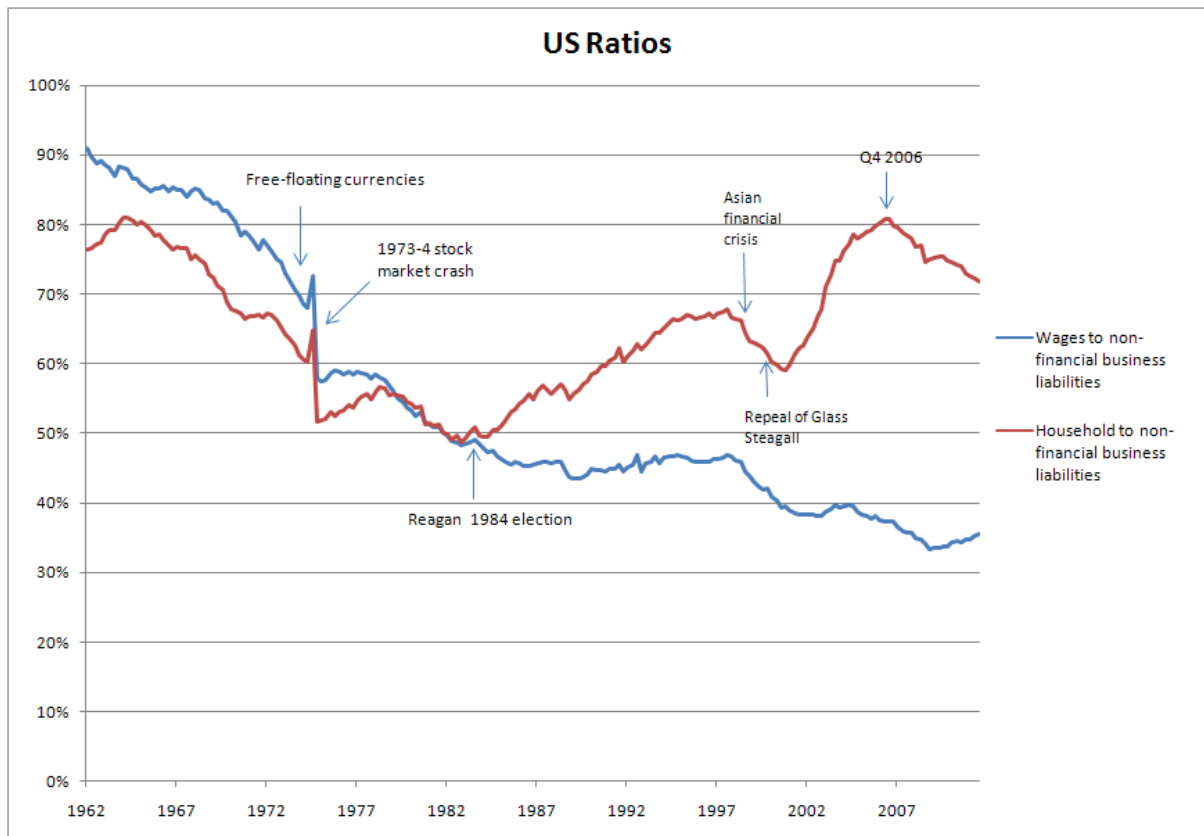
- v. w_r (*ratio of annual wages to business loans*). This figure is estimated using real data for the UK and US (below). To simulate 'sticky' wages, the model tests what happens if wages do not decline below their initial value.
- vi. hs_r (*household spending*). Since these are hedge economy simulations, household spending equals residual wages after loan payments. In speculative and Ponzi economies, households would also spend investment gains.
- vii. bs_r (*bank spending*). Hedge banks spend income in excess of reserve requirements. This is a broad definition of bank spending, including capital flows into business investments (equities and corporate debt). Bank spending is the investment of surpluses, unlike household spending.

Estimates of the wage ratio, and the household to business loans ratio, follow. For the US, data are taken from the Federal Reserve and U.S. Bureau of Economic Analysis (BEA). Three values are used, i) wage and salary disbursements ii) household and non-profit liabilities and ii) non-financial business liabilities.

From the early 1980s, there is a marked decoupling of household loans from wages in the US.

This similar to the decoupling of financial and non-financial wages (The Financial Crisis Inquiry Commission, 2011:61). This alternative graph has other nuances, namely i) a 'heart attack' in 1973-4 that corresponds to the collapse of Bretton Woods ii) an accelerated decoupling in the US after the repeal of Glass-Steagall.

Figure 11: US Wage and Household Loan Ratios



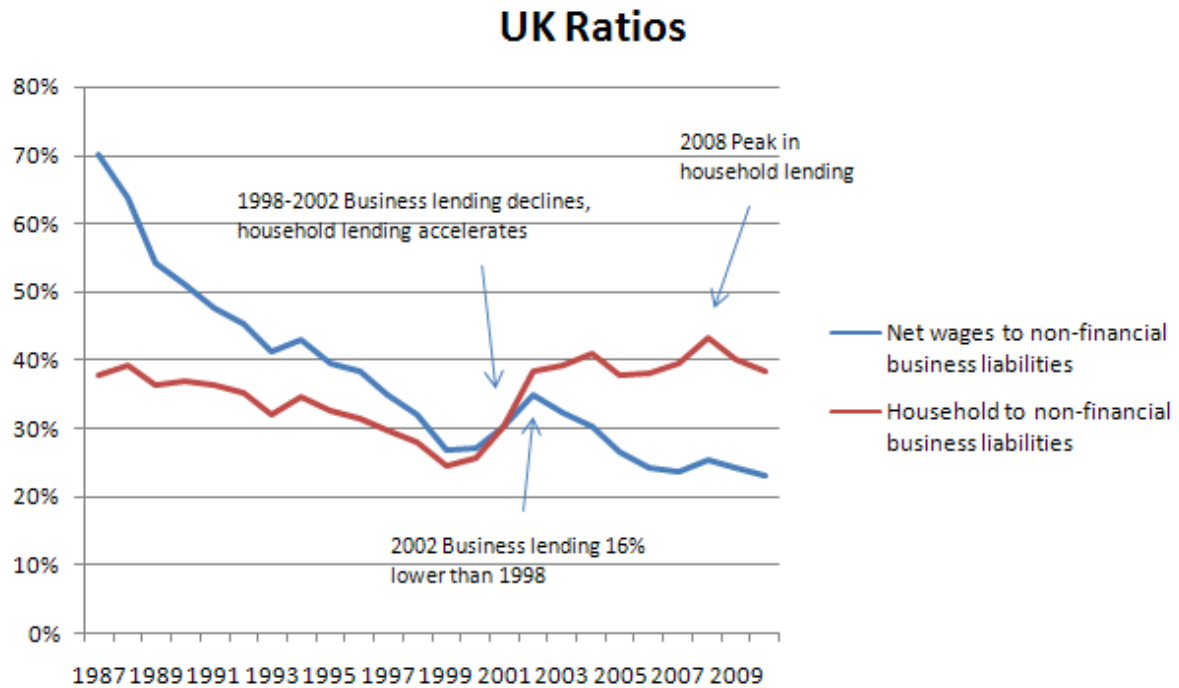
Sources: US Bureau of Economic Analysis, Federal Reserve

The ratios are consistent with the hypothesis that, after the repeal of Glass-Steagall, r_{L1} (loan payment rate for households) increased, and r_{L2} (loan payment rate for businesses) decreased. There are several possible explanations for this. New household loan practices to originate and distribute would reduce the perception of default risk (dr_L), and loan durations (d_L). At the same time, increased business investment outside the US might increase the perception of business default risk (dr_L), and loan duration (d_L)... in particular, if long-term business investment were needed.

For the UK, the Office for National Statistics does not provide data prior to 1987, nor do they provide monthly figures. The equivalent figures used are i) real households disposable income ii) liabilities of households and non-profit institutions serving households and iii) liabilities of non-financial corporations.

The UK wage ratio also declines, and relative household increases from 1998-2008. There is no ‘one-size-fits-all’ economic model; UK household lending peaked later than the US, and there was a marked decline in business lending around the Asian financial crisis (1998).

Figure 12: UK Wage and Household Loan Ratios



The UK graph is consistent with a structural break in FDI flows around 1997-8 (Ferreiro *et al.*, 2012) which the authors attributed to a ‘worldwide relocation of production of tradeable goods’ that ‘is a structural-nature process that cannot be resolved with short-term measures like exchange rate adjustments or macroeconomic (fiscal-monetary) policies’.

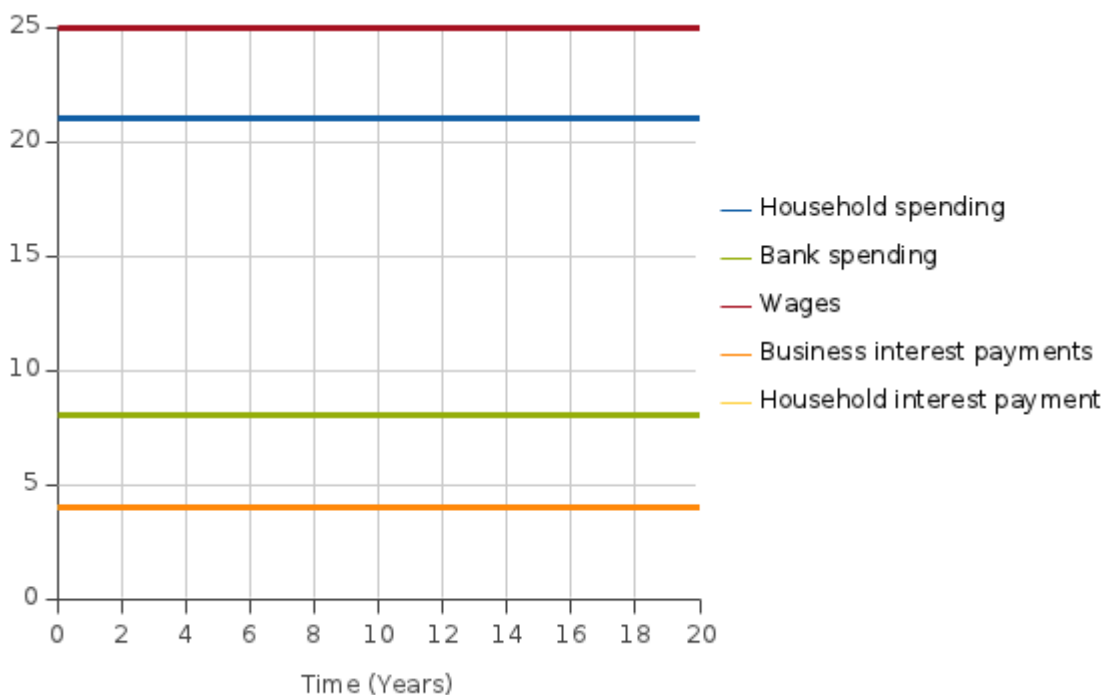
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The following simulations ask what happens if i) banks are bailed out ii) households are bailed out or iii) there is an increase in business investment (loans)? In each simulation, bailout money is spent at the rate of 25% per year.

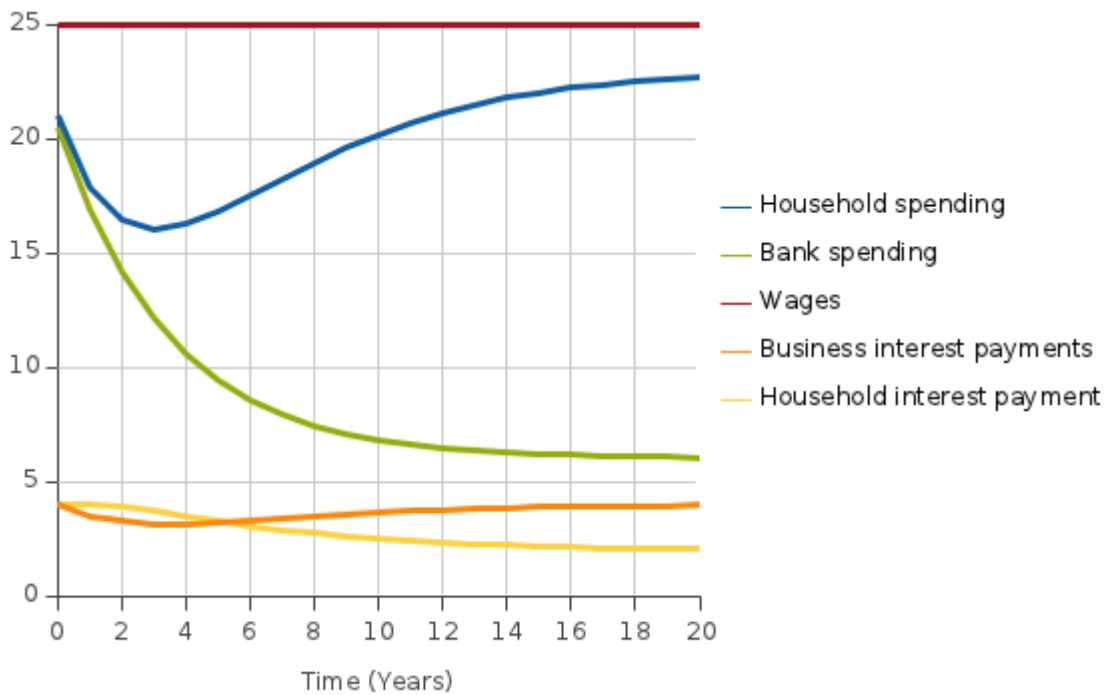
Figure 13: Parameters for Bailout Simulations

Parameter	Description	Value
Δres	Total bank reserves	20
Δa_1	Total loans to households	100
Δa_2	Total loans to businesses	100
w_T	Annual wages/business loans	25%
r_L	Bank loan rate	4%
$\Delta a_1 : \Delta a_2$	Long-run equilibrium of business to household loans	1

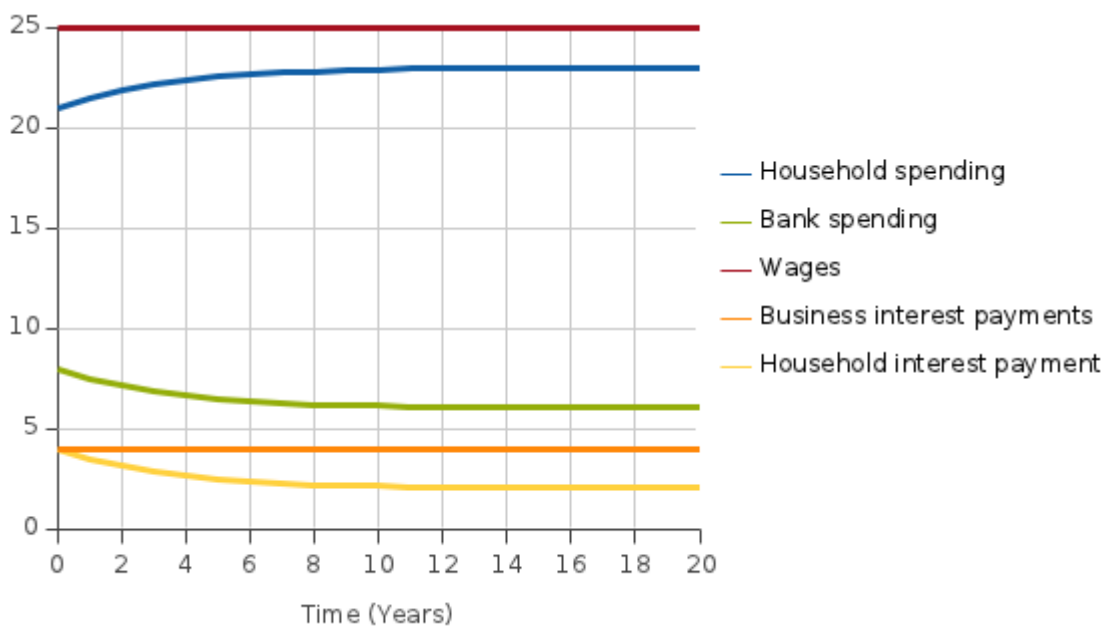
To model a bank bailout, Δres is increased by 50 (to 70). If banks do not run down reserves, there is no impact.

Figure 14: Bank Bailouts with no increase in Bank Spending

If banks follow a reserve ratio rule, and spend 25% of any excess reserves (with a 10% reserve requirement) the result is a boost to bank spending and downward pressure on wages. If households resist this (wages are 'sticky') the result is a drop in household spending.

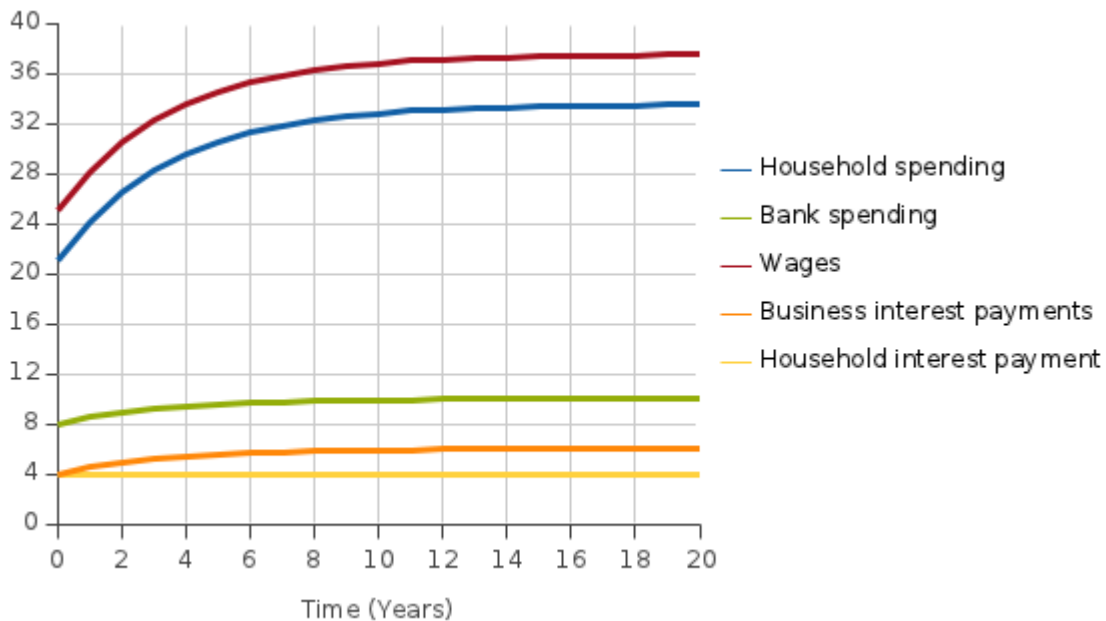
Figure 15: Bank Bailouts with Bank Reserves Rule and 'Sticky' Wages

To model the injection of capital in the household sector, Δa_1 is reduced by 50 (capital is injected at a rate of 25% of the remainder each year, to match the bank bailout simulations). Since households spend their wages, less any loan payments, the result is a reduction in bank spending and an increase in household spending. There is no downward pressure on wages:

Figure 16: Household Bailouts

Finally, business loans Δa_2 are increased by 50. To match the household and bank bailouts, the increased lending is at the rate of 25% of the remainder each year. The result is a boost to business investment and household spending (via wages), which suggests it is inflationary.

Figure 17: A Keynesian Boost



These results are consistent with Keen. Bailing out the banks with public money boosts bank spending, not the economy, and has the unfortunate consequence that there is downward pressure on wages and household spending.

Bailing out hedge households diverts household flows from loan payments to spending. Boosting business loans, provided the wage ratio increases, also boosts household spending. Which policy is the most appropriate would depend on monetary policy objectives. Bailing out hedge households is a form of monetary contraction, and boosting business loans is a form of monetary expansion with inflationary effects.

Conclusions

Using accounting techniques in macroeconomics appears to offer valuable insights. The emergence of multiple, non-ergodic economies seems possible. The central bank rate is not the only important factor: the wage ratio, ratio of household to business loans, duration of loans, loan defaults, inflation (in asset prices, wages, commodities and consumer goods), taxes and investment gains can alter the

equilibrium of an economy. There is room in such models for concepts such as 'sticky' wages, consumer confidence, and to account for shocks such as demographic change. The different behaviour of sectors, where they adopt hedge, speculative or Ponzi forms of finance, also affects the equilibrium. Tax policies matter, because they incentivise speculators to find alternative investments. In particular, preferential tax treatment of financial assets and loans might encourage their proliferation over productive investment.

A theoretical analysis suggests that a stable, high interest rate, hedge economy can emerge where a predominance of hedge households and businesses ensure liquidity and support high levels of bank spending. Hedge banks prefer a higher central bank rate, lower loan durations, lower inflation and lower default rates. Hedge households prefer the opposite.

In a speculative economy, banks are incentivised to enter investment markets where returns are high. If they do not, they risk becoming illiquid. In a speculative economy, businesses and households can still close the circuit, and total spending is reduced by an amount equivalent to business investment gains ($\Delta a_b, r_2$).

The possibility of a stable, low interest rate, Ponzi economy also emerges. Here, loans do not get repaid. As investment bubbles form, banks must reduce reserves or expand loans for the system to remain liquid. The paradox of a Ponzi economy is that, if asset prices collapse (and, with an increasing number of investment markets, there are more possibilities) then hedge banks can resume spending and increase their reserves. This is because Ponzi households and businesses get less non-commodity money for their investments. The Ponzi banks remain liquid and solvent provided:

$$\Delta res > \Delta a. (2r_l + x_1 + x_2)$$

The paradox of a Ponzi economy is that private banks must i) speculate to increase reserves ii) rely on systemic crises to rebuild their balance sheets.

The hedge economy simulations show that a Keen-type bailout to 'go early, go hard, go households' is an effective way to contract the monetary base. A Keynesian boost to business investment (loans) is also effective, providing businesses increase wages.

The choice between a Keen-type bailout and Keynesian boost might depend on the external balance. To reduce imports, a Keynesian boost might increase domestic production, benefitting the household sector through wages. If exports are high, then a Keen-type bailout would impact household spending directly, and reduce the external imbalance. Bank bailouts are the least effective, exerting downward pressure on wages and/or household spending.

Financial regulation also matters. With international Ponzi banks, there is a significant problem if an investment market collapses. By definition, Ponzi banks have already spent their unrealised profits. Somehow, the international payments system needs to clear Ponzi debts and remove Ponzi agents. The solutions might include reparations from Ponzi banks ($d_L < 0$), turning Ponzi debt into equity or 'junk' debt ($d_L \rightarrow \infty$), and the household bailouts and Keynesian boosts described above.

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