THE EMERGENCE OF DEBT AND SECULAR STAGNATION IN AN UNEQUAL SOCIETY: A STOCK-FLOW CONSISTENT AGENT-BASED APPROACH

WORKING PAPER

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ABSTRACT

Using an agent-based stock-flow consistent model that includes different classes of households, status consumption and a Minskyan banking sector, we analyse the relationship between rising saving rates, the accumulation and distribution of private financial wealth and the evolution of public debt. Conducting a series of experiments, we find evidence for Keynes' famous claim that a rise in the propensity to save will not necessarily be matched by a rise in the propensity to invest, culminating in either chronic government deficits or consistently high unemployment rates if the government refuses to accept those deficits, a result that emerges from the interaction of fully decentralized agents. Furthermore, the model indicates that promoting consumer credit can at best provide a very short-lived relief to this problem.

Keywords propensity to save · wealth accumulation · public debt · unequal distribution of income and wealth · consumer credit · household bankruptcy agent-based stock-flow consistent modeling

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1 Introduction

In 1943 Keynes suggested that once industrialised nations had been through the immediate phase of post-war reconstruction and had endured a protracted phase of steady economic growth (made possible by what we would now call Keynesian stabilization policies), they would enter a third phase, in which low unemployment rates would become increasingly difficult to achieve (Keynes, 1943). Behind this was his concern that once a certain level of prosperity was reached, attained levels of higher income would lead to higher saving rates, which might not be matched with sufficiently high demand for capital goods. Therefore, Keynes predicted that at some stage, desired saving would come to substantially exceed planned investment. A formalization of this problem was given by Harrod (1939), who argued that the warranted rate of growth (g_w) – the rate of growth necessary to satisfy producer expectations ex post – is given by

$$g_w = s/c$$

where s denotes total saving divided by output and c the value of capital necessary per unit of output. Thus, any development that increases s raises the warranted rate of growth, meaning that income would have to grow at a higher pace in order to create sufficient demand to satisfy producer expectations. If actual growth does not follow in the necessary direction – not an unlikely scenario given the rise in s – producers will not be able to sell all of their output, leading to a downward revision of production plans and rising unemployment.

While Keynes did not go into detail on why investment demand would not accommodate those higher saving rates, such explanations have subsequently been proposed by Hansen (1939) and Steindl (1952). While Hansen argued that an eventual decline in population growth would lead to stagnating investment demand, Steindl predicted that the rise of oligopolies at advanced stages of capitalist development would lead to rising profit margins, which would have a depressing impact on capacity utilization rates and therefore depress investment.[4] Only recently Summers (2014, 2015) revived this debate, arguing that the economy would be in a state of 'secular stagnation' due to chronically low investment and high saving. He points to low population growth (similar to Hansen) and the low cost of capital goods as reasons for sluggish investment demand. According to Summers, the legacy of the financial crisis and its impact on credit supply are part of the reasons for high saving rates. Another part of the explanation is the observed rising income inequality which goes along with a higher average propensity to save. As a remedy to stagnation, Summers argues in favor of higher government deficits. This last proposition is, in turn, quite in line with Keynes original vision, as he predicted that once this phase was reached, it would be accompanied by prolonged government deficits (Guger and Walterskirchen, 1988; Keynes, 1943).

In contrast to Keynes, who did not stress the issue of income inequality, Summers references it explicitly. This begs the following question, which represents the vantage point of the present study: What happens when income concentration rises in such a way, that a small part of the population can afford – and is willing to – save ever larger parts of their income? To address this question, and to isolate the influencing factors as much as possible, the present paper uses an agent based stock flow consistent (ABSFC) model without technological change, where firms use capital and labour for production. This allows us to demonstrate that if a small but wealthy part of the population ends up saving ever more of their income, it may indeed fail to raise the propensity to invest. The inevitable short term consequence would indeed be higher unemployment and higher government deficits. However, we also find that the long term consequence are indeed a bit more ambiguous: if the government decides to accept those higher fiscal deficits and not counter them with austerity policies, unemployment may eventually end up lower in the long run. The latter happens because the chronically high government deficits enable the accumulation of ever more financial wealth in the hands of the wealthy elite, which though slowly but steadily, raises the consumption of the rich. Rising consumption expenditures by the rich class may over time even guide the economy towards full employment. This process would even be sped up if the

[4] See on this also Guger and Walterskirchen (1988) and Backhouse and Boianovsky (2018).

government tried to actively fight against increasing unemployment rates. However, if governments refuse to accept those deficits and enact fiscal counter measures, the long run outcome will be similar to the short run. Finally, increasing households' access to consumer credit might also provide a short term remedy to growing unemployment, though likely being accompanied by adverse effects in the medium to long run.

The rest of this paper paper is structured as follows: Section 2 provides a literature overview, while section 3 describes the model that use for our analysis. In section 4 we present the simulation results, which are further discussed in section 5. The final section offers some concluding remarks.

2 Literature review

2.1 Related literature using non-agent-based models

In the wake of the Great Depression, numerous scholars have picked up the phenomenon of growing household debt in non-agent-based models, using either dynamic stochastic general equilibrium models (DSGE) or stock-flow consistent models (SFC). Apart from not being agent-based (using the concept of a representative household in the first case or using aggregate behavioral equations in the second), these approaches also differ in other aspects. In contrast to the DSGE literature, our model features endogenous credit money. This means that the banking sector does not need to accumulate additional funds prior to granting a new loan. Rather, these funds are – closer in line with reality[5] – the result of the credit provisioning process, which means that credit growth does not have to be preceded by increased saving behaviour. Furthermore, these models do not account for status consumption. The SFC models discussed below on the other do feature a financial sector with endogenous credit money as well as status consumption. However, both groups of models do not deal with longer term questions tied to the accumulation and distribution of financial wealth.

Kumhof *et al.* (2015) propose a DSGE model in which an increase in the income share of the top 5% of earners leads to an increase in the supply of consumer loans available to the lower 95% as richer households receive utility from holding financial assets created by this lending process. This gives rise to consumption booms and credit defaults. Another DSGE model is proposed by Midrigan and Philippon (2016). In their model, households are able to borrow against housing collateral. They show how exogenous drops in house prices can lead to economic downturns as it raises precautionary savings. Keynes (2006) and Iacoviello (2008) propose DSGE models in which household debt is the result of households attempts to smooth consumption in the face of idiosyncratic shocks to income.

Among the SFC models, the one that is closest to the model developed in this paper comes from Kapeller and Schütz (2014), who present a stock-flow consistent model that accounts for income inequality, relative consumption concerns and a Minskyan banking sector. They show how these features can give rise to economic cycles, in which an increase in inequality leads to an increase in credit demand. When at the same time the banking sector gradually relaxes lending criteria due to prolonged periods without household bankruptcies, credit supply increases as well, leading to a debt-financed consumption boom. This boom is followed by a recession once debt payments catch up on households and eventual bankruptcies lead to a sudden decline in credit supply and a financial crisis. Their simulations also show that once sufficient time elapses and banks start to reduce their lending criteria again, the previous developments can repeat themselves. Kapeller *et al.* (2018) adopt this framework and add a governmental sector. Thereby they show how various measures of government intervention (fiscal policy, bailouts, financial regulation) can influence the intensity of these cycles. Belabed *et al.* (2018) show in a 3-country SFC model how a rise in income at the top of the income distribution leads to debt-financed consumption booms due to emulation effects following expenditure cascades (Frank *et al.*, 2014).

[5] See on this e.g. Godley and Lavoie (2007) and Caiani *et al.* (2016)

2.2 Related literature using macroeconomic agent-based models

The central question dealt with in this paper concerns the relationship between income inequality, status consumption, saving behavior and the implication for the accumulation and distribution of financial wealth. Given the relevance of agent heterogeneity, behavior based on social norms and institutions, as well as macroeconomic stock-flow constraints, this topic lends itself rather naturally for an analysis via ABSFC modeling. Nevertheless, it has not been addressed explicitly in the existing literature, although a number of models are closely related to the present endeavor.

Dosi *et al.* (2013) introduce an agent-based model with Keynesian, Minskian and Schumpeterian elements. The model also explores the relationship between inequality, saving, investment and unemployment, yet it also differs from the present model in a number of important ways: First, Dosi *et al.* (2013) focus on the *functional* income distribution between wages and profits and show that unequal economies are less stable and show more unemployment. Below we focus on the personal as well as class-based income distribution. Second, a main concern of the authors is the short- and long-term effect of fiscal and monetary policy. Therefore, the model takes a more comprehensive view then the one introduced here since it also takes into account technological change and long-term growth. By contrast, our model represents a steady-state economy to focus more specifically on main question at hand and is not geared to replicate more general macroeconomic stylized facts as Dosi *et al.* (2013) do. Our focus on a steady state economy allows for a more nuanced depiction of the household sector, by considering status consumption, household saving and private debt, all factors that are not present in Dosi *et al.* (2013).

The ABSC of Caiani *et al.* (2019) features different worker classes with distinct consumption behavior and saving rates. The authors calibrate their model to empirical data on income and wealth inequality and show that progressive taxation leads to increasing lower wages and address inequality reduce unemployment and boost long-term growth. While the use of different worker classes and the consideration of different re-distributive policies is similar in our model, the main question of Caiani *et al.* (2019) concerns the implications for innovation and long-term growth. Both of these issues are beyond the scope of the model discussed below. At the same time, we model the household sector and consumption norms in much greater detail.

Russo *et al.* (2016) put the effects of consumer credit at the centre of their analysis: they find that household access to consumer credit leads to lower unemployment rates in initial periods, yet also to more fragility of the overall system and higher unemployment in consecutive periods when household debt reaches excessive levels. Similar to our model, they focus on short- and medium-term effects, yet they do not consider the effects of social norms such as conspicuous consumption and do not consider different classes.

Similar to our model, the households in Cardaci (2018) orient their desired consumption on the households just above them in the income distribution and study the implications of household debt. Their focus is, however, on the causes for financial crises in the United States, which is why, other than in the model considered below, the housing market, debt collateral and emerging credit networks play an essential role in their model. They point to the short run positive effects of household debt on output, but also the negative impact that emerges over the longer time horizon.

D'Orazio (2019) discusses an ABSFC model that concentrates on the impact of bank regulation in the presence of income inequality and household debt. She finds that higher inequality increases instability and leads to higher unemployment. In this model higher saving propensities also lead to higher unemployment. In contrast to the model discussed below, investment decisions do not play a role. At the same time, it uses a quite specific decision rule for determining household consumption and saving, originally proposed by D'Orazio and Giulioni (2017), yet which does not feature the Veblenian conspicuous consumption aspect that is central in the model discussed below.

This is different in Rengs and Scholz-Wäckerle (2018), who introduce a comprehensive ABSFC model that features a quite sophisticated consumption behavior. In this model, agents belong to endogenously evolving classes and determine their consumption under the influence of bandwagon, Veblen and snob effects. Rengs and Scholz-Wäckerle (2018) are mainly concerned with the co-evolutionary dynamics resulting from their Veblenian consumption patterns on the one,

and firm specialization decisions on the other hand. However, in contrast to Rengs and Scholz-Wäckerle (2018) we focus on the evolution of financial wealth and debt, as well as government policies.

3 Model

The model introduced in this section builds upon Kapeller and Schütz (2014) and extends the SFC modelling framework proposed there to an agent based setting. That is, the current model adapts both concepts of Veblenian conspicuous consumption (Veblen, 1899[1970]) and a Minskyan bank sector (see Minsky, 1986), which have been modelled by Kapeller and Schütz (2014) in an aggregate macroeconomic model, for agent based modelling. Thereby, it is meant to offer more detailed insights on the dynamics of secular stagnation in the presence of household debt and financial instability.

The model comprises (1) a firm class that is made up by 50 consumption good firms and a single investment good firm, (2) a worker class that consists of 4800 workers, half of which being, due to the assumed income inequality, high-income earners, the other half being low-income earners, (3) a class of 500 capitalists who own equal shares of the firm and banking sector, (4) an aggregate banking sector and (5) a government. They model is analyzed using Monte Carlo Simulations where the model is run 15 times, each model run containing 400 time-steps.

The order of events in each time-step is as follows:

1. Production planning: Firms compute their desired output, resulting labour-, credit- and investment demand based on their expectations
2. Wage setting: Firms decide on a wage to offer to each worker group on the labour market; simultaneously, workers adjust their reservation wage
3. Labour market: Workers and firms meet on the labour market where jobs, incomes and unemployment benefits are assigned
4. Price setting: Firms adjust their production plans according to the number of workers hired, actual production takes place and the price for each firm's product is set
5. Market for capital goods: Firms and the government realize their investment, thereby changing their capital stock and their ability to produce in the future
6. Bank profits and capitalist income are computed, as are taxes and government income
7. Consumption demand and private debt: Workers and capitalists compute their consumption demand (including status consumption) and their resulting demand for credit. Banks set their margin of safety and decide on whether to issue credit to respective households or not.
8. Market for consumption goods: Households buy consumption goods according to their demand and their financial constraint (i.e. acquired credit).
9. All individual accounts are updated and checked for consistency
10. Aggregate accounts are computed and checked for SFC

3.1 Firms' production planning

Sales expectations. Consumption good firms wish to sell as many goods as possible. Therefore, in the beginning of each period, all firms evaluate their market situation. In order to do so, each firm f computes their expectation error $e_{f,t}$ as the difference between their sales expectations $\hat{q}_{f,t-1}$ and actual sales $q^{sold}_{f,t-1}$ in the previous period[6]. This process is

[6]This can only be done, however, if the firm was able to produce as much as it expected to sell or, otherwise, if it sold less than produced. In case the firm's production does not meet its sales expectations but it sells its entire stock of goods, sales expectations will not be adjusted. In this case, an adjustment will take place as soon as the firm is able to increase its production.

similar as modelled by Caiani *et al.* (2016).

$$e_{f,t} = q^{sold}_{f,t-1} - \hat{q}_{f,t-1} \tag{1}$$

Their sales expectations are, then, adjusted by this error by a parameter α that controls the adjustment speed.

$$\hat{q}_{f,t} = q^{sold}_{f,t-1} + \alpha e_{t,f} \tag{2}$$

That is, if the firm sold more than expected, it will increase its sales expectations. Otherwise, sales expectations will be decreased. The desired production $q^*_{f,t}$ of firm f, then, is simply computed by adding an inventory buffer β^q to the sales expectations and subtracting current inventories $q^{inv}_{f,t}$.

$$q^*_{f,t} = (1 + \beta^q)\hat{q}_{f,t} - q^{inv}_{f,t} \tag{3}$$

Capital good firms. The capital good firm is assumed to have more information about the investment demand. In order to absorb any production boom and be able to always provide sufficient capital goods, capital firms are, in the beginning of each model run, endowed with an inventory. In each period, the capital good firm will produce as much as necessary to re-attain that inventory level. In other words, it will produce as much as has been sold in the previous period. This is similar to assuming a pre-ordering system as is done in Caiani *et al.* (2016). Their desired production is therefore set to maintain a desired stock of goods Q^*.

$$q^*_{f,t} = Q^* - q^{inv}_{f,t} \tag{4}$$

Labour demand. After computing the firm's desired output, labour demand $L^D_{f,t}$ of firm f can be computed as follows:

$$L^D_{f,t} = \frac{q^*_{f,t}}{A^L} \tag{5}$$

where A^L is the productivity of labour, which is assumed to be the same for all workers. Note that the model only features full-time jobs. Therefore, each firm's labour demand will be rounded down to its integer value.

Following a Leontief production function, firms require both *high wage* and *low wage* workers to an extent of an exogenously given labour demand ratio, λ. Note that the present model does not feature any technical change – the composition of labour necessary for production, therefore, remains constant throughout time. Labour demand for both groups can then be computed as:

$$L^{D,low}_{f,t} = \lambda L^D_{f,t} \tag{6}$$

$$L^{D,high}_{f,t} = (1 - \lambda) L^D_{f,t} \tag{7}$$

Note that the model only features full-time workers, where each firm prefers to hire one worker too little than one too many. If it is not clear whether a high-wage or a low-wage worker should be employed, the firm chooses randomly.

Investment demand. All firms, regardless of whether they produce consumption or capital goods, wish to keep their capital stock sufficiently large in order to keep up current desired production plus some capital buffer β^K. Therefore, investment demand $I^D_{f,t}$ of firm f is computed as follows:

$$I^D_{f,t} = \frac{(1 + \beta^K)q^*_{f,t}}{A^K} - (1 - \delta)K_{f,t}, \tag{8}$$

where δ denotes the depreciation rate of capital and A^K is capital productivity. That is, investment demand of each firm is determined by the difference of capital necessary to produce current desired production plus some buffer and the available capital in the next period.

3.2 Wage setting

Firms' offered wage. In every period, each firm decides whether to change its offered wage. Firms will increase the wage they offer to workers by the revision factor ϕ_F if either (a) the currently offered wage was lower than the lowest of the workers' reservation wages – in this case, the firm is forced to raise its wages if it is to employ any workers – or if (b) employment is relatively high, i.e. exceeds some critical value ϵ^{high}. Note however, that due to the growth constraint on the model economy in the absence of technical change, firms will stop to further increase wages if there is full employment. Firms will decrease their offered wages if employment does not meet the ϵ^{high} threshold by the revision factor ϕ_F.

The wage offered to low-income-workers is determined as a share of the wage offered to high-income-workers. In a last step, wages are adjusted to inflation.

Workers' reservation wage. Workers adjust their reservation wage once a year, i.e. once in four periods. Each worker will increase their reservation wage by factor $\phi_{w,t}$, i.e. the lowest wage that they are willing to work for, if they have been employed for all of the past four periods. They will decrease their reservation wage by factor $\phi_{w,t}$ if (a) their current reservation wage was higher than the highest wage offered in the last period – assuming that workers would rather settle for a wage that is a little lower than they would prefer than be unemployed. Or if (b) they were unemployed for two or more of the last four periods.

$$\phi_{w,t} = U[0.01, 0.04] \tag{9}$$

Note, however, that reservation wages cannot fall beneath what would be necessary for subsistence consumption and a given tax rate.

3.3 Labour market

After each firm's offered wages and offered positions and each worker's reservation wage have been determined, workers and firms meet in the labour market. Each worker applies for jobs in each period. However, workers who have been already employed in the previous period, will be able to enter the labour market earlier than those who have been unemployed. That is, only if the overall labour demand is extended, unemployed workers will be able to get a job and if overall labour demand is reduced, previously employed workers will join the unemployed. In order to implement this idea, workers are split in two groups – the previously employed and the previously unemployed. First, the group of previously employed workers enters the labour market in a random order. Each worker checks if there are positions available to them[7] that offer a wage that exceeds their reservations wage. If that is the case, the worker will take the highest paying job on the market. That is, if firms cannot fill all their job offerings, this will be due to insufficient wages. Workers are, if employed, paid the wage offered by the firm. Else, if they did not find a job, they receive an unemployment benefit from the government that is equal to inflation adjusted subsistence consumption s.

[7] Note that type-1-workers cannot apply for type-2 positions and vice-versa – regardless of their employment status.

3.4 Price setting

After jobs are assigned, firms compute their actual production $q_{f,t}^{realized}$ as the minimum of desired and possible production $q_{f,t}^{P}$, given the current labour supply.

$$q_{f,t}^{realized} = min(q_{f,t}^{*}, q_{f,t}^{P}) \tag{10}$$

$$q_{f,t}^{P} = min(L_{f,t}^{S} * A^{L}, K_{f,t} * A^{K}) \tag{11}$$

Prices are set as a mark-up $\mu_{f,t}$ over labour costs per unit of production. The latter will be increased or decreased in each period, depending on the size of the expectation error $e_{f,t}$, the average price $\bar{p}_t$ and whether there is full employment Ω and excess demand for consumption goods Q^{D+}. The mark-up will be increased either if the expectation error (positively) exceeds some critical error θ and the firm's price in the last period $p_{f,t-1}$ was lower than the average on the market $\bar{p}_{t-1}$ or if there is full employment and excess demand. This latter condition is to ensure that in a full-employment scenario (which, due to the absence of technical change will in our model necessarily be associated with stationary production), prices will only be increased if there is excess demand – otherwise, the full employment scenario might lead to an inflationary spiral. The mark-up will, on the other hand, be decreased if there is a large negative error that exceeds the threshold $-\theta$ and the firm's price in the last period $p_{f,t-1}$ was higher than the average on the market $\bar{p}_{t-1}$.

$$p_{f,t} = (1 + \mu_{f,t}) \frac{(L_{f,t}^{S,high} w_{f,t}^{high} + L_{f,t}^{S,low} w_{f,t}^{low})}{q_{f,t}^{realized}} \tag{12}$$

$$\mu_{f,t} = \begin{cases} (1 + \delta^{\mu})\mu_{f,t-1} & \text{if } (\Omega \wedge Q^{D+}) \vee (e_{f,t} > \theta \wedge p_{f,t-1} < \bar{p}_{t-1}) \\ (1 - \delta^{\mu})\mu_{f,t-1} & \text{if } e_{f,t} < -\theta \wedge p_{f,t-1} > \bar{p}_{t-1} \wedge \neg(Q^{D+} \wedge \Omega) \\ \mu_{f,t-1} & \text{otherwise} \end{cases} \tag{13}$$

3.5 Market for capital goods

In each period, firms enter the market for capital goods in a random order. Here, they buy as many capital goods they need or can afford, respectively – as long as there is sufficient supply. After private investment by firms has taken place, the government buys a fixed sum of capital goods. Each firm's new capital stock can now be computed as

$$K_{f,t+1} = I_{f,t}^{realized} + (1 - \delta)K_{f,t}, \tag{14}$$

where $I_{f,t}^{realized}$ denotes the actual amount of capital product purchased by firm f in period t. Note that, for now, the model does not feature any technical change or process innovation. Capital productivity is, therefore, constant throughout all periods and for all capital goods.

3.6 Bank profits, capitalist and government income

Bank profits. The bank's profits can be computed as the sum of interest received on loans i_t^l and paid on deposits i_t^a for each agent x as well as insolvency payments $t_t^{insolvency}$ and debt cancellation t_t^{cancel}.

$$\Pi_{b,t} = (1 - \tau_b)(-i_t^a + i_t^l - t_t^{cancel} + t_t^{insolvency}) \tag{15}$$

$$i_t^a = \sum_{x=1}^{n_x} i_{x,t}^a \tag{16}$$

$$i_t^d = \sum_{x=1}^{n_x} i_{x,t}^d \tag{17}$$

Since the bank is assumed to be owned by all capitalists to equal shares, the bank will distribute its profits equally:

$$\Pi_{b,t}^{dist} = \begin{cases} \Pi_{b,t} & \text{if } \Pi_{b,t} > 0 \\ 0 & \text{else} \end{cases} \tag{18}$$

Capitalist income Capitalists are assumed to hold equal shares of all firms and the bank. Their respective income $y_{c,t}$, therefore, consists of an equal share of distributed firm and bank profits $\Pi_{f,t-1}^{dist}$ and $\Pi_{b,t}^{dist}$, respecively, they receive interest on deposits $i_{c,t}^{a}$ and pay interest on loans $i_{c,t}^{l}$ and installments on eventual loans $pb_{c,t}$. The latter are computed as a share ζ of current loans $M_{c,t}^{l}$ of capitalist c. Note that firm profits are taken from the previous period because this period's profits have not been realized yet.

$$y_{c,t} = \Pi_{b,t}^{dist} + \Pi_{f,t-1}^{dist} + i_{c,t}^{a} - i_{c,t}^{l} + pb_{c,t} \tag{19}$$

$$pb_{c,t} = \zeta M_{c,t}^{l} \tag{20}$$

Government income In each period, the government receives taxes from worker incomes, capitalist incomes and firm profits. However, since the government pays an unemployment benefit to all unemployed workers and spends a fixed sum on public investment, public deficit becomes possible. This deficit will be financed by the banking sector which – in turn – receives interest payments.

3.7 Consumption demand and private debt

Workers' consumption behaviour A main feature of the current model is the worker's consumption function that includes a conspicuous consumption component. Following the concept of conspicuous consumption as introduced by Thorstein Veblen (1899[1970]), workers are assumed to orient their consumption demand – to some extent ρ – on the consumption of others. Namely, in a desire to express higher social status, each worker desires to copy the average consumption of the decile of workers who have consumed just more than themselves in the past period $C_{w,t-1}^{higher}$. Consumption demand $C_{w,t}^{D}$ of each worker w is, then, computed as

$$C_{w,t}^{D} = \rho C_{w,t-1}^{higher} + (1-\rho)(s_t + m_w^{income}(y_{w,t} - s_t) + max(0, m_w^{wealth} \cdot M_{w,t}^{a}) \tag{21}$$

where s_t denotes subsistence consumption, m_w^{income} and m_w^{wealth} denote marginal propensity to consume out of income and wealth of workers, respectively, $y_{w,t}$ is the income of worker w and $M_{w,t}^{a}$ are the assets of worker w. Note that consumption demand is computed as a nominal value. That is, rather than orienting their consumption on the real products purchased by others, workers imitate the amount spent by others. Subsistence consumption, however is inflation-adjusted and can therefore be interpreted as the real amount of products needed in order to survive and maintain some minimum amount of social dignity.

Credit worthiness. Given the inequality in worker incomes and the desire for conspicuous consumption, it is possible that workers' consumption demand cannot be fully satisfied with their own financial means. In this case, the respective worker will apply for a consumption credit, which, in turn, will be issued by the banking sector if the worker is considered to be credit worthy. Following the work of Minsky (1986) we assume that the banking system considers a household credit worthy if its income exceeds a margin of safety $marg_{b,t}$. Following the work of Minsky (1986), we treat this margin as endogenous: Periods of relative stability cause the margin to decline, as it makes bankers grow more confident and more likely to discard the potential risk of credit default. On the other hand, once bankruptcies eventually do start to occur, they are quick to revise the very same margin upwards, potentially leading to a substantial

restriction of credit. Additionally, we assume that the banking sector's balance sheet exposure to household debt also influences these risk perceptions and therefore the margin of safety. Formally we incorporate this as follows:

$$marg_{b,t} = \sigma \cdot marg_{b,t-1} + \eta \cdot n_{t-1}^{bankrupt} + \nu \cdot \Delta L_t \tag{22}$$

Where $\sigma \in (-1, 0)$ denotes the perceived stability parameter that causes the margin of safety to slowly decline, whereas η, the distress parameter causes the margin to quickly increase with the number of new bankruptcies in the past period $n_{t-1}^{bankrupt}$. L_t denotes the leverage ratio of workers, that is the total amount of household loans relative to bank equity an increase in the L_t leads to rising margins as the exposure of the banking sector to household credit grows.

Each worker's income must exceed the margin of safety in order to be rated creditworthy. If they do not fulfill that condition and cannot repay outstanding loans, they will be filed bankrupt. As long as they are considered to be credit worthy, each worker will be granted as much credit as desired.

Insolvency. A worker who can neither afford their debt payments nor apply for further credit is considered to be bankrupt. In this case, they will go through a phase of insolvency. That is, for the next five years (i.e. 20 periods) after their bankruptcy occurred, the worker concerned will be obligated to return their entire income that exceeds their subsistence consumption to the banking sector and they cannot take on further credit. In return, the banking sector will cancel their debt after those five years of insolvency.[8]

Capitalist consumption Note that for simplicity we assume that only worker households are affected by conspicuous consumption and that individual capitalist consumption can simply be computed as

$$C_{c,t}^{D} = a_t + m_c^{income}(y_{c,t} - a_t) + max(0, m_c^{wealth} \cdot M_{c,t}^{a}) \tag{23}$$

where a_t denotes autonomous consumption of capitalists.

3.8 Market for consumption goods.

In each period, worker and capitalist households enter the market for consumption goods in order to satisfy their respective consumption demand. Workers get to enter the market before capitalists. This is to ensure that in case of supply shortage (i.e. firms underestimating actual demand) the entire subsistence consumption can be met.

Ranking Parameter. Each household ranks the consumption good firms depending on their offered price as well as their geographical distance. Similar to Caiani *et al.* (2018), in order to add a distance dimension, each household and each consumption good firm is positioned on a circle, where all members of the same agent-class x are positioned equidistantly on a 360 degree circle. Their position remains the same throughout all periods.

$$interval_x = \frac{360}{n_x} \tag{24}$$

$$positions_x = [\frac{interval_x}{2}, \frac{interval_x}{2} + interval_x, \frac{interval_x}{2} + 2 \cdot interval_x, ..., \frac{interval_x}{2} + n \cdot interval_x] \tag{25}$$

The distance between a household and a firm can then be computed as the shortest distance on the 360 degree circle.

$$d_{h,f} = min(abs(pos_f - pos_h), 360 - abs(pos_f - pos_h)) \tag{26}$$

Firms are then ranked according to a ranking parameter that weights distance and price via the parameter η . The ranking parameter will increase with low distance and low price. Therefore, the firm with the highest ranking parameter

[8] This corresponds to proceedings prescribed by the Austrian bankruptcy law.

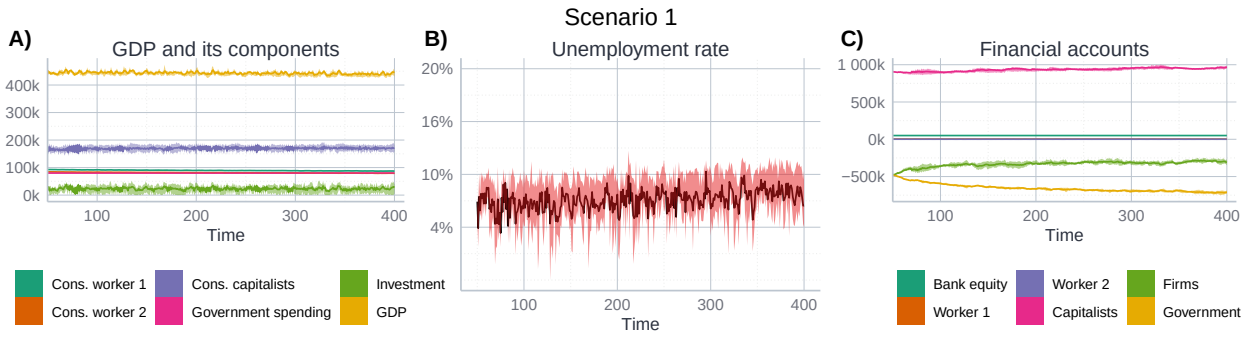

Figure 1: Model dynamics for scenario 1. The bold line represents the mean, the shaded area the inter-quartile range of the 15 simulation runs.

will be the highest on the respective household's preference list.

$$ranking_p aram = \frac{\bar{p_t}}{\eta \cdot d_{h,f} + (1-\eta)p_{f,t}} \tag{27}$$

The household will try to satisfy their entire demand with their highest ranked firm. If the firm does not have enough goods left, the household will turn to the next-highest ranked firm.

3.9 Update accounts and check for SFC

Agent accounts are updated as soon as a transaction takes place. In the end of each period however, it is checked if the following condition holds, i.e. whether each single account is stock-flow consistent:

$$\Delta(M_x^A - M_x^L) = T_{x,t} \tag{28}$$

where T is the sum of transactions of agent x. All transactions for each respective agent are listed in Table 3.

After the consistency of all single accounts has been checked, we check whether all aggregate flows and all aggregate accounts add up to zero, as shown in Table 3 in the appendix.

4 Simulation results

4.1 Scenario 1: Baseline

Figure 1 shows our baseline scenario in which we assume that households do not have access to loans (an assumption that is lifted in scenario 5). After a brief 25 period burn-in phase (not reported in the figure), GDP and its components converge on a very stable stationary path, the stationarity being due to the assumed absence of technological progress. Unemployment also stabilizes, eventually fluctuating around the 7.5% level. The net financial wealth of the various groups follow minor trends: a downards tendency in public debt finds its mirror image in slightly upward trending net financial wealth positions of capitalists and firms.

4.2 Scenario 2: Higher saving rates

In our next scenario, we assume that capitalist consumption out of wealth is slightly lower (declining from 5% to 1%). In this case, we see an immediate rise in unemployment and a decline in GDP (figure 2). This development dramatically adds to the trend of rising government debt, as rising unemployment benefit payments and lower tax revenues take their toll on government finances. However, after some time, we see a reverse in output and unemployment: As the financial wealth of capitalists accumulates (since, eventually, unemployment benefits and interest payments by the government

Figure 2: Model dynamics for scenario 2. The bold line represents the mean, the shaded area the inter-quartile range of the 15 simulation runs for scenario 2. The dashed lines refer to scenario 1 (see also Figure 1).

Figure 3: Model dynamics for scenario 3. The bold line represents the mean, the shaded area the inter-quartile range of the 15 simulation runs for scenario 3. The dashed lines refer to scenario 2 (see also Figure 2).

end up as profits on their accounts), their consumption starts to increase over time, taking an ever larger share of total consumption. These growing consumption expenditures drag the economy out of the slump, taking it on a path towards full employment.

4.3 Scenario 3: Counter-cyclical fiscal spending

In the previous scenario, the government took on a passive role by simply accepting a higher deficit, but not actively taking any measures against growing unemployment in the short run. Changing that, we assume that the government raises government expenditure by a fixed amount. As expected, this dampens the rise in unemployment. Furthermore, it also speeds up the accumulation of capitalist wealth in the long run, as government spending contributes to firm profits, government debt payments bolster the profits of the banking sector and both eventually end up on the deposits of capitalist households. Thereby, these developments speed up the transition towards full employment at the price of higher government debt and a more unequal distribution of financial wealth.

4.4 Scenario 4: Raising taxes

While the previous scenarios assumed that the government took on a very lenient stance against growing fiscal deficits, this scenario simulates a fiscal reaction in the form of a tax increase. More precisely, we assume that it raises the (initially lower) tax on wage income up to the level of the tax on capitalist income. The result is a much larger increase in unemployment in the short run as well as permanently higher unemployment in the long run. Furthermore, though the tax burden is levied on workers (which is in line with actual political developments across OECD countries, see Egger *et al.*, 2019), it also hampers the accumulation of wealth by the capitalist class.

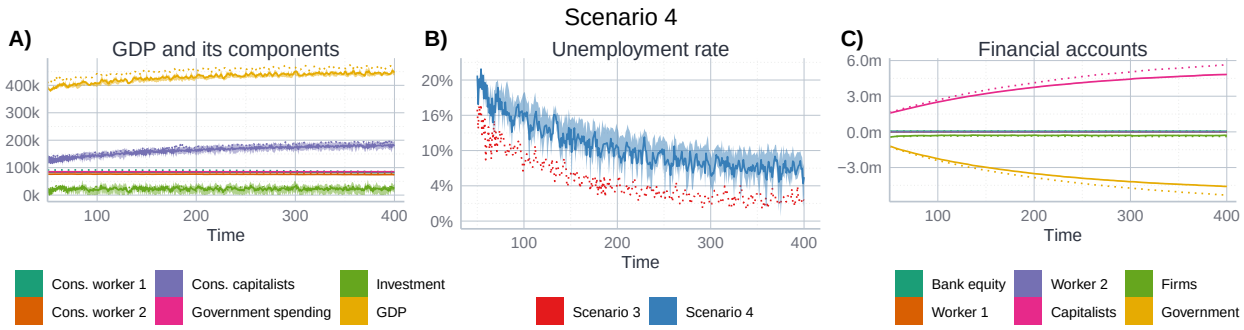

Figure 4: Model dynamics for scenario 4. The bold line represents the mean, the shaded area the inter-quartile range of the 15 simulation runs for scenario 4. The dashed lines refer to scenario 3 (see also Figure 3).

4.5 Scenario 5: Liberation of consumer credit

In a final move, we will take a look at a development that only recently took center stage in the run-up to the Great Recession: household credit. In particular, we assume that the banking sector is willing to provide credit to households as long as they are deemed credit worthy. This assesment takes place in the Minskyan way presented in the model section. This new development is followed by a decline in net financial wealth, especially of type 2 workers, but also of type 1 workers as worker households are now able to take up loans in order to keep up with those slightly above them. As a result, consumption is slightly higher compared to the previous scenario, transmitting into slightly higher GDP and a lower unemployment rate. However, the effect is rather short-lived, since, once household credit starts expanding, the banking sector's margin of safety is rising too, eventually denying access to credit for an increasing number of households and resulting in growing household bankruptcies. With many worker households indebted, their total consumption actually falls short of the level observed in the previous scenario once the first phase is over. Figure 6 shows that due to their level of debt average income of type 2 workers is actually lower than in the previous scenario. In this second phase of a post consumption boom world, unemployment seems to be, if anything, even slightly above the levels observed in the previous scenario without consumer credit. Furthermore, we see how the rise in household debt provides a slight boost to the capitalist wealth accumulation, as consumption expenditures ultimately end up in their accounts.

These bankruptcies in the household sector lead to a continued deterioration of bank equity over time. As far as the model goes, the decline in equity has the consequence of reducing households' access to credit, since it raises the banking sector's leverage ratio, which increases the margin of safety. However, apart from that, we abstained from making further assumptions about the consequences of these losses, i.e. about who has to shoulder that burden. We did so because one could imagine two different scenarios, where one could make a convincing case for either of them. In the first one, capitalists (being the owners of said banks) would have to ultimately balance these losses with their own wealth, leading to a transfer of wealth from the private deposits of capitalists to the banking sector's equity account. While this scenario is straight forward, experience from past financial crises induces one to think of a different scenario, namely the government stepping forward to come up for these losses. This way, we could think of the equity losses as a further addition to government debt. So while the first scenario would provide a minor blow to capitalist wealth accumulation, the latter would further exacerbate the growing gulf between the wealth of the very rich and the rest of society. Since both seem plausible, we decided to leave this question open for the time being.

5 Conclusion

In this paper, we started out with John Maynard Keynes' claim that once western societies would reach a certain level of economic development, saving rates would have increased to an extent that they won't be matched by rates of

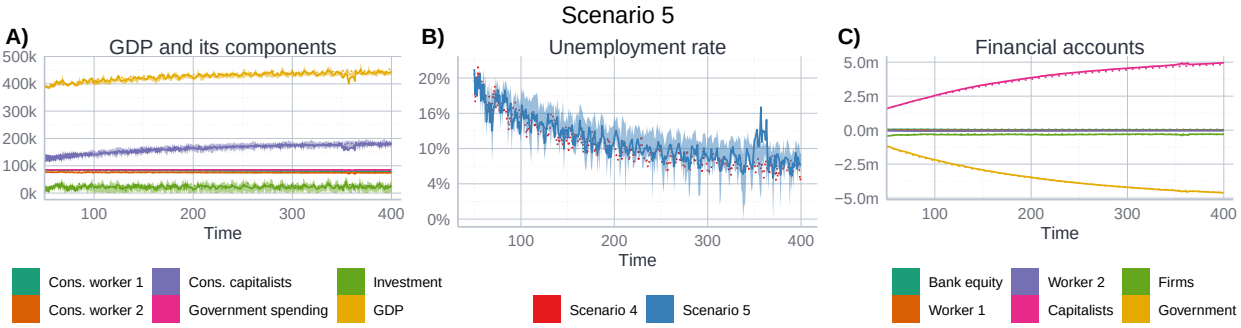

Figure 5: Model dynamics for scenario 5. The bold line represents the mean, the shaded area the inter-quartile range of the 15 simulation runs for scenario 5. The dashed lines refer to scenario 4 (see also Figure 4).

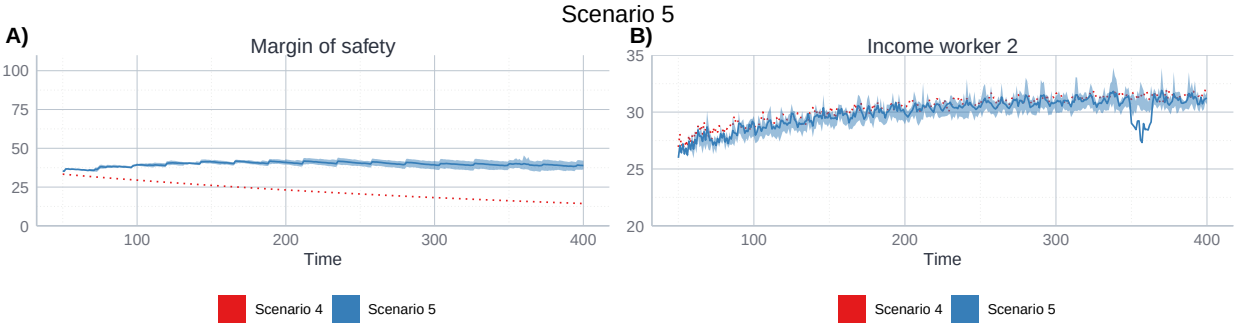

Figure 6: Model dynamics for scenario 5. The bold line represents the mean, the shaded area the inter-quartile range of the 15 simulation runs for scenario 5. The dashed lines refer to scenario 4 (see also Figure 4).

capital accumulation (Keynes, 1943). At that point, societies would either have to accept consistently high rates of unemployment or chronic government deficits. Going one step further, we combined this notion with the stark increase in the concentration of income and wealth taking place over the last decades, arguing that we might indeed witness those increasing saving rates, as income concentrates with a small subgroup of society, whose material abundance allows its members to save ever larger portions of that income, thus taking society closer to the state imagined by John Maynard Keynes.

Trying to validate this claim, we developed an agent-based stock-flow consistent model that takes into account income inequality between different groups of agents, where we mimic the stylized fact that members of the high income group tend to have much higher saving rates. Moreover, we assumed that status consumption plays an important role, meaning that households tend to aspire to the consumption level of those perceived slightly above them. What we find is that, indeed, a rise in the saving rate of the the rich leads to a rise in unemployment and growing government deficits (due to rising unemployment benefits and a fall in tax revenues) in the short run. However, what we also observe is that if the government accepts these deficits (i.e. does not try to balance the books through tax increases or spending cuts), the economy might, in the long term, converge on a path towards full employment. The reason for this long run outcome is that government deficits favor the accumulation of wealth of the very rich (either through unemploymemt benefits spent by unemployed households ending up as firm profits or government interest payments boosting financial sector profits). As income and wealth of the rich grow, so does their consumption. Eventually, the consumption of the rich starts to rise above its initial level despite their higher saving rate. The result is an economy in which more and more consumption activity falls on the rich, with the government keeping the system alive with accumulating more and more debt.

This scenario can become even more extreme when the government tries to react to the rise in unemployment in the short run by immediately raising government expenditures. In our experiments, this step would not only dampen the

rise in unemployment in the short run, but would also accelerate the long run convergence towards full employment, of course at the price of even faster accumulation of government debt. On the other hand, if the government was concerned about the deficit and, therefore, did make attempts towards balancing its books by raising taxes, unemployment would be consistently higher.

Finally, we also took a look at how the liberation of household credit could compensate for the initial rise in the saving rate triggered by the very rich. It turns out that households taking loans to 'keep up with the Joneses' only provides a very limited remedy, as its effect is not very large and can only be sustained for a short time, as debt quickly accumulates, leading to lower household consumption and less access to credit afterwards.

This leaves us with the conclusion that Keynes might indeed have been right in arguing that, as societes grow richer, they might have to choose between consistently high unemployment or chronic government deficits. However, due to the limitation of our analysis this can only be a preliminary conclusion. First, Keynes himself pointed out two solutions to this problem: income redistribution and reduction of working hours. While he was of the opinion that the first one is only a temporary solution due to the limits to which this can be done, he referred to the second one – shorter working hours – as the only potent solution. Though the introduction of such a policy is outside of the scope of the present analysis, it surely presents a very promising avenue for future research. Another limitation of our analysis is the assumed absence of technological progress. Here it would be interesting to see in future research how different assumptions about the evolution of technological progress would modify these results.

Acknowledgements

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Appendix

All variables used throughout the model are listed in Table 1. Table 2 and 3 contain all stocks and flows.

A	A^L	Labour productivity
	A^K	Capital productivity
C	$C^{higher}_{w,t-1}$	Average consumption of the 10% of workers who earn just more than worker w in period $t-1$
	$C^D_{w,t}$	Consumption demand of worker w in period t
D	D^{cancel}_t	Debt cancellation by the banking sector in period t
	$d_{h,f}$	Distance between household h and firm f
E	$e_{f,t}$	Expectation error of firm f in period t
L	$L^D_{f,t}$	Labour demand of firm f in period t
	$L^{D,low}_{f,t}$	Demand for low-income labour of firm f in period t
	$L^{D,high}_{f,t}$	Demand for high-income labour of firm f in period t
	$L^S_{f,t}$	Labour supply of firm f in period t
	$L^{S,low}_{f,t}$	Supply of low wage workers of firm f in period t
	$L^{S,high}_{f,t}$	Supply of high wage workers of firm f in period t
I	$I^D_{f,t}$	Investment demand of firm f in period t
	$I^{realized}_{f,t}$	Realized investment of firm f in period t
	i^a_t	Amount of interest paid by the banking sector to holders of bank deposits in period t
	i^l_t	Amount of interest paid by debtors to the banking sector in period t
	$i_{x,t}$	Amount of interest paid to the banking sector or received from the banking sector by actor x in period t
K	$K_{f,t}$	Capital stock of firm f in period t
L	L_t	Leverage ratio of workers in period t
M	$M^l_{x,t}$	Loans of agent x in period t
	$M^a_{x,t}$	Assets of agent x in period t
	m^{income}_w	Workers' marginal propensity to consume out of income
	m^{wealth}_w	Workers' marginal propensity to consume out of wealth
	m^{income}_c	Capitalists' marginal propensity to consume out of income
	m^{wealth}_c	Capitalists' marginal propensity to consume out of wealth
P	$p_{f,t}$	Price of firm f in period t
	$\bar{p}_t$	Average price for consumption or capital goods, respectively, in period t
	$pb_{x,t}$	Amount of credit dingsdangs to the banking sector by agent x in period t
	pos_f	Position of firm f
	pos_h	Position of household h
Q	$\hat{q}_{f,t}$	Expected sales of firm f in period t
	$q^{sold}_{f,t}$	Number of good sold by firm f in period t
	$q^*_{f,t}$	Desired production of firm f in period t
	$q^{inv}_{f,t}$	Inventory of firm f in period t
	$q^{realized}_{f,t}$	Actual production of firm f in period t
	$q^P_{f,t}$	Possible production of firm f in period t
	Q^*	Desired stock of goods of the capital firm
	Q^{D+}	Existence of excess demand
S	s_t	Subsistence consumption in period t
T	t^{cancel}_t	Cancellation transaction from the banking sector to insolvent households
	$t^{insolvency}_t$	Insolvency transaction from insolvent households to the banking sector
	$T_{x,t}$	Total transactions of agent x in period t
W	$w^{low}_{f,t}$	Wage offered to low-income workers by firm f in period t
	$w^{high}_{f,t}$	Wage offered to high-income workers by firm f in period t
Y	$y_{w,t}$	Income of worker w in period t
A	α	Adjustment to expectation error $e_{f,t}$
B	β^q	Inventory buffer parameter
	β^K	Capital buffer parameter
Δ	δ	Depreciation rate of capital
	δ^μ	Change in mark-up value
E	ϵ^{high}	Critical value for high employment
Z	ζ	Installment rate
H	η	Weight on distance parameter
Θ	θ	Critical error threshold
Λ	λ	Share of low-income workers
M	$\mu_{f,t}$	Price mark-up of firm f in period t
N	ν	Influence of the change in the leverage ratio on the margin of safety
Π	$\Pi_{b,t}$	Banking sector profit in period t
	$\Pi^{dist}_{b,t}$	Profit distributed from the banking sector to capitalists in period t
	$\Pi^{dist}_{f,t}$	Profit distributed from firm to capitalists in period t
R	ρ	Conspicuous consumption parameter
T	τ_b	Tax rate on banking sector profits
Φ	ϕ_F	Wage revision factor of firms
	$\phi_{w,t}$	Reservation wage revision factor of worker w in period t
Ω	Ω	Quasi full employment parameter

Table 1: All variables and parameters

Table 2: Stock matrix

	Households			**Firms**	**Government**	**Banks**	$\sum$
	Worker 1	Worker 2	Capitalists				
Money deposits	$+M_{high}$	$+M_{low}$	$+M_c$	$+M_f$	M_G	$-M$	0
Capital				$+K_f$	$+K_g$		K
Balance (net-worth)	$-V_{high}$	$-V_{low}$	$-V_c$	$-V_f$	$-V_g$	$-V_b$	$-K$
$\sum$	0	0	0	0	0	0	0

Note that $M = M_{high} + M_{low} + M_c + M_f + M_G$ and $K = K_f + K_g$. Subtracting net worth assures that columns and rows add up to zero. The only row not adding up to zero relates to the capital stock, which is the only stock that is only an asset and not a liability at the same time. See Godley and Lavoie (2007) for further details.

Table 3: Flow matrix

	Households			**Firms**		**Government**		**Banks**		$\sum$
	Worker high	Worker low	Capitalists	Current	Capital	Current	Capital	Current	Capital	
Consumption	$-C_{high,t}$	$-C_{low,t}$	$-C_{c,t}$	$+C_t$						0
Private investment				$+I_t$	$-I_t$					0
Gov. investment				$+G_t$		$-G_t$				0
[Production]				Y_t						
Wages	$+W_{high,t}$	$+W_{low,t}$		$-W_{high,t}$ $-W_{low,t}$						0
Taxes	$-T_{high,t}$	$-T_{low,t}$	$-T_c$	$-T_f$		$+T_{high,t}$ $+T_{low,t}$ $+T_c$ $+T_f$				0
Unempl. Benefits	$+u_t \cdot U_{high,t}$	$+u_t \cdot U_{low,t}$				$-u_t \cdot U_{high,t}$ $-u_t \cdot U_{low,t}$				0
Interest	$+r \cdot M_{high,t-1}$	$+r \cdot M_{low,t-1}$	$+r \cdot M_{c,t-1}$	$+r \cdot M_{f,t-1}$		$+r \cdot M_{g,t-1}$		$-r \cdot M_{high,t-1}$ $-r \cdot M_{low,t-1}$ $-r \cdot M_{c,t-1}$ $-r \cdot M_{f,t-1}$ $-r \cdot M_{g,t-1}$		0
Repayment	$+\phi \cdot M_{high,t-1}$ $-\phi \cdot M_{high,t-1}$	$+\phi \cdot M_{low,t-1}$ $-\phi \cdot M_{low,t-1}$	$+\phi \cdot M_c(t-1)$ $-\phi \cdot M_c(t-1)$	$+\phi \cdot M_f(t-1)$ $-\phi \cdot M_f(t-1)$		$+\phi \cdot M_g(t-1)$ $-\phi \cdot M_g(t-1)$				0
Insolv. Payments	$-\Omega_{high,t-1}$	$-\Omega_{low,t-1}$						$+\Omega_{high,t-1}$ $+\Omega_{low,t-1}$		0
Debt Cancellation	$+\Phi_{high,t-1}$	$+\Phi_{low,t-1}$						$-\Phi_{high,t-1}$ $-\Phi_{low,t-1}$		0
Profits			$+\pi_f \Pi_{f,t} + \pi_b \Pi_{b,t}$	-$\Pi_{f,t}$	$+(1-\pi_f)\,\Pi_{f,t}$			-$\Pi_{b,t}$	$+(1-\pi_b)\,\Pi_{b,t}$	0
Δ Deposits	$-\Delta M_{high,t}$	$-\Delta M_{low,t}$	$-\Delta M_{c,t}$		$-\Delta M_{f,t}$		$-\Delta M_{g,t}$		$+\Delta M_t$	0
$\sum$	0	0	0	0	0	0	0	0	0	0

The superscripts d and s denote demand and supply. Note that $C = C_{high} + C_{low} + C_c$ and $M = M_{high} + M_{low} + M_c + M_f$ that for the respective sector $r = r_D$ if its money balance is positive and $r = r_L$ otherwise. Note further that for the respective sector $\phi = 0$ if its money balance is positive and that repayment of debt is done out of current income (and enters with a positive sign since money deposits are negative for indebted households) and is canceled out in the same column since repayments go directly into the respective deposits. Note finally that all rows and columns add up to zero, assuring the model's stock-flow consistency. See Godley and Lavoie (2007) for further details.