A Steindlian account of the distribution of corporate profits and leverage:

A stock-flow consistent macroeconomic model with agent-based microfoundations

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Abstract

Post Keynesian economics has largely forgotten Steindl's insight that monopolisation of the corporate sector redistributes profits to those firms least likely to invest them productively. Agent-based methods can be used to incorporate Steindl's insights into a simple stock-flow consistent model of the monetary circuit. This model illustrates the 'maldistribution of profits' and 'enforced indebtedness' of heterogeneous firms alongside the tendency towards stagnation that occurs with rising monopolisation. The model also demonstrates Minsky's assertion that firms' leverage rises over the business cycle can be reconciled with Kalecki's macroeconomic identities showing that profits are 'financed' by the investment expenditures of firms.

Keywords	Stock-flow consistent, heterogeneous agents, Post-Keynesian
JEL codes	C63, E16, E22, E25, E42

1 Introduction

In Post Keynesian theory the distribution of total income between labour and capital is determined by the average mark-up of prices over costs in non-competitive markets. In most models, that average mark-up is incorporated by imposing an unexplained parameter representing the 'degree of monopolisation'.[1]

This approach contrasts with that taken by Steindl (1952) in his groundbreaking work on the tendencies of monopoly capitalism. The ability of firms to impose uncompetitive prices depends on their market power. Since the relative position of firms is not constant, Steindl observed, the overall distribution of income will be affected not only by the size of mark-ups imposed, but also by the shifting structure of the corporate sector.

With time, Steindl argues a monopolistic core of firms will come to dominate the economy. The prices charged by those firms—and the share of output subject to such pricing—will then rise and aggregate demand will fall. How firms react will depend on their position in the market: monopolistic firms will resist the pressure to cut prices and instead accept reduced demand for their output. Smaller firms, subject to competitive forces, will be forced to cut prices in an attempt to maintain sales. The outcome will be a divergence in profit margins and an increase in the relative profitability of large monopolistic firms. If the squeeze on profits of competitive firms is intense some will go out of business, further increasing the market power of the monopolists.

While monopolisation results in the redistribution of profits to larger firms, the resulting weakness in aggregate demand leads to unused productive capacity. Large firms with inelastic mark-ups will react by scaling back planned investment. The outcome of monopolisation is the appropriation of profits by firms least likely to use them productively.

Mark-up pricing plays a dual role in this process: at the microeconomic level, the price system distributes profits among firms; at the macroeconomic level it determines the distribution of income between labour and capital. The two processes cannot be logically separated since feedback from both occurs via effective demand. Instead of being determined by an exogenous average mark-up, the distribution between labour and capital in Steindl's model evolves on the basis of shifting market structure, rising monopoly and a tendency towards stagnation.

Steindl's model was an important influence on scholars who first developed 'neo-Kaleckian' growth theory. The insight that firms may react to excess capacity by scaling back investment plans was formalised in the seminal models of Rowthorn (1981) and Dutt (1984). These models and their descendents form an important building block of the 'stock-flow consistent' (SFC) approach, which extends these models by adding accounts for monetary and financial variables (Lavoie & Godley, 2001).[2]

These stock-flow consistent models are an important step forward: they formalise the financial constraints logically imposed when self-contained economic systems are divided

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[1]See Hein (2014) for an overview of Post Keynesian growth models.

[2]Stock-flow consistency is a general logical constraint. While most authors using the approach have favoured Post Keynesian growth models as a basis, examples also exist of models from other theoretical traditions, such as neoclassical dynamic general equilibrium, e.g. Kumhof & Rancière (2010)

up by macroeconomic sector—firms, households and government—or by country. But since these models tend to treat each sector as a single decision-making and accounting unit, they inevitably abstract from microeconomic processes within those sectors—such as shifts in market structure or debt-financed asset price inflation (Michell & Toporowski, 2011; Michell, 2014b).

Is has recently been argued that such shortcomings can be overcome by using 'agent-based' modelling techniques (Caverzasi & Godin, 2014). These techniques first appeared in cross-disciplinary research between computer science, physics and biology, before being adopted by economists. They originated with models in which large numbers of individual 'units' (such as animals or gas particles) interact on the basis of relatively simple sets of rules. Despite the simplicity of the rules, the systems produce complex behaviours such as herding and flocking.

The model presented in this paper uses the agent-based method to formalise Steindl's insights about the microeconomic aspects of monopolisation within a macro model of the monetary circuit.[3] The result is a system in which the distribution of profits and income is not determined by an exogenous parameter, but instead evolves over time in response to changing market structure. The distribution of leverage and liquidity among firms is tracked using stock-flow accounting.

2 Distribution of income and profits in Kaleckian and Post Keynesian economics

The distribution of income between wages and profits plays a central role in Post Keynesian economics. This contrasts with the approach taken by neoclassical economists, who not only downplay the relevance of the division of income, but in general exclude it from consideration entirely by assuming the economy behaves like a scaled-up Cobb-Douglas production function (Michell, 2014a, pp. 8–9). While the capital-labour split has recently been rediscovered by the mainstream in the wake of Piketty's bestselling *Capital in the 21st Century* (2014),[4] these concerns form part of a much longer-standing tradition among Post Keynesian scholars, particularly those working in the Kaleckian tradition.

The primary determinant of the distribution between wages and profits in Kalecki's economics is the 'average degree of monopoly'.[5] In the simplest formulation it is assumed that labour productivity is approximately constant below full employment. Firms set prices as a fixed mark-up over marginal labour costs which are therefore also constant. The share of profits in total income is then fixed by the output-weighted average mark-up. Kalecki refers to this as the 'degree of monopoly'—'The relative share of gross

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[3]See Argitis et al. (2014) for an overview of the monetary circuit.

[4]Piketty assumes that the economy behaves like a CES production function with an elasticity of substitution greater than unity (Jump, 2014).

[5]Kalecki's theory of income distribution is first introduced in Kalecki ([1938] 1990) and was further developed in Kalecki ([1939] 1990, [1943] 1990, [1954] 1965).

capitalist income and salaries in the aggregate turnover is with great approximation equal to the average degree of monopoly.' ([1938] 1990, p. 9)[6]

The 'average degree of monopoly' is thus determined by two factors: the degree of monopoly in each industrial sector and the relative weight of each industry in the economy.

Kalecki was criticised by his contemporary, Oscar Lange, for his tendency to overlook the significance of shifts in demand and production between industries:

> The average degree of monopoly for the whole economy being a weighted mean is changed by a shift in output between industries. Thus it has little meaning to say that the distribution of income is 'determined' by the average degree of monopoly. (Lange, 1941, p. 281, quoted in Kriesler, 1987, p. 48)

Since shifts in industrial structure will affect the average mark-up, changes in the composition of demand will alter the functional distribution of income. Assuming that the propensity to consume out of profits is lower than out of wages, such shifts will lead to changes in aggregate demand, output and total employment.

Uneven monopoly power across firms and industries also has implications for the distribution of profits among corporations:

> The changes in the degree of monopoly are not only of decisive importance for the distribution of income between workers and capitalists, but in some instances for the distribution of income within the capitalist class as well. Thus, the rise in the degree of monopoly caused by the growth of big corporations results in a relative shift of income to industries dominated by such corporations from other industries. In this way income is distributed from small to big business (Kalecki, [1954] 1965, p. 18)

This observation provides the starting point for Steindl's classic work on the monopolisation of the US corporate sector, *Maturity and Stagnation in American Capitalism* (1952) which explicitly incorporates the distribution of profits among firms. Steindl introduces the idea that monopoly will lead to the 'maldistribution of profits'. He argues that in a competitive market firms will react to excess capacity by cutting prices and lowering profit margins. This cost-cutting will drive out 'marginal' producers so concentration increases. Once competition gives way to oligopoly, larger firms are no longer under pressure to engage in cost-cutting and cease to react by cutting prices but instead reduce output.

The long-run tendency towards increasing industrial concentration leads to the emergence of a 'cartelised' sector of the economy, characterised by a high degree of monopoly. At the same time, there remains a fringe of firms operating in markets which reasonably approximate a competitive structure. The relative inelasticity of mark-ups in the cartelised sector of the economy results in higher gross profit margins for these firms. The tendency towards concentration results generated a rising share of profits in the cartelised sector, at the expense of competitive firms. The outcome of this 'maldistribution of profits' is disproportionately higher gearing ratios among small competitive firms.

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[6]Kalecki's classification of salaries alongside profits—not labour income—tends to be overlooked in recent work.
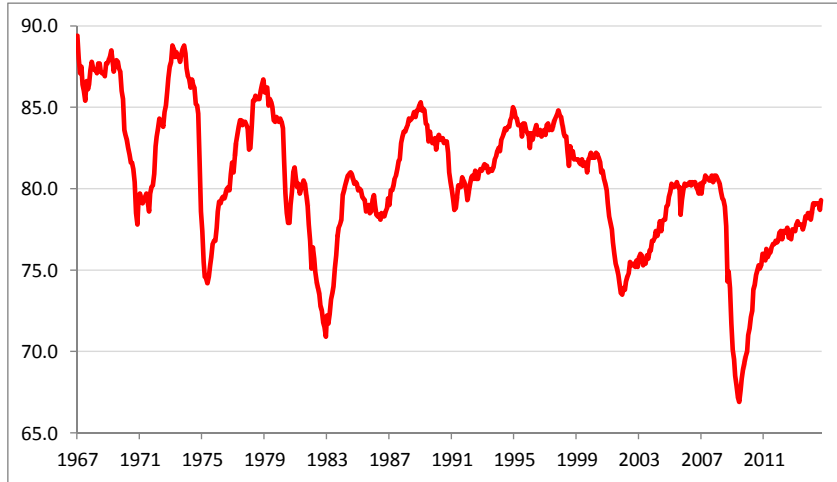
Figure 1 US capacity utilisation: total industry, per cent of capacity

Overall, the result of increasing monopolisation is twofold: in the macroeconomic sphere, a tendency towards stagnation, under-investment and excess capacity and, in the microeconomic sphere, a divergence between the cash piles of monopolists and rising leverage in the rest of the corporate sector.

These predictions, made in 1952, appear to have stood the test of time. Figure 1 shows the rate of capacity utilisation for the total industrial sector of the United States since 1967. A steady downward trend is clear: following each recession, capacity utilisation fails to regain its previous level.

Figure 2 shows selected items from the consolidated balance sheet of the US non-financial corporate sector. Non-financial assets—the capital stock—rose from around 110% of GDP to peak at just under 150% of GDP in the early 1980s before declining to under 100% in the early 1990s and in the aftermath of the 2008 recession. Over the period, gross debt has risen steadily but this increase has been more than matched by an even greater increase in holdings of financial assets.

Steindl's emphasis on the importance of excess capacity influenced those authors who developed what came to be known as the Kaleckian growth model (Rowthorn, 1981; Dutt, 1984). The key feature of this model is an investment function of form,

$$g^I = \gamma_0 + \gamma_r r + \gamma_u u \tag{1}$$

where g_i^I is investment in growth terms, r is the rate of profit and u the rate of capacity utilisation. By embedding this equation in an aggregate demand-driven model, a system which exhibits 'wage-led' growth is obtained: an increase in the share of income received
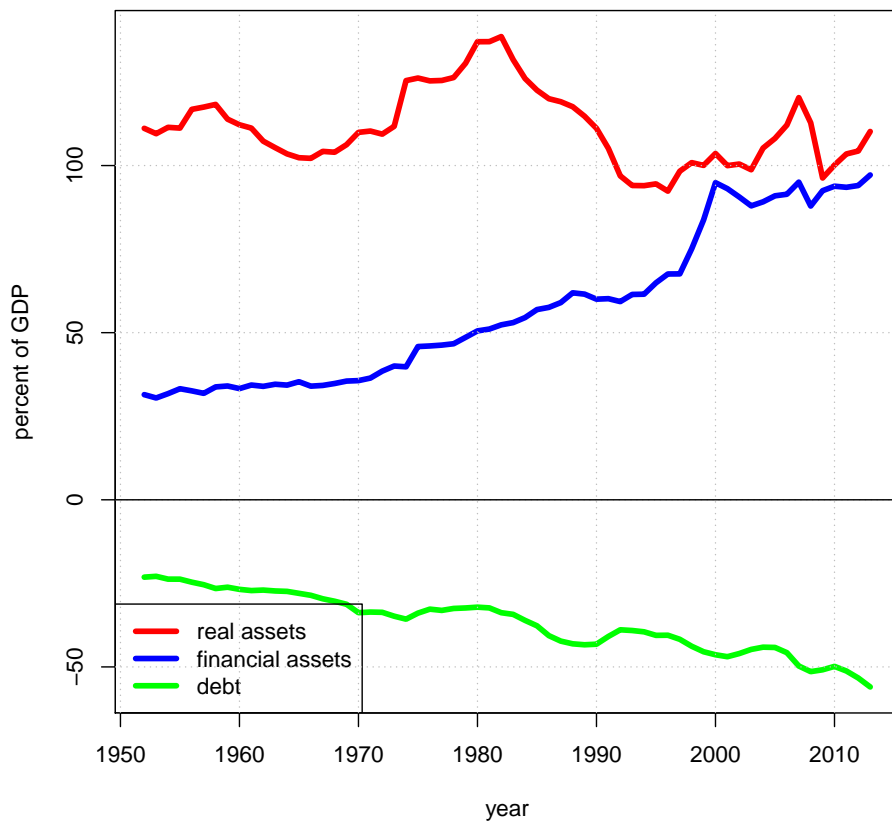
Figure 2 Consolidated balance sheet of US non-financial corporate sector

Source: Federal Reserve (2014), author's calculation

by labour raises consumption demand which in turn stimulates investment, leading to higher growth.

This investment function was criticised by Bhaduri & Marglin (1990), among others, for the assumption that the economy may operate above full capacity over the long run (See Lavoie, 1995, for a discussion). Bhaduri & Marglin propose an alternative investment function in which the rate of profit is replaced with the profit *share*. On the basis of the modified investment function, it is shown that the economy can be either 'wage-led' or 'profit-led' depending on the relative strength of the effects of capacity utilisation and the profit share. This inspired a large empirical literature which sets out to determine whether countries are in fact wage-led or profit led.[7]

Both the theoretical and empirical literature tends to take as given the mark-up determining the functional distribution of labour—treating it as an exogenous parameter in theoretical models and an explanatory variable in econometric specifications.[8] Steindl's insight that monopoly firms tend to drain funds from the circular flow, thus increasing the fragility of competitive firms, has not been been pursued in the Post Keynesian literature. The model presented in this paper develops this aspect of Steindl's analysis.

3 Stock-flow consistent microfoundations

The stock-flow consistent approach originates with the work of Godley & Cripps (1983) and was subsequently developed by Lavoie & Godley (2001) and Godley & Lavoie (2007). The method uses flow-of-funds accounting techniques to add financial and monetary variables to macroeconomic models. Consistency is maintained by requiring that the sum of financial transactions over any given time period sums to zero and that the sum of financial assets and liabilities on the aggregate balance sheet also sums to zero (Michell, 2012).

The widespread adoption of stock-flow consistent techniques by Post Keynesian authors has generated a rapidly expanding literature (a comprehensive summary is given by Caverzasi & Godin, 2014). One open debate within this literature relates to the issue of microfoundations. Michell & Toporowski (2011) argue that model-building on the basis of macroeconomic aggregates rules out the analysis of those financial market processes which are mainly driven by transactions between agents in the same macroeconomic sector. Such processes include debt-financed asset bubbles (household sector) and mergers and acquisitions booms (firms sector).

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[7]The seminal contribution to this literature was the study by Bowles & Boyer (1995). Significant subsequent contributions include Naastepad & Storm (2007) and Stockhammer et al. (2009). Hein & Vogel (2008) provide a good literature review.

[8]Bhaduri & Marglin (1990) qualify their approach with the comment '... in order to examine the connection between real wage and unemployment it is necessary to perform at least 'thought experiments' based on exogenous variations in the real wage rate.' (p. 376). The approach has been criticised by Toporowski: 'In Kalecki's analysis of capitalism, profits are determined by capitalists' consumption and their investment ... The function of the price system is to distribute that surplus around the capitalists and firms in the economy. This is a key point that distinguishes Kalecki's theory from that of many Ricardian Marxists, and Post-Keynesians, for whom profits are a mark-up on labour costs, so that the price system determines the distribution of income between wages and profits.' (Toporowski, 2011)

This, of course, is a shortcoming of almost all macroeconomic models, whether Post Keynesian or of the neoclassical representative-agent variety. But it has serious implications for models designed with monetary and financial realism as defining characteristics.

As well as financial market process, these models also face difficulties with the dynamics of distribution of income, wealth or leverage among individual units within macroeconomic sectors—at least when going beyond simple two- or three-way divisions such as splitting households into workers and rentiers. It is this type of process that is at the heart of Steindl's model.

One proposal for overcoming these issues is to use agent-based modelling (ABM) techniques to provide microfoundations for stock-flow consistent models. Proponents of such a synthesis include Bezemer (2011) but, so far, only a handful of models of this type have yet emerged—e.g. Kinsella et al. (2011); Carvalho & Guilmi (2014). Using Steindl's theory as point of departure, this paper makes an initial exploration of hybrid SFC-ABM macro modelling.

Agent-based methods provide a way to capture distributional dynamics within the firms sector as market structure varies. By keeping track of both the financial positions of individual firms and macroeconomic monetary aggregates, it can be shown that *gross* debt positions arising out of the 'maldistribution of profits' can rise—leading to an expansion of bank balance sheets—even while the net deficit of the firms' sector as a whole falls. This is because the cash stockpiles that accumulate on balance sheets of large monopoly firms outweigh the rising leverage of smaller competitive firms. Such a pattern was visible in advanced economies in the run up to the 2008 crisis (although the situation was complicated by the extensive use of debt to finance leveraged buy-outs, equity buy-backs and dividend payouts, Lazonick & Mazzucato, 2013; Michell, 2014b). Since 2008, the accumulation of cash and other liquid assets by large firms has accelerated, with stockpiles reaching record levels (Economist, 2012; FT, 2014)

The model described here sheds light on a tension in Minsky's analysis, highlighted by Lavoie & Seccareccia (2001) and Toporowski (2008) among others. This tension arises out of the problems of reconciling Minsky's assertion that financial fragility—the leverage ratio of firms—tends to rise during an investment boom with Kaleckian accounting identities which demonstrate that macroeconomic profits rise *pari passu* with investment expenditure. The model demonstrates how the relative weight of firms with 'Ponzi' financing structures can rise relative to those with 'hedged' balance sheets, even as the financial deficit of the firms' sector falls and total cash holdings of the firms sector increases.

4 A Steindlian model of the corporate sector

4.1 Overview

The model presented in this section is in the spirit of Steindl, not the letter. The model captures Steindl's key insight that differential monopoly pricing power will lead

to divergence in profits and leverage. The model is relatively primitive in assumptions but nonetheless generates a rich range of behaviour.

Following Steindl (1952), Rowthorn (1981) and Dutt (1984), the main feature of the model is a 'wage-led' investment function. Unlike previous aggregate demand-driven models in which this function describes the behaviour of the sector as a whole, each firm makes a separate investment decision based on outcomes realised in the previous period.

Instead of the investment function presented in Steindl (1952), the more widely-discussed version from the Rowthorn-Dutt class of models is substituted. It is assumed that the parameters of this investment function are the same for each firm. Heterogeneity is introduced by allowing the balance sheet of each firm to evolve independently, and assuming that the pricing behaviour of each firm depends on its relative strength in the market.

In addition to investment in capital goods, firms also make a decision on how much output to produce in each period. Uncertainty over future demand leads to the possibility that sales plans may not be achieved and profits not realised. This contrasts with the formulation in simple Post Keynesian growth models in which goods market clearing is assumed by enforcing the identity that saving equals investment. These models, and related empirical research such as Stockhammer et al. (2009), have been criticised by dos Santos (2013) for their reliance on the market clearing assumption—an implication of dropping this assumption is that, even with a 'wage-led' investment function, an increase in growth may be achieved alongside a rising profit share if firms run down inventories. More importantly, the possibility exists that consumer goods may remain unsold due to an insufficiency of demand. Realised profits are determined by sales while capacity utilisation is determined by production decisions—regardless of whether the goods produced are sold.

The firms sector is combined with a simple Keynesian macroeconomic consumption function and a consolidated 'horizontalist' banking sector. The banking sector is assumed to fully accommodate all demands for loans at a fixed exogenous rate of interest. It pays the same rate of interest on deposits as it charges on loans and makes no profits. No consideration is given to issues of capital adequacy or liquidity. Bankruptcy is treated in a highly simplified way by assuming that households' deposits are reduced when loans are written off.

The model is constructed on the basis of two main logical blocs. The first is the heterogeneous firms sector. Decisions are made by individual firms on the basis of their current balance sheet and their expectations about the future. Balance sheets are tracked for each firm. The second bloc is a simple stock-flow consistent simultaneous equation system. Accounting logic is used to ensure that the stocks and flows generated by individual firms sum exactly to the equivalent aggregates at the macroeconomic level.

Godley & Lavoie introduce what they call the 'quasi-Walrasian' principle for checking the consistency of stock-flow consistent systems. This principle states that any stock-flow consistent system will be over-determined, since any single equation of an n-equation system will be logically implied by the other $n-1$ equations of the system. The consistency of the system can thus be checked by dropping any single equation—usually the identity that the demand for money equals the supply of money is chosen—and

	Households	Firms	Banks	Total
Fixed capital		$+K$		$+K$
Inventories		$+IV$		$+IV$
Deposits	$+D_h$	$+D_f$	$-D_S$	0
Loans		$-L_D$	$+L_S$	0
Total (Net Worth)	NW_h	NW_f	0	$+(K+IV)$

Table 1 Macroeconomic balance sheet of the model.

Fixed capital	$+k_i$
Inventories	$+iv_i$
Deposits	$+d_{fi}$
Loans	$-l_i$
Total (Net Worth)	nw_i

Table 2 Balance sheet of an individual firm, i.

ensuring that it is nonetheless fulfilled when the system is simulated numerically. This principle is extended to cover the microeconomic agent-based bloc of the system.

4.2 Model structure

Starting with the macroeconomic bloc, the aggregate balance sheet of the model is shown in Table 1. The economy is divided into three sectors: households, firms and a consolidated banking system. Assets are denoted with a plus sign and liabilities with a minus sign. Most of the action takes place within the firms' sector: firms hold both fixed capital and inventories of finished consumer goods and finance their positions using loans obtained from the banking system. Additionally, firms are assumed to manage their liquidity by holding bank deposits. Households hold only one type of asset: bank deposits. The banking system issues loans and takes deposits from both firms and households.

Households supply labour to firms and receive wages in return while also receiving interest from banks on their deposits. It is assumed that in each period, households choose how much to consume as a fixed proportion of previous-period income and wealth. Saving is a residual, determined once total output and employment are known.

The most detailed part of the model is the firms sector. There are a large number N heterogeneous firms. Each firm $i \in N$ has a balance sheet as shown in Table 2. This reproduces the balance sheet of the aggregate firms sector from Table 1 at the microeconomic level.

In line with the Post Keynesian literature, it is assumed that there exists a completely elastic supply of constant-productivity labour so firms face no constraints in their output decision. Heterogeneity in the firms sector is modelled on the basis of different stocks of assets and liabilities on firms' balance sheets. The greater the size of the firm—proxied

by the volume of fixed capital held—the greater the market power and thus the price mark-up imposed by the firm.

The system is modelled in discrete-time. Decision-making and accounting is done in a three-step process in each time-period. In the first step, firms and the household sector make decisions about consumption, investment, output, pricing and finance. In the second step, aggregate values are found by summing over all firms in order to determine the values of macroeconomic variables. These variables are inserted into the stock-flow consistent macro bloc of the model and the system is solved, yielding total aggregate demand.

The third and final step of the model involves distributing this aggregate demand among the heterogeneous firms. Demand is distributed on the basis of the relative 'size' of the firms but also incorporates a stochastic element. This stochastic element moderates the tendency towards increasing monopolisation. Once the the total demand faced by each firm is known, final balance sheet positions for each firm can be calculated.

4.3 Specification of the model

Specification of the model is presented in order of the three-stage process outlined above. In the first step, each firm makes behavioural decisions based on outcomes realised in the preceding period.

4.3.1 Decisions made by firms before production commences

Before commencing production, each firm makes decisions about the following magnitudes: output (which determines how many workers to hire); new fixed capital investment; and new bank borrowing.

Firms' investment decisions are the drivers of the whole system—in Kaleckian and Keynesian demand-driven systems, it is the investment decisions of firms which most directly effect aggregate demand.

The investment function is taken from the neo-Kaleckian growth model of Rowthorn (1981) and Dutt (1984) discussed above. The formulation is a slightly modified version of Equation 1:

$$g_i^I = \gamma_0 + \gamma_r r_{i(-1)} + \gamma_u u_{i(-1)} \tag{2}$$

This investment function has been chosen because its properties—as a macroeconomic behavioural equation, at least—have been investigated extensively (see the discussion in Section 2). Here, however, the function specifies the investment decision of an individual firm. The equation states that the capital accumulation of each firm (in growth terms) is determined on the basis of three factors: firstly, by 'animal spirits', represented by an exogenous parameter, γ_0, secondly, by the rate of profit, r, achieved in the previous period and, thirdly, by capacity, u, used in the previous period. The greater the degree of unused productive capacity, the lower the intended rate of accumulation. This may be outweighed, however, if the rate of profit is supported by high profit margins caused

by monopoly mark-up pricing. γ_r and γ_u are parameters that fix the sensitivity of investment to the rate of profit and to capacity utilisation.

The rate of profit and the degree of capacity utilisation for each firm are defined as follows,

$$r_i = e_i/k_i \tag{3}$$

$$u_i = y_i/yf_i \tag{4}$$

where e_i is the expenditure spent on output produced by firm i over the period (total revenue), k_i is the 'size' of the capital stock held by the firm, y_i is the output produced over the period. Capacity utilisation is defined as the ratio of output to the full-capacity output of the firm, yf_i. This is defined as follows,

$$yf_i = vk_i \tag{5}$$

where the capital/full capacity output ratio, v, is treated as an exogenous parameter.

Since at the time the firm makes its investment decision, these ratios are not yet known, the decision is made on the basis of demand and profits in the previous period.

Once the desired growth of the capital stock is determined, the demand for investment, ι_D by firm i is,

$$\iota_{Di} = g_i^I \cdot k_i \tag{6}$$

Each firm must decide on output, pricing and employment. The firm makes a prediction of sales it will achieve, e_i^E, on the basis of previous period revenue, $e_{i(-1)}$ scaled by the growth rate, g_i^I,

$$e_i^E = e_{i(-1)}(1 + g_i^I) \tag{7}$$

Firms are assumed to hold a stock of inventories to cope with unexpected increases in demand. The desired level of inventories, iv_i^D is a proportion of expected sales.

$$iv_i^D = \rho \cdot e_i^E \tag{8}$$

Each firm's production decision is then based on predicted revenues and relative size of current inventories relative to desired inventories.

$$y_i = e_i^E + iv_i^D - iv_i \tag{9}$$

Once the firm has decided how much to produce, it then decides on the price mark-up it will impose. This is determined on the basis of the relative size of the firm. The 'size' of each firm is proxied by the firms' share of total fixed capital,

$$s_i = k_i/K \tag{10}$$

where $K = \sum k_i$. The mark-up of prices over wages, τ_i is then determined as follows,

$$\tau_i = s_i N\text{T} \tag{11}$$

where N is the number of firms and T is an exogenous parameter representing the degree of monopolisation (or weakness of labour) in the economy as whole. Thus, an 'average sized' firm will impose a mark-up of T, while a firm double the average size will impose

a mark-up of 2T, and so on. The 'degree of monopoly' is thus not fully endogenous—the model still relies on an exogenous parameter for the overall strength of capital. In general, however, this will differ from the 'average degree of monopoly' which depends on market structure and the relative size of firms.

The gross profit margin this firm intends to achieve on the basis of *realised* sales is,

$$m_i = \frac{\tau_i}{1 + \tau_i} \tag{12}$$

Assuming constant labour productivity, the wage bill implied by this gross margin is the following

$$wb_i = \frac{y_i}{m_i \cdot y_i} \tag{13}$$

Now the firm must decide how much, if at all, it needs to borrow. Firms are assumed to hold a stock of liquidity—bank deposits—in order to cope with unexpected shortfalls in demand. The minimum volume of deposits desired is determined as a proportion θ of current expenditures—the wage bill and net interest payments:

$$d_{fi}^D = \theta \cdot [wb_i + \bar{r} \cdot (l_{fi(-1)} - d_{fi(-1)})] \tag{14}$$

The liquidity the firm *expects* to hold at the end of the period without further borrowing is calculated on the basis of deposits held at the end of the previous period and expected net profits less intended investment

$$d_{fi}^E = d_{fi(-1)} + e_i^E - wb_i - \bar{r} \cdot (l_{fi(-1)} - d_{fi(-1)}) - \iota_{di} \tag{15}$$

Finally, it is assumed that firms make an asymmetric decision on borrowing. If predicted liquidity exceeds desired liquidity, firms make no change to their borrowing and keep excess liquidity on their balance sheets (Toporowski, 2010). On the other hand, if faced with a shortfall of liquidity, firms request new loans to make up the deficit.

$$\Delta l_{Di} = \begin{cases} d_{fi}^D - d_{fi}^E, & \text{if } d_{fi}^D \geq d_{fi}^E \\ 0, & \text{otherwise} \end{cases} \tag{16}$$

4.3.2 The macroeconomic stock-flow model

The second stage of the simulation process involves summing over flows generated by individual firms in order to obtain aggregate flows. Total output is given by the sum of firms' output.

$$Y = \sum y_i \tag{17}$$

The total wage bill is the sum of firms' wage bills.

$$WB = \sum wb_i \tag{18}$$

Investment demand is the sum of individual firms' investment demands. It is assumed that the supply of capital goods accommodates demand (firms correctly predict the demand for new capital goods) so that the change in the capital stock is equal to

investment demand.

$$\Delta K = I_D = \sum \iota_{Di} \tag{19}$$

Finally, the total demand for new lending is given by the sum of loan demands from firms. Since a pure 'horizontalist' banking sector is assumed, this will also be the level of loans supplied.

$$\Delta L_S = \Delta L_D = \sum \Delta l_{Di} \tag{20}$$

Household consumption and total aggregate demand can now be calculated. Total household income is the sum of the wage bill and interest received on bank deposits held at the end of the previous period.

$$Y_h = WB + \bar{r} \cdot D_{h(-1)} \tag{21}$$

As with firms, the consumption of the household sector is determined on the basis of previous-period outcomes. The consumption function is a linear function of both previous-period income and previous-period wealth (assumed to be held entirely as deposits),

$$C_D = \alpha_1 Y_{h(-1)} + \alpha_2 D_{h(-1)} \tag{22}$$

Households' saving—and thus the change in their holdings of bank deposits—is a residual given by the difference between income received and consumption expenditure.

$$\Delta D_h = S_h = Y_h - C_D \tag{23}$$

Total expenditure is the sum of consumption and investment demand

$$E = C_D + I_D \tag{24}$$

Since firms' production decisions, and thus their wage payment commitments, are decided *before* total aggregate demand is known, total production of goods and total demand for those goods will not, in general, be equal. Firms face a problem of realisation of profit: if sales predictions are overly optimistic, firms will accumulate inventories and profits will be below expectations. Total profits are given by revenues (total expenditure) less costs (the wage bill).

$$F_T = E - WB \tag{25}$$

Just as inventories adjust to accommodate excess supply or demand in the consumer goods market due mistakes in predictions about demand, firms' money balances adjust to accommodate realised profits. Thus, the change in firms' aggregate deposits is given by the change in total borrowing plus total profits less net interest payments on previous period net lending and expenditure on investment on fixed capital.

$$\Delta D_f = \Delta L_S + F_T - r \cdot [L_{S(-1)} - D_{f(-1)}] - I_D \tag{26}$$

The total 'demand' for deposits is:

$$\Delta D_D = \Delta D_h + \Delta D_f \tag{27}$$

From the balance sheet of the banking system, the supply of loans must equal the

supply of deposits

$$\Delta D_S = \Delta L_S \tag{28}$$

4.3.3 Accounting performed after solving the macroeconomic system

Once the system of equations in Section 4.3.2 has been solved, total aggregate expenditure on consumption goods and fixed capital is known. This aggregate demand is then distributed amongst firms according to the following equation

$$e_i = \zeta \cdot s_i + (1 - \zeta) \cdot \epsilon_i \tag{29}$$

Where ϵ_i is a stochastic variable such that $\sum \epsilon_i = 1$. The variable ζ is a parameter which determines the extent to which total aggregate demand is randomly distributed ($\zeta = 0$) or distributed entirely on the basis of the relative size of firms ($\zeta = 1$). Since $\sum \epsilon_i = \sum k_i = 1$, the sum of shares of expenditures will sum to total aggregate demand: $\sum e_i = E$

Each firm is then in a position to compare expected revenues with actual revenues, and thus to discover how much profit has been realised in this period. Realised gross profits are the difference between revenues and wage costs,

$$f_i = e_i - wb_i \tag{30}$$

and the change in inventories will equal the difference between expected and actual sales

$$\Delta iv_i = y_i - e_i \tag{31}$$

The change in deposits held by this firm can be calculated. Since we have assumed a horizontalist banking system, any demand for lending will have been granted and the change in loans, Δl_i held by the firm will equal the demand for loans Δl_{Di}. Likewise, it is assumed that firms correctly predict the demand for capital goods, so that supply adjusts to meet demand and each firm's investment, ι_i, is equal to its investment demand ι_{Di}. However the possibility of bankruptcy must first be considered.

4.3.4 Bankruptcy

The possibility exists that realised profits falling short of expected profits—and firms may even make losses. Firms use their stocks of bank deposits to cover unexpected shortfalls and replenish their liquidity in the subsequent period by borrowing from banks.

The possibility also exists that firms will have insufficient cash on hand to cover costs in the current period. In this case the firm is considered bankrupt and must default on its loans.

For the sake of simplicity, bankruptcy is treated in a cursory way. Once a firm is declared bankrupt, its *financial* balance sheet is wiped clean—the loans owed by that firm are written off. It is assumed that capital and inventories are retained and the firm is able to resume trading.

Instead of modelling bank capital directly, the hit is proxied by reducing bank deposits held by households. Bankruptcies thus reduce the net worth of the household sector relative to the corporate sector.[9]

Formally, the 'net cash position'—i.e. the surplus or shortfall—is given by the stock of deposits plus net profits (gross profits minus interest payments), less investment expenditures, plus the current period increase in borrowing.

$$n = d_{fi(-1)} + f_i - r \cdot (l_{fi(-1)} - d_{fi(-1)}) - \iota_i + \Delta l_i \tag{32}$$

So bankruptcy can be represented by the following conditional statement

$$d_{fi} = \begin{cases} n, & \text{if } n \geq 0 \\ 0, & otherwise \end{cases} \tag{33}$$

This requires the following adjustments to be made to balance sheet stocks at both the micro and macro levels:

$$\Delta L_S = \Delta L_D = \Delta D_h = \Delta D_S = \Delta l_i = \begin{cases} -l_i & \text{if } n \geq 0 \\ 0, & otherwise \end{cases} \tag{34}$$

In the case that the firm is not declared bankrupt, the change in deposits held by each firm will thus be equal to the following

$$\Delta d_{fi} = f_i - r \cdot (l_{fi(-1)} - d_{fi(-1)}) - \iota_i + \Delta l_i \tag{35}$$

4.3.5 Summary variables and consistency checking

The macro system described in Section 4.3.2 has one equation missing. This is the identity that the 'supply' and 'demand' for bank deposits must be equal:

$$\Delta D_D = \Delta D_S \tag{36}$$

This equation is not included because it is logically implied by the other equations of the system—Godley & Lavoie (2007) refer to this as the 'quasi-Walrasian' principle. This identity provides a way to check the stock-flow consistency of the system: when simulating the system numerically the identity must hold.

In the combined SFC-ABM approach developed here, the quasi-Walrasian principle can be extended to check the consistency between the micro and macro blocs of the model. Equation 26 is the identity stating that the change in total firms' deposits is a residual determined by realised profits. This equation can also be calculated by summing over the deposits held by firms at the end of the period (after bankruptcy adjustments).

$$D_F = \sum d_{fi} \tag{37}$$

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[9]This treatment of bankruptcy is unsatisfactory—a more realistic approach would be to assume that some of the the capital stock and inventories of bankrupt firms will be bought at reduced rates by other firms and the remainder abandoned.

At no point in the simulation is this aggregate value substituted into the macroeconomic system of simultaneous equations. Nonetheless, if the model is stock-flow consistent, this must equal the value calculated at the aggregate level.[10]

When the model is simulated, both Equations 36 and 37 are found to hold. This confirms that the model is stock-flow consistent at both the macroeconomic *and* microeconomic levels. Given the relative simplicity of the model presented here, checking the consistency of the system of equations is a relatively straightforward process. However, the modelling approach taken here could be extended to produce more complex models, increasing the importance of this consistency checking procedure.

Finally, aggregate measures of the average gross profit margin, the rate of profit and the overall level of capacity utilisation are calculated. The aggregate gross profit margin is given by,

$$m = \frac{E - WB}{E} \tag{38}$$

and from this, the 'average degree of monopoly' can be determined. The (average) rate of profit is,

$$r = F_t/K \tag{39}$$

and the overall level of capacity utilisation,

$$u = Y/YF \tag{40}$$

These measures will be used when simulating the model to summarise the results in terms of familiar macroeconomic variables.

5 Simulation results

5.1 Speed of concentration

The model is simulated for 250 periods. While these are labelled '1000'–'1250', these numbers are arbitrary so this should be not be thought of as representing any particular period of historical time.

The initial parameters are shown in the Appendix. The model is simulated with ζ in the range 0.5–0.9. This parameter determines how aggregate demand is distributed among firms. The higher the value, the weaker the stochastic element in the allocation of demand—and the more powerful the process of concentration.

The results of the simulations are shown in Figures 3 and 4 of the Appendix. Each of the two figures contains three columns of graphs. From left to right, these columns show simulation results with ζ set at 0.5, 0.7 and 0.9—the tendency towards concentration is weakest in the leftmost column and strongest in the rightmost.

Starting with Figure 3, the top row shows the distribution of capital among firms. The X-axis shows the size of the capital stock held by each firm, normalised so the

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[10]A similar check can be made to ensure that the total aggregate change in inventories IV found by summing over individual firms balance sheets is equal to the level implied by the macroeconomic identity $\Delta IV = Y - E$.

mean is equal to one. The Y-axis shows the number of firms holding that amount of capital. Each graph shows the initial distribution (blue) and the final distribution after simulation (green).

In all three cases, the initial allocation of capital is made so that there are approximately equal numbers of firms of each size between zero and twice the mean. When monopolisation is strongly moderated by randomisation ($\zeta = 0.5$), the distribution of capital converges on what resembles a normal distribution—as predicted by the Central Limit Theorem. When the stochastic element is minimised however ($\zeta = 0.9$), the distribution becomes heavily skewed, with a large cluster of below-average sized firms alongside a long tail of large firms. This resembles the log-normal distribution for firms that Steindl (1965) noted in the empirical data. The intermediate case ($\zeta = 0.7$) looks close to a normal distribution but is skewed so that the majority of firms are slightly below the mean.

The second row of Figure 3 plots the growth of investment (green) and output (red) against time. In the $\zeta = 0.5$ case, the model exhibits cyclical behaviour. This is because stochastic shocks generate and amplify feedbacks between investment and output in the presence of backward-looking expectations: when aggregate demand exceeds expectations, investment increases, raising output, capacity utilisation and profits. As the capital stock increases, the rate of profit eventually peaks and investment stalls. This resembles the business cycle mechanism outlined by Kalecki ([1939] 1990) with the difference that lags in expectations replace lags in the production of the capital stock.

In the case that ($\zeta = 0.7$), this cyclical pattern is still discernible but much weaker. Instead the main pattern is a a gradual increase in the rate of growth as market structure adjusts to its final pattern. To understand this pattern, the remaining rows of Figure 3 must be inspected. These show the aggregate rate of profit, r, aggregate capacity utilisation u and the wage share WB/Y plotted against time.

All three measures rise as market structure converges towards a 'steady state': a stronger tendency towards monopolisation leads the system to converge on a distribution with a higher aggregate wage share and higher rate of growth: with $\zeta = 0.5$, GDP growth oscillates between 4% and 5%; with $\zeta = 0.7$ growth converges towards 8%.

When the randomisation of demand that restrains corporate concentration is weak ($\zeta = 0.9$) a third pattern emerges. As a few large firms rise to dominate the economy, the aggregate profit rate rises as in the intermediate case. However, the dominance of the monopolistic sector leads to a falling wage share and rising excess capacity, as predicted by Steindl. The rising rate of profit is not enough to outweigh the depressive tendencies arising from excess capacity, and investment and GDP growth fall steadily. This configuration in fact fails to converge to a 'steady state' market structure as in the other two cases: the long-run outcome of simulations with this set of parameters is a binary distribution in which a single firm ends up being the 'whole economy' and the remaining firms are eliminated. There is thus a tipping point beyond which the self-reinforcing effect of concentration overwhelms the stochastic element.

The microeconomic patterns that emerge within the firms' sector are summarised in Figure 4. This figure shows how growth rates, profit rates, capacity utilisation and financial assets and liabilities are distributed among firms after simulation is complete.

As in the first row of Figure 3, the X-axis of all sub-figures lists the sizes of firms, normalised so the mean equals one. The first three rows of the figure show plots of firm size against firm-level investment growth rates, g_i^I, profit rates r_i and capacity utilisation u_i. Each point in each sub-figure represents a single firm.

The greater the degree of monopolisation, the greater the degree of polarisation in profit rates and capacity utilisation. When $\zeta = 0.5$, profits and utilisation rates appear almost randomly distributed among firms. However, after a strong concentration process ($zeta = 0.9$), clear patterns emerge.

For smaller firms, variance in all three measures is high—this will in part be due to the fact that the size of stochastic shocks will be relatively larger for small firms, so there will be more 'noise' at the lower end of the scale. Variance decreases with firm size and a positive trend between firm size, growth and profits is emerges. Thus, *within* the firms sector, large firms are more profitable and invest and grow faster—but at the *aggregate* level (Figure 3) this process increases the overall market share of large firms, leading to excess capacity and slowing total investment and growth.

On the other hand, even within the firms sector, capacity utilisation falls as firm size increases—large firms tend to operate with more excess capacity than smaller firms.

The fourth row of the matrix shows the distribution of loans among firms. This is measured in 'nominal' terms (i.e. not normalised as a share of capital stock).[11] With a strong stochastic component in the demand distribution function, the distribution of loans shows no clear pattern. However, with a concentrated firms sector, an inverted-U shape is displayed. This can be explained as follows: since the nominal borrowing of each firm is not normalised against the size of that firm, with an even distribution of leverage among firms, a positive linear relationship between firm size and debt levels would be expected: large firms will have greater debts in order to finance their (larger) capital stocks. This is the pattern generated for firms *below* the mean. Once firm size increases beyond the mean, however, leverage starts to fall so that firms greater in size than four times the mean have no almost no debt: the higher share of output and profits accruing to large monopolist firms allows them to finance their investment entirely through retained earnings.

The same series is plotted in red on the final row of the Figure. This time it is normalised against the capital stock of the firm. For the case $\zeta = 0.9$, a clear inverse relationship between firm size and debt is shown. This pattern is also visible in the case $\zeta = 0.7$, although the variance is much greater. No obvious pattern can be seen when $\zeta = 0.5$—this row of sub-figures also includes the cash balances held by the firms sector (green). This clusters around the target liquidity ratio of firms, except in the case of large firms in the presence of strong concentration. These firms hold large cash balances, well in excess of that needed for day-to-day liquidity management, because the profits of these firms exceeds their desired investment so that firms have no choice but to accumulate cash stockpiles.

Finally, 'net leverage' is also shown for each firm (in blue). This is calculated as loans less deposits as a proportion of real capital. With concentration, this measure has a

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[11]The units for the two rightmost plots are millions of 'pounds'.

clear negative relationship with firm size—and beyond a certain level turns negative—large firms have no debts and hold large cash stockpiles. Steindl's insights about 'forced indebtedness' of small business and the 'maldistribution of profits' in favour of large firms emerge clearly. The simulations also closely recreate the patterns seen in Figures 1 and 2

5.2 Financial fragility

The model can also be used to shed light on the fallacy of composition allegedly committed by Minsky ([1975] 2008; [1986] 2008) in his Financial Instability Hypothesis—by arguing that leverage ratios rise over the course of the business cycle, Minsky appears to contradict Kalecki's ([1954] 1965) macroeconomic accounting identities which demonstrate that higher investment leads to higher profits.[12]

Minsky's analysis involves classifying firms on the basis of the soundness of their balance sheet. Firms are divided between three categories: 'hedge' firms, which are able to repay both principal and interest out of profits, 'speculative' firms, which can cover interest payments only, and 'Ponzi' firms that must borrow in order to pay interest due on past borrowing. During an investment boom, Minsky argues, the fragility of balance sheets weakens so that a shock—such as a rise in the rate of interest—can lead to an increase in Ponzi financing structures and crisis.

The balance sheets of firms in our model can be classified along the lines suggested by Minsky. Since questions of risk and maturity have been abstracted from and loans are assumed to be continually rolled over, an assumption on the maturity of loans needs to be made. If it is assumed that loans are granted for five periods, in order for a firm to be a 'hedge' unit, profits in each period must exceed interest payments plus a fifth of outstanding loans. A speculative firm is one in which profits are less than that of hedge firms but still sufficient to pay interest in each period without recourse to further debt. A Ponzi firm is one for which profits are insufficient even to cover interest payments. This classification scheme is a bit rough and ready but will serve as a first approximation.

Figure 5 uses the same column structure as Figures 3 and 4. The first row shows household saving as a share of GDP plotted against time. Since households hold no capital and the net financial position of the banking sector is assumed equal to zero, household saving is equal to the net financial deficit of the firms sector. In the cases $\zeta = 0.5$ and $\zeta = 0.7$, this deficit is close to constant over the long run. In the high-concentration case, however, household saving—and thus the deficit of the firms sector—is steadily decreasing. This is the result of the falling share of wages in total income. At the same time, as shown in the next row, the concentration of firms leads to rising investment as a share of GDP.

The final row of 5 shows the evolution of the financial structure of the firms sector over time. The number of hedge firms (green), speculative firms (blue) and Ponzi firms (red) are shown as well as the number of bankruptcies per period (light blue). In the case with the least concentration, nearly half of firms are classified as 'Ponzi' and an

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[12]See Lavoie & Seccareccia (2001), Toporowski (2008) and Passarella (2012) for discussion.

average of about 50 bankruptcies occur each period. The reason for this is the lower rate of growth (around five percent) in this scenario. It should be noted that the 'Ponzi' classification is an instantaneous measure, and will partly reflect stochastic shocks in demand—the profits of a 'Ponzi' firm may recover in the next period.

Despite the apparent financial fragility of firms in both this scenario and the 'intermediate' scenario ($\zeta = 0.7$), the financial structure of the firms sector is steady—the number of firms of each type remains roughly constant over time. In the high-concentration scenario however, there is a steady rise in the number of firms switching from 'speculative' to 'Ponzi' in each period: financial fragility is rising. But this is taking place at the same time as the net financial deficit of the firms sector is falling and investment as a share of output is rising.

While the scenario does not correspond exactly to a Minskian investment boom, it does demonstrate how Minsky's definition of rising financial fragility *is* compatible with rising investment and a falling financial deficit of the firms' sector—so long as firms are heterogeneous. This also highlights the problems in assuming of a pure 'horizontalist' banking sector: banks continue lending to firms despite the increasing prevalence of Ponzi units. With a more sophisticated model of bank behaviour, a point would be reached at which banks would raise interest rates or restrain credit growth. Similarly, the investment function implies that firms do not consider their financial fragility when deciding on their investment and output decisions. With modifications to overcome these shortcomings, the model could simulate a true 'Minsky moment' and credit crisis.

5.3 Sensitivity to excess capacity

Figure 6 shows how the behaviour of the system is altered by adjusting the sensitivity of investment to the rate of profit and capacity utilisation. The rows contain series already described in the previous sections. The columns are as follows: in all three simulations, the concentration parameter is high: $\zeta = 0.9$. The first column reproduces the simulation shown in the rightmost column of the previous figures, but extends the time-span.

The end result of the disequilibrium process will be total concentration—a single firm dominating the market. At this point the model will behave in the same way as the equivalent macro model.

The simulations show that as concentration progresses, the rate of profit initially increases even as capacity utilisation falls. Eventually, this trend reverses as falling aggregate demand erodes profits. From this point, output, capacity utilisation and the rate of profit all decline steadily.

The second column shows how this process unfolds in the case that firms are less sensitive to excess capacity. The baseline parameters shown in the index are adjusted: γ_u is reduced to 0.01 and γ_r is increased to 0.3. In this case, while the absolute growth rate is lower, the fall in growth as concentration takes place is much less severe: growth falls from around 4% to around 3.75% compared to the previous case in which growth falls from around 7.5% to around 5%.

5.4 An increase in the interest rate

The final experiment demonstrates the effect of a rise in the rate of interest. Since interest payments have no direct effect on investment and no distinction is made between wages and interest income when making consumption decisions, a rise in the rate of interest simply increases household income, raises consumption and thus increases aggregate demand, output and capacity utilisation.

The rightmost column of Figure 6 shows a simulation with parameters set as in the middle column. During the simulation (at $t = 1100$), the rate of interest is increased from 3% to 6%. Output growth, the rate of profit and capacity utilisation all immediately increase in response. The effect on the firms sector is to shift around 200 firms from speculative to Ponzi finance.

Since neither firms nor the banking system react, there is no further effect of this change—the system continues its trajectory towards single-firm dominance. With firms and the banking system modelled in a more sophisticated way, however, such a rise in rates could be the tipping point leading to financial and economic crisis—the so-called 'Minsky moment'.

6 Conclusion

Post Keynesian economics tends to overlook both the role of prices in distributing profits and the role of market structure in distributing wages. Yet Steindl's insights on the 'maldistribution of profits' in capitalism hold considerable relevance for the era of 'financialisation' in which the cash hoarding of monopolistic firms is matched by the indebtedness of small firms and households.

Using agent-based techniques, Steindl's insights are formalised and incorporated into a simple stock-flow consistent model of the monetary circuit. Numerical simulations generate the following results: investment cycles in a steady state growth path; disproportionate profits, leverage and financial fragility among firms; rising concentration alongside falling output and excess capacity; monopolisation accompanied an initially rising rate of profit and an eventual reversal; and deepening financial fragility alongside rising investment and a falling deficit for the corporate sector.

The results of this simple model demonstrate the potential of the SFC-ABM synthesis. Stock-flow consistent techniques provide a method for formalising Post Keynesian propositions—disproving claims that Post Keynesian economics lacks 'coherence, formalism and logic' (Lavoie & Godley, 2001, p. 307) and providing an alternative to mainstream models of optimising representative agents and 'rational' expectations.

The mainstream has moved on, however, since the crisis: the representative-agent, a target of much criticism, has increasingly been replaced with heterogeneous agents. Aspects of stock-flow accounting have been incorporated into dynamic general equilibrium models. Post Keynesian economics needs to keep pace with these developments.

The introduction of hetergenous agents into stock-flow models has enormous potential—With a heterogeneous household sector, models will incorporate the

dynamics of income distribution, speculative financial behaviour and debt-financed consumption and asset purchases. Price-setting and wage-bargaining by workers and firms will be modelled on the basis of differential market power and decentralised wage-bargaining and price setting. Heterogeneous banks will enable modelling of the distribution of liquidity, capital and risk alongside recent financial developments such as securitision, derivatives trading and repo lending. All of these features will be included in models while retaining the key features of Post Keynesian monetary macroeconomics: endogenous creation of credit money and disequlibrium adjustment mechanisms, even in the long run.

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Appendix: Notation, parameters and simulation figures

Notation

Demand and supply are denoted by uppercase subscripts. For example, consumption demand, C_D and consumption supply, C_S.

Macroeconomic sectors (firms, households) are denoted by lower-case subscript for sectors. For example, deposits held by households, D_h and deposits held by firms, D_f.

Variables referring to magnitudes associated with individual firms are indexed by subscript i. For example, the output produced by firm i is denoted y_i.

Previous period values are denoted by subscript (-1). For example, previous-period output is denoted $Y_{(-1)}$.

Desired and expected values are denoted by superscript D and E. For example, firms' desired deposits, F^D and firms' expected deposits, F^E.

List of parameters

Symbol	Value	Description
N	1000	Number of firms
α_1	0.7	Consumption out of income
α_2	0.1	Consumption out of wealth
γ_0	0.02	Animal spirits
γ_r	0.2	Sensitivity of investment to profit rate
γ_u	0.04	Sensitivity of investment to capacity utilisation
ρ	0.2	Desired inventory to output ratio
θ	0.5	Desired liquidity of firms as percentage of current costs
v	4	Capital/full capacity output ratio
$\bar{r}$	0.03	Rate of interest
T	0.25	Average mark-up
ζ	0.5–0.9	Strength of monopolisation tendency

Simulation figures
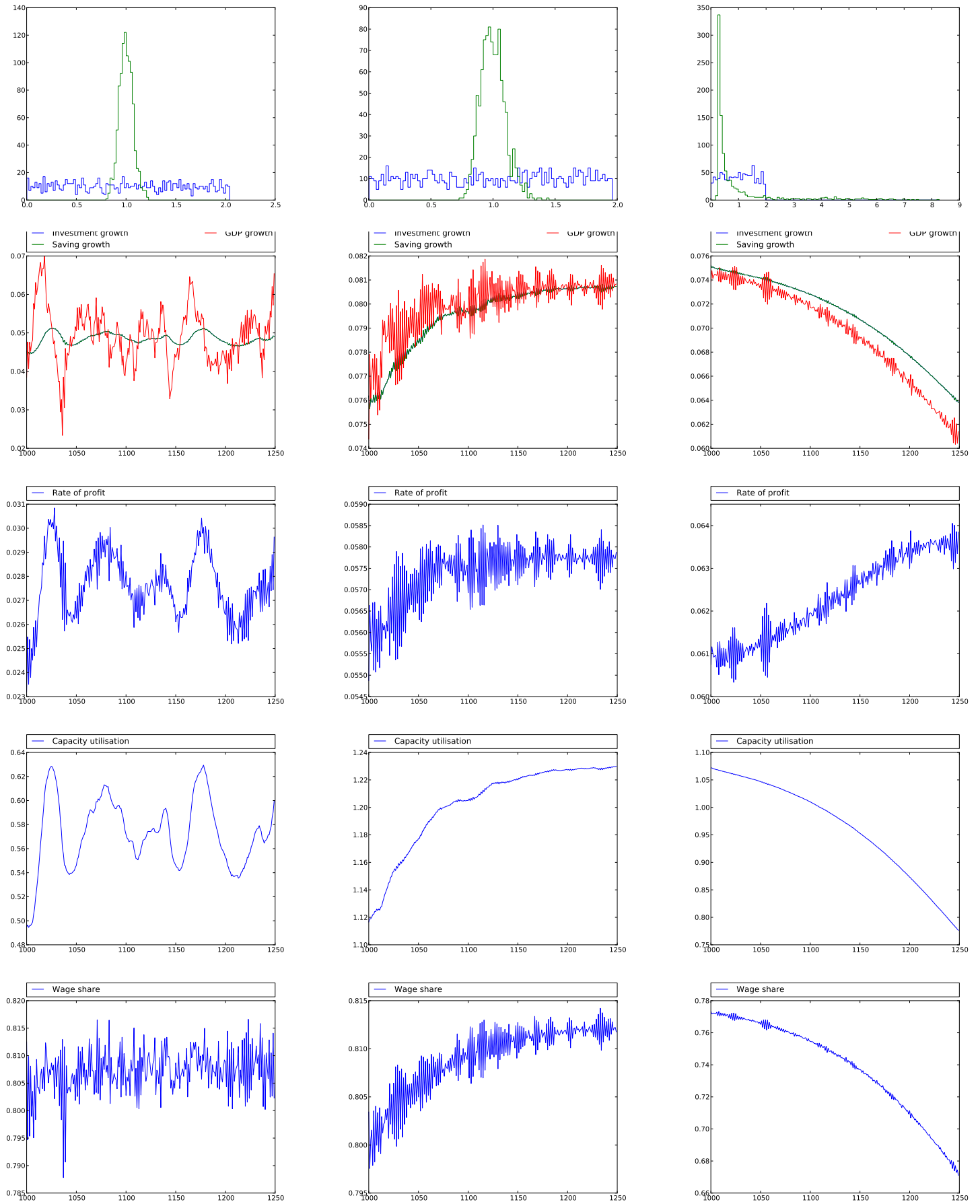
Figure 3 By row from top: 1. distribution of capital; 2. GDP and investment growth; 3. aggregate profit rate; 4. aggregate utilisation rate; 5. aggregate wage share
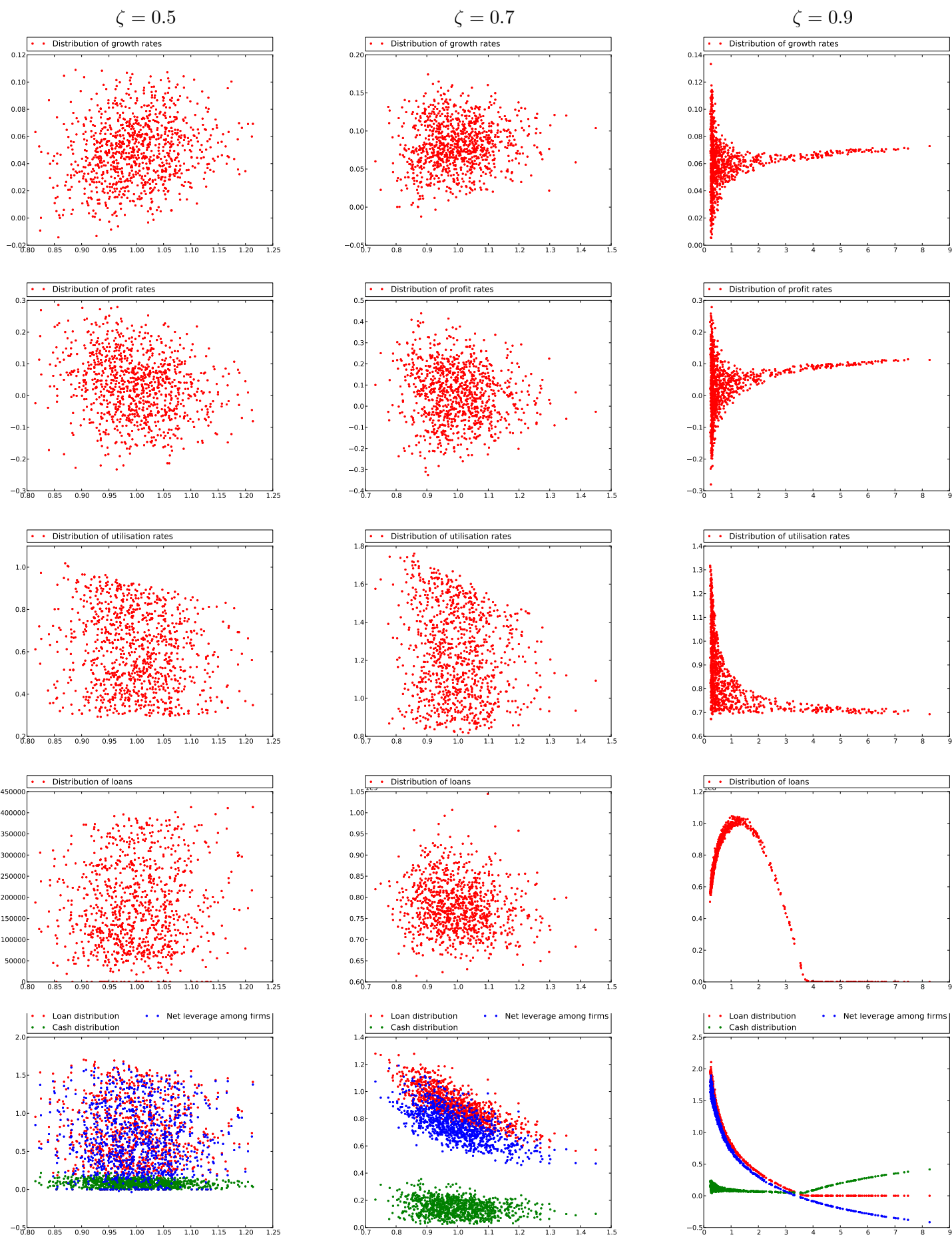
Figure 4 By row from top, distribution of: 1. growth rates; 2. profit rates; 3. capacity utilisation; 4. loans (nominal); 5. loans, deposits, net leverage (% of capital)
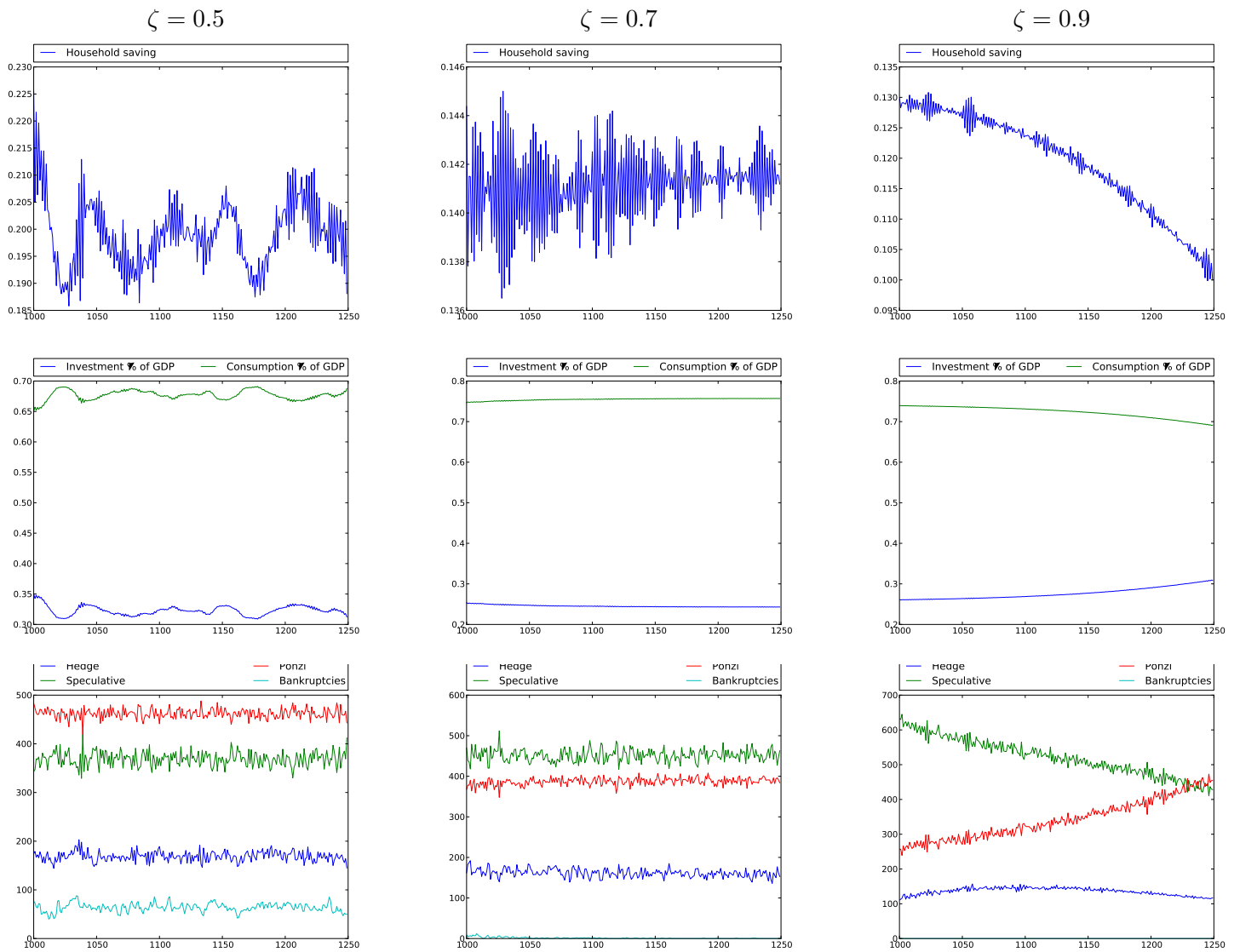
Figure 5 Top row: household saving (% of GDP); bottom row: firms' financial structure (number of firms)
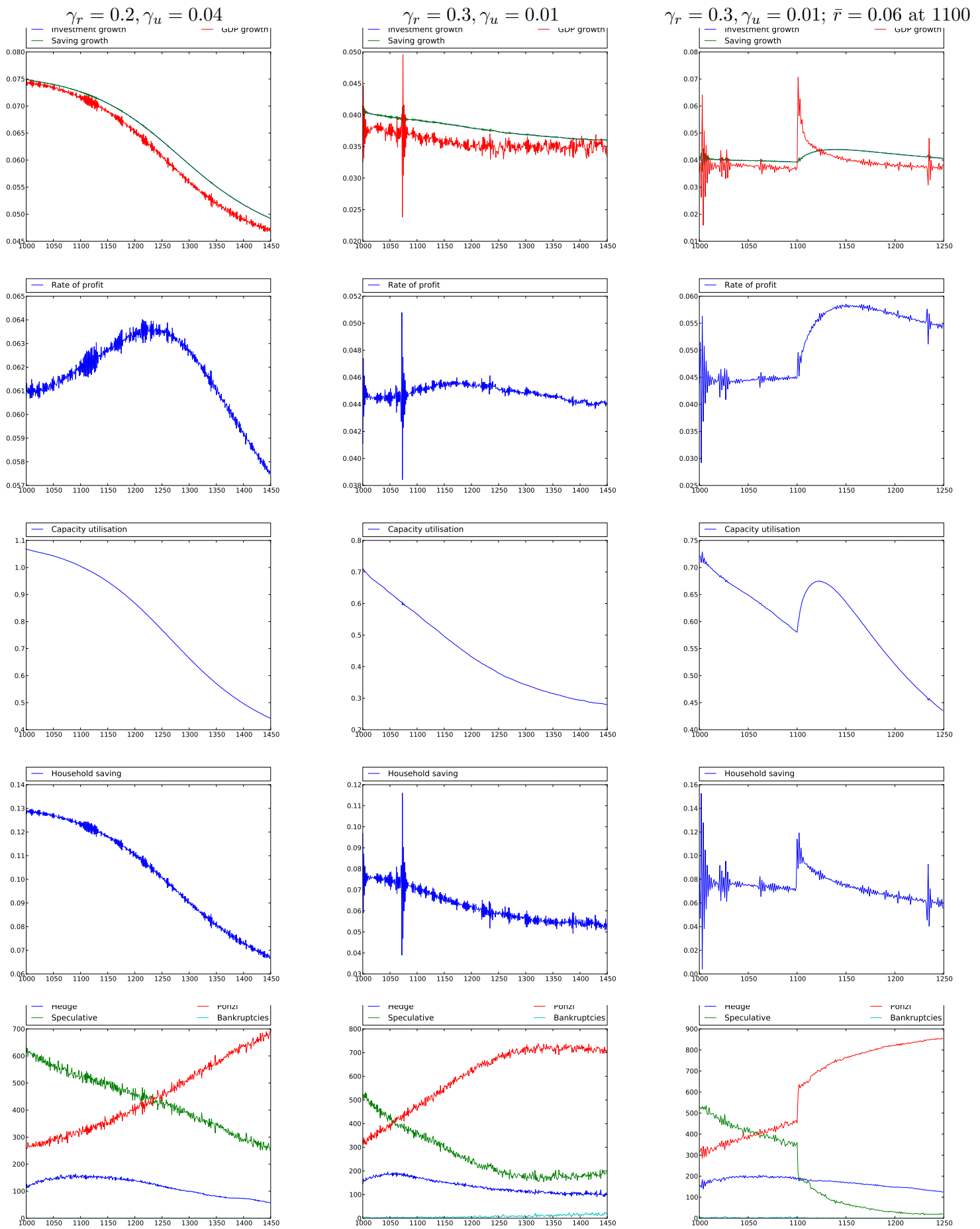
Figure 6 By row from top: 1. GDP and investment growth; 2. aggregate profit rate; 3. aggregate utilisation rate; 4. household saving; 5. financial structure