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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 Godley and Lavoie (*Monetary Economics: An Integrated Approach to Credit, Money, Income, Production and Wealth*, 2007) and the Theory of the Monetary Circuit to give a mathematical representation of Minsky's Financial Instability Hypothesis. In the extended circuit, 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 stable carry trades emerges. In high interest rate, hedge economies, powerful banks invest surplus loan interest. With speculation, banks lobby to enter investment markets and the system is precariously liquid/illiquid. In a Ponzi economy, where loans never get repaid, solvency is a balance between increasing reserves, reducing interest rates and rebuilding banks' balance sheets during systemic crises. Simulating bank bailouts, household bailouts and a Keynesian boost suggests that bank bailouts are the least effective intervention, exerting downward pressure on wages and household spending: austerity.

JEL E10, E27, E43, E58, E60

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

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1 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). In the literature, 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). The empirical failure of 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 'because the interest rate is sufficiently low to provide repayment incentives' (Hellwig and Lorenzoni, 2009: 1137). 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 fiat money 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 this Extended Monetary Circuit to gain insights into the carry trade, austerity, 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 is countered by increased supply (lower reserve ratios) rather than higher loan prices. If the central bank maintains liquidity by lending freely, a persistent, low interest rate asset bubble is possible.

2 They Saw It Coming: The Theory of the Monetary Circuit

There were economists and analysts who ‘saw this (crisis) coming’ by considering the stocks and flows between different sectors of the economy. ‘Accounting (or flow-of-funds) macroeconomic models helped anticipate the credit crisis and economic recession. Equilibrium models ubiquitous in mainstream policy and research did not’ (Bezemer, 2010: 676). For this group, economics cannot be reduced to ‘methodological individualism’ (Passarella, 2012: 3) because different economic sectors have different roles.

Bezemer suggests that “the accounting approach’ within ‘Post-Keynesian’ economics shared by Godley, Baker, Hudson, Keen and others seems to have been particularly predictively successful” (Bezemer, 2010: 679). The approach in this paper is implemented using the methodology of 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).

The G&L models are consistent with the Theory of the Monetary Circuit, which is attributed to Graziani (1989) and the ‘French and Italian post-Keynesian school, the so-called circuitistes’ (Godley and Lavoie, 2007: 47). In the original form of the Monetary Circuit, the first step is when banks lend to businesses. Businesses use this *initial finance* to buy labour. The initial circuit closes when households spend their wages, either on immediate consumption, or by purchasing financial assets that have been issued by businesses. In subsequent circuits, businesses only borrow the additional money they need to finance production. Although the role of credit money was re-emphasised after the collapse of Bretton Woods (Graziani, 1989), there is evidence across Europe and Asia that for the last five thousand years there has been a ‘broad alternation between periods dominated by credit money and periods in which gold and silver come to dominate’ (Graeber, 2009: 213).

In discussing the role of banks, Graziani emphasised that ‘in any model of a monetary economy, banks and firms cannot be aggregated into one single sector’

(Graziani, 1989: 519). He considers four agents i) a central bank ii) private banks iii) firms and iv) wage-earners or households. Stocks of non-commodity money are increased or decreased by the debt and credit operations taking place between the Central Bank and private banks. With a single bank, there is ‘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, 1930, quoted in Graziani, 1989: 524).

With unlimited credit, 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 process 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).

Banks can generate monetary profits from the circuit indefinitely, ‘even if their ventures are 100% debt-financed’ (Keen, 2010: 4). Keen simulates the effects of an exogenous injection of money into either i) the bank vault or ii) household deposit accounts, to gain insights into the crisis (see Table 1).

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. Keen’s system is dynamic: notes flow to firms from the bank vault, firms pay wages and interest, and workers receive wages and interest. Critically, both banks and households consume. This consumption allows firms to repay their loans and close the circuit.

Using estimated model parameters, Keen simulates the effects of injecting government money into either bank vaults or worker deposits. He concludes that injecting money into worker deposits to ‘go early, go hard, go households’, (Gruen, 2008, quoted in Keen, 2010: 22) would have a more immediate and substantial effect during crises.

Table 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: 24)

This paper repeats those simulations with an extended circuit, and includes a simulated Keynesian boost. In the extended circuit there is a *second, household circuit* where banks lend to households, and households invest in property. Bank and household spending are treated as the redundant equations, to gain insights into banking regulation.

3 Circuit Theory Extended

In their growth model prototype, Godley and Lavoie 'assume that households as well as firms borrow from banks' (Godley and Lavoie, 2007: 378) but these new loans are determined, not by asset prices, but as a proportion of disposable income. This extension relaxes that constraint.

Indeed, the 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: 300). 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 that asset bubbles do matter. 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 agreement and the generalised floating of exchange rates’ (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: 871-873).

In the extended circuit, investment gains provide a boost to spending. Banks spend their surplus income, which places them in competition for consumption and financial assets. Spending has two elements, i) immediate consumption and ii) deferred consumption which is invested in financial assets. The model allows for multiple investment markets, with different levels of investment gain. There is no limit to the further disaggregation of sectors, or to the addition of new financial assets. Therefore the impact of any asset bubble, in any sector, can be modelled.

Keen, and Godley and Lavoie, have already introduced the possibility of modelling economic shocks, because they included ‘real world’ flows like wages. An extreme 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. Accounting models also introduce the possibility of simulating the effect of taxes (on wages, investment and lending), and step changes in behaviour or expectations (such as new financial products that alter loan characteristics). The extended model retains these features.

In the extended model, the role of government is an intermediate state: funded by both loans and the taxing of stocks and flows. Government spending therefore impacts both circuits, and there is the possibility of simulating these interventions and distortions in future work. Lastly, the extended model includes the impact of inflation in asset prices, wages, commodity prices and consumer goods.

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The extended circuit 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 produce (businesses), or using them to boost spending (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 spending (households).
- iv. Inflation is everywhere.

The models assume that investment markets do not clear fully, and that each sector has different motives for borrowing. In the *household circuit*, households borrow to invest in property, and defer a proportion of their spending (pensions). In the ‘real world’, some households might go further, and leverage their loans to invest in financial assets, while other households might rent.

Following Graziani, in the *business circuit*, firms require *initial finance* to pay wages and begin production. In subsequent phases, firms raise capital by issuing financial assets, and use loans to invest in financial assets (such as commodities). Hedge businesses repay initial finance when the full production cycle ends.

Bank loans have a higher priority than equity in a bankruptcy, and this pecking order differentiates between loan and investment accounts. In the ‘real world’, the distinction is more nuanced. Ultimately, however, the central bank steps in if hedge businesses and households cannot roll over their loans, to avert a liquidity crisis.

3.1 Hedge Economy

In the first model of a hedge economy, borrowers repay their loans from realised investment cash flows. Households pay for consumption from wages, and sell their investments (property) to re-pay their loans and close that part of the circuit. If households are hedging, their spending *across the sector* is less than wages. Deferred household spending (pensions) is an investment in the business cycle. In other words, the role of business is to borrow and invest across the full production cycle, to smooth aggregate, lifetime consumption.

Hedge businesses invest in productive assets, pay wages and buy goods and services from other businesses. The aggregate consumption of businesses is zero, and the business circuit is closed when household consumption ceases (so all goods and services have been sold). The household circuit closes when households repay their loans.

Lastly, hedge banks do not invest. They simply maintain a reserve ratio, create loans, receive loan interest, divert any excess into bank spending and ‘close the circuit’ when loans are fully repaid (see Table 2).

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

Table 2: 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	$+2\Delta a. r_L$		$-\Delta a. r_L$		$-\Delta a. r_L$		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
Repay principal	$+\Delta res$	$-\Delta res$	$+\Delta a$	$-\Delta a$	$+\Delta a$	$-\Delta a$	0
Σ	0	0	0	0	0	0	0

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 = bank spending rate (the ratio of bank spending to loans).

In the tradition of Godley and Lavoie, 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 (see Table 3).

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:

$$\text{Bank spending } (bs_r) = 2\Delta a \cdot r_L \quad (1)$$

As the loan payment rate (r_L) approaches zero, bank spending also approaches zero.

On the other hand, since

$$\text{Household spending } (hs_r) = \Delta a \cdot (w_r - r_L) \quad (2)$$

As the loan payment rate (r_L) approaches zero, household spending increases. In other words, banks prefer higher loan payment rates, whereas households prefer 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 the central bank rate rises, 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

Table 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

investment risk, banks can recoup capital losses by selling assets, but they cannot recoup missed loan (interest) payments. Lastly, the duration of loans (d_L) to households and businesses can increase or decrease. As loan durations (d_L) decrease, loan payments increase (and vice-versa). In summary:

$$\text{Bank spending} = 2\Delta a \cdot r_L = f\left(\frac{cb_r(1-dr_L)}{d_L}\right) \quad (3)$$

What is the impact of inflation on the model? Since each term is a function of Δa or Δr ***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:

$$\text{hyperinflation: } d_L \rightarrow \infty \quad (4)$$

$$\text{deflation: } d_L \rightarrow 0 \quad (5)$$

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, there is also a living wage (w_{lv}) such that:

$$w_r > (w_{lv} + r_L) \quad (6)$$

Such that low wages and high loan payment rates can drive households into speculative and Ponzi behaviour, to maintain a living wage.

The model has two other interesting features. Businesses, if they seek to increase total spending, are split between raising wages, and a preference for higher loan payment rates, since:

$$\text{Total spending} = \Delta a \cdot (w_r + r_L) \quad (7)$$

This is because higher loan payment rates (r_L) increase bank spending, but exert downward pressure on wages because loan payments by businesses increase.

Both businesses and households prefer an increase in lending to businesses. This is illustrated by separating household and business loans in the spending formulae, as shown in Table 4.

Table 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 = household lending and a_b = business lending.

An increase in household lending (Δa_h) will reduce household spending, but has no impact on total spending. So it is only banks that prefer an increase in household lending.

In summary (Table 5):

Table 5: Preferences by Sector

		Banks	Households	Businesses
Loan payment rate (Equation 3)	Central bank rate (cb_r)	Higher	Lower	Split between higher loan payment rates to raise bank spending, and lower to raise household spending
	Loan duration (dr_L) and inflation	Lower	Higher	
	Repayment default rate (dr_L)	Lower	Higher	
Ratio of household to business loans		Prefer both to rise	Prefer higher business loans, and lower household loans	Prefer higher business loans

The hedge economy model shows that the central bank rate, and ratio of household to business loans, are not politically neutral. Hedge banks 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 be neutral or negative across the full productive 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_r) 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 rate 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.

3.2 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. Households 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; investment returns such as dividends on equities; coupon payments on bonds; or interest on deposit accounts.

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 results shown in Table 6.

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

Since we are interested in spending, that row is treated as the redundant equation (Table 7).

Table 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
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
Spending	$-\Delta a. bs_r$		$-\Delta a. hs_r$		$+\Delta a. hs_r$ $+\Delta a. bs_r$		0
Repay principal	$+\Delta res$	$-\Delta res$	$+\Delta a$	$-\Delta a$	$+\Delta a$	$-\Delta a$	0
Σ	0	0	0	0	0	0	0

Table 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
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
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 households and businesses, a number of survival constraints become apparent.

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

$$\sum_1^n \Delta a_n \cdot r_L > \sum (a_1 r_1 + a_2 r_2 + a_3 r_3 + \dots a_n r_n) / n \quad (8)$$

In the simple example above, where households and businesses borrow the same amount:

$$\text{Bank spending} = f \left(\frac{cb_r(1-dr_L)}{d_L} - \frac{(r_1+r_2)}{2} \right) \quad (9)$$

As before, speculative banks are likely to prefer higher central bank rates, lower loan defaults and shorter loan durations. Additionally, speculative banks will prefer lower investment gains (r_1 and r_2). Alternatively, they can lobby to invest in markets where they expect to achieve investment gains that are higher than their cost of borrowing. Since private banks have information on capital flows to (and from) investment markets, they are well-placed to benefit from such speculation.

Banks 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, or investment markets will not clear. Businesses and households also need to defer some spending until they have realised investment gains. If they do not, some businesses and households will become insolvent (Table 8).

The effect of speculation is therefore i) a reduction (or deferment) of spending until investment gains are realised, ii) the possibility of zero or negative bank spending, with banks that are precariously liquid/illiquid (Equation 8), or iii) the more plausible possibility that speculation increases liquidity problems, which leads to monetary expansion.

Households continue to prefer an increase in w_r , a reduction in r_L , and a reduction in Δa_h . Banks prefer an increase in r_L and all loans. As before,

Table 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 = household lending, a_b = business lending,
 r_1 = return on household investments and r_2 = return on business investments.

households and businesses share a preference for higher business loans (Δa_b). There are three main differences from the hedge economy, however:

- 1) Banks lobby to invest in markets, where they expect to achieve investment gains that are higher than their cost of borrowing
- 2) Banks prefer to lend in sectors where returns are low, and to invest in sectors where returns are high: *the carry trade*
- 3) Compared to the hedge model, total spending is *reduced* by $\Delta a_b \cdot r_2$. Speculative businesses can still close their circuit, but they do so by realising their investment gains.

3.3 Ponzi Economy

In the third model, sectors do not wait until investment markets clear before spending their gains. 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 the living wage constraint (Equation 6)).

Ponzi businesses increase borrowing on the strength of unrealised investment gains. In practice, the lines between current, loan and investment accounts are blurred, but the important factors are that unlike loan interest, investment gains are unpredictable and not contractual. Ponzi businesses might use loans to invest in financial assets, like derivatives, where there is no delivery. So while speculators invest in futures and forwards up to the delivery date; Ponzi investors will increase loans on the strength of unrealised gains, such as those in option markets.

For simplicity, the model assumes two extremes with a defined relationship between r_1, r_2 and r_L . These are:

$$\text{Bubble formation, where } \frac{r_1 + r_2}{2} > r_L \quad (10)$$

$$\text{Bubble collapse, where } \frac{r_1 + r_2}{2} < r_L \quad (11)$$

If we define x_1, x_2 as excess gain/loss then

$$\text{Household investment gain } (r_1) = r_L + x_1 \quad (12)$$

$$\text{Business investment gain } (r_2) = r_L + x_2 \quad (13)$$

For simplicity, x_1, x_2 are either positive or negative across all markets (Table 9).

Technically, bank spending now relies on their ability to manage reserves, since the last row no longer sums to zero. Banks, businesses and household spend their unrealised gains: there is no longer an accounting identity. The circuit never closes and households and bank capital varies by:

$$\Delta a. (2r_L + x_1 + x_2) \quad (14)$$

in each productive cycle.

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

$$\Delta res > \Delta a. (2r_L + x_1 + x_2) \quad (15)$$

Since Δres is largely comprised of government debt then, provided the loan base expands, a solvent Ponzi circuit is perfectly plausible. Solvency is a balance between increasing Δres , reducing loan payment rates (r_L) and having markets with low (or negative) excess investment 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.

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

$$\Delta a_h. x_1 + \Delta a_b. x_2 < 0 \quad (16)$$

As in the speculative economy, banks prefer to invest in markets where excess gains (x_1, x_2) are positive, and to lend in markets where excess gains (x_1, x_2) are negative: ***the carry trade***.

During bubble formation, solvency requires that new reserves are created (Equation 14). During bubble collapse, if households do not increase spending above wages (Table 10) the business circuit does not close. Without debt-fuelled household spending, businesses are unable to meet their loan and wage obligations.

Table 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

Table 10: Preferences in Ponzi Model

Transaction	Banks	Households	Businesses	Σ
Spending	$+\Delta a_b \cdot x_1$ $+\Delta a_b \cdot x_2$	$-\Delta a_b \cdot w_r - \Delta a_h \cdot x_1$	$+\Delta a_b \cdot w_r - \Delta a_b \cdot x_2$	0

Since:

$$\text{Total spending} = \Delta a_b \cdot w_r - \Delta a_b \cdot x_2 \quad (17)$$

Ponzi businesses prefer that excess business gain (x_2) is negative. In other words, Ponzi businesses prefer that their total investment gains are less than r_L .

Paradoxically, banks are able to spend and rebuild reserves during systemic crises, since bank spending (Equation 16) is positive if excess gains (x_1, x_2) are negative.

In summary, bank solvency in a Ponzi economy is aided by i) banks speculating on carry trades ii) the creation of new reserves during bubble formation ii) the rebuilding of banks' balance sheets during systemic crises.

4 Simulations

The following sections estimate parameters for the hedge economy model, and then simulate a range of bailout tests as per Keen (2010), with the addition of a Keynesian boost.

The model parameters are estimated as follows:

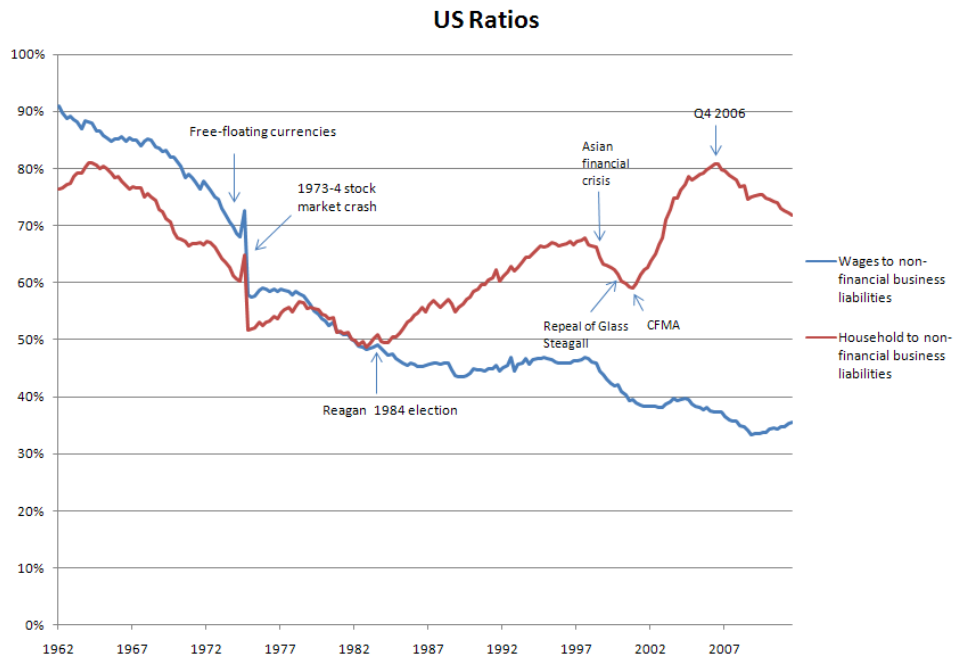
- i. Δres (*total bank reserves*). For the sake of convention, bank reserves are set at 10%, although in a hedge economy reserves are not necessary.
- ii. $\Delta a_1/\Delta a_2$ (*the ratio of household loans to business loans*). A single loan payment rate (r_L) is used with $\Delta a_1 = \Delta a_2$, as above. 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 includes the investment of loan income surpluses.

Estimates of the wage rate (w_t), and the household to business loans ratio ($\Delta a_1/\Delta a_2$), follow. For the US, data are taken from the Federal Reserve and US 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 is similar to the decoupling of financial and non-financial wages (The Financial Crisis Inquiry Commission, 2011: 62). This alternative graph has other nuances, namely i) a ‘heart attack’ in 1973–74 that corresponds to the collapse of Bretton Woods ii) an accelerated decoupling in the US after the Commodity Futures Modernization Act (Figure 1)

Figure 1: US Wage Rate and Household Loan Ratio



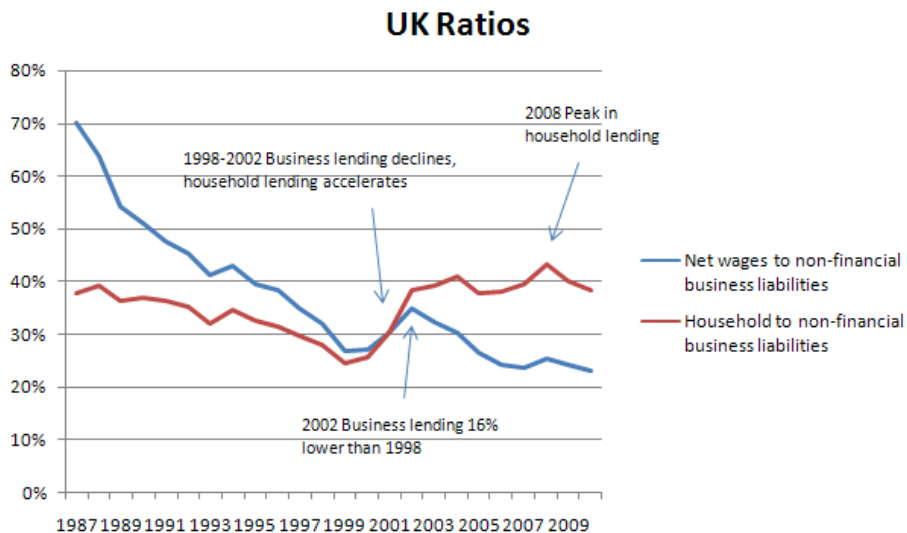
Sources: US Bureau of Economic Analysis, Federal Reserve

These results are consistent with the hypothesis that, after the repeal of the Commodity Futures Modernization Act, 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 rate also declines, and relative household loans increase from 1998–2008. Consistent with the post-Keynesian tradition, 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 2).

Figure 2: UK Wage Rate and Household Loan Ratio



The UK graph is consistent with a structural break in FDI flows around 1997–1998, which Ferreiro et al. (2012) 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’ (Ferreiro et al., 2012: 25-33).

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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 (Table 11).

To model a bank bailout, Δres is increased by 50 (to 70). If banks do not run down reserves, there is no impact (Figure 3).

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: *austerity* (Figure 4).

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 5).

Table 11: 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_r	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

Figure 3: Bank Bailouts with no increase in Bank Spending

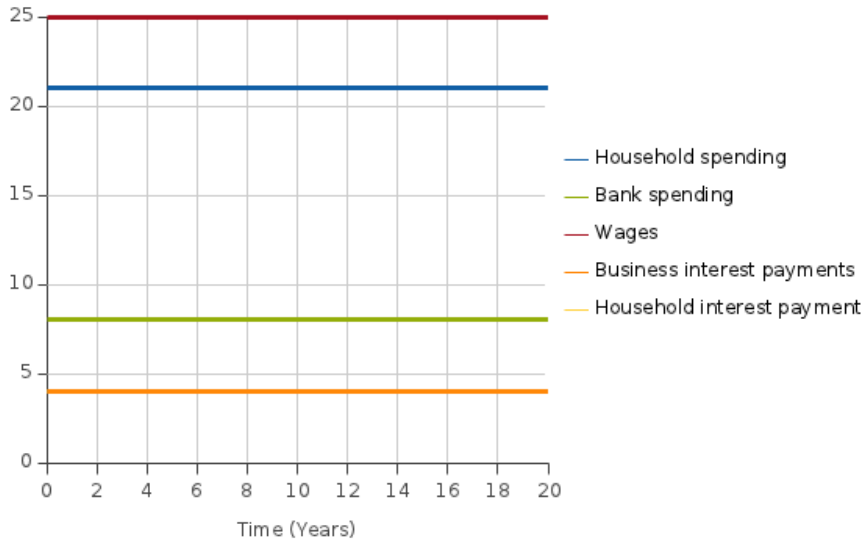


Figure 4: Bank Bailouts with Bank Reserves Rule and 'Sticky' Wages

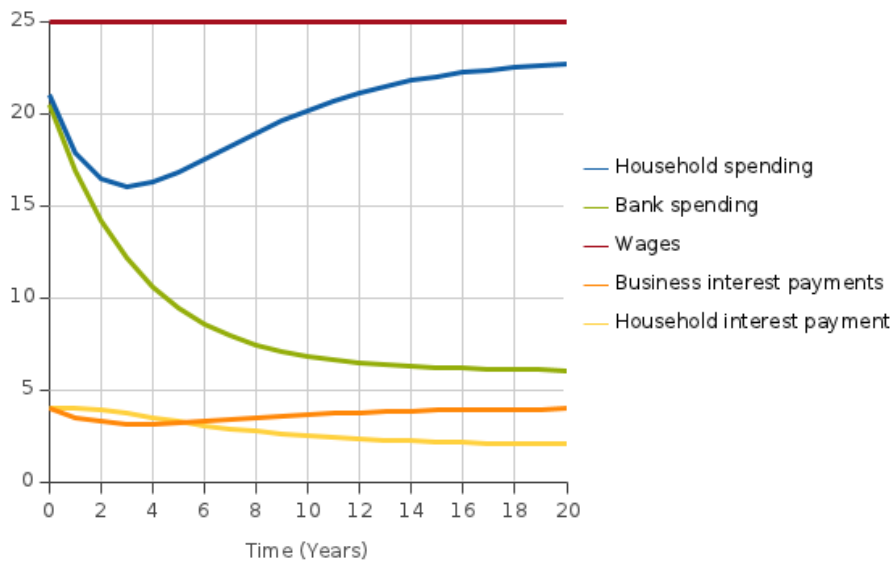


Figure 5: Household Bailouts

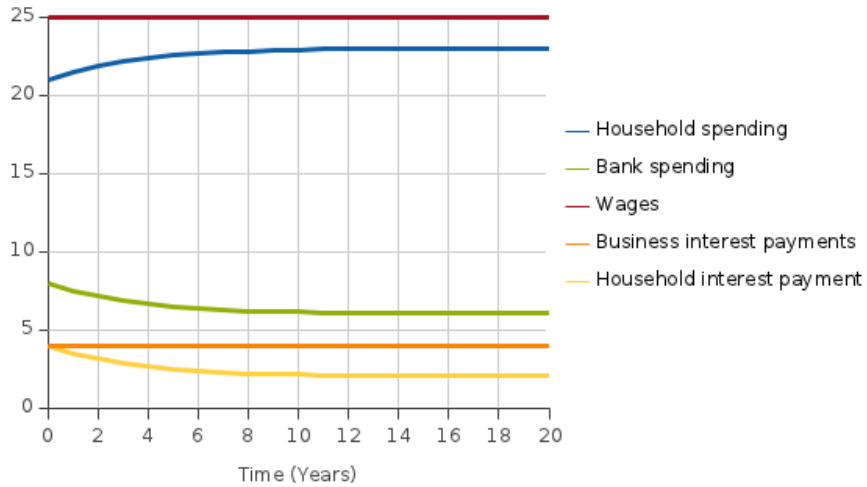
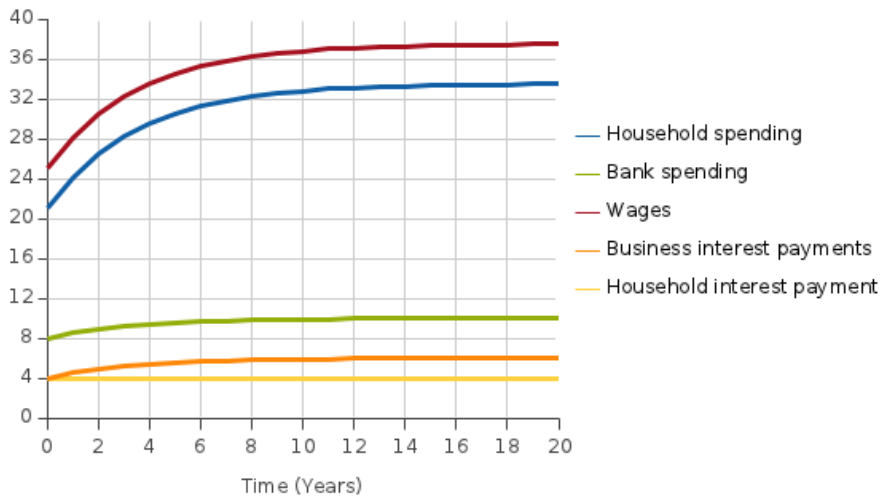


Figure 6: A Keynesian Boost



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 could be inflationary (Figure 6).

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 rate 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.

5 Conclusions

Using accounting techniques in macroeconomics appears to offer valuable insights. The co-existence of multiple, non-ergodic economies seems possible. The central bank rate is not the only important factor: the wage rate, ratio of household to business loans, duration of loans, loan defaults, inflation (in asset prices, wages, commodities and consumer goods), taxes, investment gains, and government interventions 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 expansion 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, but total spending is reduced by an amount equivalent to business investment gains ($\Delta a_b \cdot r_2$).

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 banks can resume spending and increase their reserves. This is because Ponzi households and businesses get less non-commodity money for their investments. The banks remain liquid and solvent provided:

$$\Delta r > \Delta a. (2r_L + x_1 + x_2) \quad (15)$$

In a Ponzi economy, bank solvency is aided by i) banks speculating on *carry trades* ii) the creation of new reserves (monetary expansion) during bubble formation ii) the rebuilding of banks' balance sheets during systemic crises.

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 could 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 surplus. Bank bailouts are the least effective, exerting downward pressure on wages and/or household spending: *austerity*.

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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