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The emergence of debt and secular stagnation in an unequal society: A stock-flow consistent agent-based approach

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The emergence of debt and secular stagnation in an unequal society: A stock-flow consistent agent-based approach*

Working Paper

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February 3, 2022

Abstract

We use an agent-based stock-flow consistent model of a closed economy without technological change that considers different classes of households, status consumption and a Minskyan banking sector to analyze 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. The result emerges endogenously from the interaction of fully decentralized agents. 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 John Maynard Keynes suggested that once industrialized 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 exceed planned investment substantially. 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

$$g_w = s/c$$

Here, s denotes total saving divided by output and c the capital output ratio. 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. This, however, is anything but certain since while a rise in s leads to an increase of g_w, it is not unlikely to come with a decrease in the *actual* growth rate g due to a relative reduction of consumption activities. If this indeed leads to actual growth not following the warranted growth rate to a sufficient degree, 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.[5]

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 a similar vein, Mian *et al.* (2021) recently argued that the rising income inequality has put the economy into a state of 'indebted demand', with the saving rate of lenders (the rich) exceeding the saving rate of borrowers (the non-rich).

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 introduces an agent-based stock-flow consistent (ABSFC) model without technological change, where firms use capital and labor 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.

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

However, we find that the long term consequence are more ambiguous than one would have expected: if the government decides to accept these 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 be sped up further if the government tried to actively fight against increasing unemployment rates. However, if governments refuse to accept the deficits and enact fiscal austerity measures, the long run outcome will be similar to the short run, i.e. high levels of unemployment. Finally, while increasing households' access to consumer credit might also provide a short term remedy to growing unemployment, it will most likely be accompanied by adverse effects in the medium to long run.

To explicate the derivation of this conclusion, 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 then discussed in Section 5.

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 macroeconomic stock-flow consistent (SFC) models. 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 differ from the model introduced below in several crucial aspects. In contrast to the DSGE literature, the stock of credit money in our model – as in most of the agent-based macro literature and in line with empirical evidence (see, e.g., Caiani *et al.*, 2016; Godley and Lavoie, 2007) – is endogenous. This means that the banking sector does not need to accumulate additional funds prior to granting a new loan. Rather, these funds are the result of the credit provisioning process, which means that credit growth does not have to be preceded by increased saving behavior. Moreover, these models do not account for status or conspicuous consumption (Veblen, 1899[1970]). The concept that people aspire to a conventional standard of living, which is the level of consumption enjoyed by the people they identify with (e.g. Hogg and Terry, 2000), is quite well established and has been widely used as an argument to account for the increase in debt-based consumption in the run-up to the Great Recession.[6] While the SFC models discussed below do feature a financial sector with endogenous credit money as well as status consumption, neither of the two groups of models deals 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. Midrigan and Philippon (2016) introduce a DSGE model in which 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. Krueger and Perri (2006) and Iacoviello (2008) propose DSGE models in which household debt is the result of the attempt of households to smooth consumption in the face of idiosyncratic shocks to income.

More recently, Mian *et al.* (2021) have proposed a two-agent model with non-homothetic consumption-saving behavior. Assuming that the propensity to save rises with the level of wealth, they find that higher inequality leads to higher debt levels and lower aggregate demand in the long run.

[6] See e.g. Bowles and Park (2005), Christen and Morgan (2005), Krueger and Perri (2006), Neumark and Postlewaite (1998), Pollin (1988) and Schor (1999). See on this also Kapeller and Schütz (2014) and Kapeller and Schütz (2015). For an overview see Van Treeck (2014).

Among the SFC models, the one that is closest to the model developed below 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 – resulting in bankruptcies which eventual 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).

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 differs from our model in several important respects: 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 the class-based income distribution. Second, a main concern of Dosi *et al.* (2013) is the short- and long-term effect of fiscal and monetary policy. Therefore, the model takes a more comprehensive view than the one introduced here since it also takes into account technological change. By contrast, our model represents a steady-state economy to focus more specifically on the isolated effect of income concentration and is not geared to replicate more general macroeconomic stylized facts as the model of Dosi *et al.* (2013) does. This 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 of which factors that are not present in Dosi *et al.* (2013) and in subsequent versions of the K+S model.

The ABSFC 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 reduces unemployment and boosts 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 us, Cardaci (2018) study the implications of household debt when households orient their desired consumption on their upper neighbors in the income distribution. Their focus is, however, on the causes for financial crises in the United States, which is why 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. They find 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, however, investment decisions do not play a role. At the same time, while it uses a quite specific decision rule for determining household consumption and saving – originally proposed by D'Orazio and Giulioni (2017) – it does not feature the Veblenian conspicuous consumption aspect that is central in our model 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. The authors 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 present model is built around the two concepts of Veblenian conspicuous consumption (Veblen, 1899[1970]) and a Minskyan bank sector (see Minsky, 1986). It takes the operationalization of these concepts of the macroeconomic SFC model of Kapeller and Schütz (2014) and Kapeller *et al.* (2018) a step further by embedding them into an economy with heterogeneous agents, which are modeled explicitly and whose interactions drive the dynamics of the overall model.

In all, the model comprises

1. a firm class that is made up of 50 consumption good firms and a single capital good firm,
2. a worker class that consists of 4800 workers, half of which being high-income earners, the other half being low-income earners[7],
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.

The model consists of 340 time-steps. Since each time step can be interpreted as a quarter, this makes an observational period of 85 years. It is analyzed using Monte Carlo Simulations for which the model is run 50 times for each parameter constellation.

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

1. **Production planning**: Firms compute their desired output, and the resulting labor-, credit- and investment demand based on their expectations (see Section 3.1)
2. **Wage setting**: Firms decide on a wage to offer to each worker group on the labor market; simultaneously, workers adjust their reservation wage (see Section 3.2)
3. **Labor market**: Workers and firms meet on the labor market where jobs, incomes and unemployment benefits are assigned (see Section 3.3)
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 (see Section 3.4)

[7]This feature allows us to control the income inequality *exogeneously*, a feature that is necessary given the research question pursued in this paper.

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 (see Section 3.5)
6. **Computation of profits and income**: Bank profits and capitalist income as well as taxes and government income are determined (see Section 3.6)
7. **Consumption demand and private debt**: Workers and capitalists compute their consumption demand and their resulting demand for credit; banks set their margin of safety and decide on whether to issue credit to respective households or not (see Section 3.7)
8. **Market for consumption goods:** Households buy consumption goods according to their demand and their financial constraint (i.e. acquired credit, see Section 3.8)
9. **Update of accounts:** All individual and aggregated accounts are updated and checked for consistency (see Section 3.9)

3.1 Production planning

Consumption good firms. Consumption good firms are assumed to be boundedly rational and profit-seeking and, therefore, strive to sell as many goods as possible. Thus, in the beginning of each period, each consumption good firm f^C[8] computes its expectation error $e_{f^C,t}$ as the difference between their sales expectations $\hat{q}_{f^C,t-1}$ and actual sales $q^{sold}_{f^C,t-1}$ in the previous period (for a similar approach see Caiani *et al.*, 2016):[9]

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

Then, firms adjust their sales expectations by this error and by a parameter α that controls the adjustment speed:

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

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

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

Capital good firms. To absorb production booms and to provide sufficient capital goods, the capital good firm f^K is, at the start of each model run, endowed with an inventory $q^{inv}_{f^K,0} = Q^*$. Then, in each period, it will produce as much as necessary to re-attain that inventory level. In other words, it will produce as much as it sold in the previous period. This is, in effect, similar to assuming a pre-ordering system as is done in Caiani *et al.* (2016). The desired production of the capital good firm is therefore set to maintain initial inventory Q^*:

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

Labor demand. After computing desired output, each firm (regardless of whether it produces consumption or capital goods) f computes its labor demand $L^D_{f,t}$ as

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

[8] Throughout this entire section, lower-case characters are used as subscripts in order to denote the agent type, whereas the corresponding capital letter refers to the sector.

[9] 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.

where A^L is labor productivity, which is assumed to be the same for all workers. Since the model only features full-time jobs, each firm's labor demand will be rounded down to its integer value[10].

Following a Leontief production function, firms require both *high wage* and *low wage* workers to an extent of an exogenously given labor demand ratio, λ. The model does not feature technical change. Therefore, the composition of labor necessary for production remains constant throughout time. Labor demand for both groups is, thus, given as

$$L_{f,t}^{D,low} = \lambda L_{f,t}^{D} \tag{6}$$

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

In the intermediate cases where 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 $I_{f,t}^D$ of firm f is computed as follows:

$$I_{f,t}^{D} = \frac{(1+\beta^K)q_{f,t}^{*}}{A^K} - (1-\delta)K_{f,t} \tag{8}$$

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. Firms decide whether to change their offered wages in each period. They will increase their wage 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 would stop to further increase wages if there were full employment. Firms will decrease their offered wages by the revision factor ϕ_F if employment does not meet the ϵ^{high} threshold. The wage offered to low-income-workers is determined as a share of the wage offered to high-income-workers, and all wages are adjusted to inflation.

Workers' reservation wage. Workers adjust their reservation wage once a year, i.e. every four periods. Each worker will increase their reservation wage by the factor $\phi_{w,t}$ drawn from an interval $\mathcal{U}$ if they have been employed for all of the past four periods. They will decrease their reservation wage by $\phi_{w,t}$ if (a) their current reservation wage was higher than the highest wage offered in the last period – assuming that workers would rather work for a wage that is a little lower than their desired wage than be unemployed; or if (b) they were unemployed for two or more of the last four periods. Note, however, that reservation wages cannot fall beneath what would be necessary for subsistence consumption and taxes. That is, reservation wages and unemployment benefits paid by the government must be sufficiently high to ensure that net income is sufficient to afford subsistence (see Section 3.3 below).

[10] This is to ensure that income inequality is not due to part-time labor but can be controlled exogenously.

3.3 Labor market

After determining offered wages and positions as well as reservation wages, workers and firms meet in the labor market. Each worker applies for jobs in each period. However, workers who already were employed in the previous period, will be able to enter the labor market earlier than those who have been unemployed. That is, only if the overall labor demand rises, unemployed workers might be able to get a job. And only if overall labor demand decreases, previously employed workers might become unemployed. Practically, workers are split in two groups – the previously employed and the previously unemployed. First, the group of previously employed workers enters the labor market in a random order. Each worker checks if there are positions available to them – assuming that high-wage workers cannot apply for low-wage positions and vice-versa, regardless of their employment status – that offer a wage that exceeds their reservation 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 them offering wages that are too low. If employed, workers are paid the wage offered by the firm. If they did not find a job, they receive an unemployment benefit u from the government, which equals the inflation adjusted subsistence consumption s.

Each worker's disposable income is computed as

$$y_{w,t} = \begin{cases} (1-\tau_w)\mathcal{W}_{w,t} + i^a_{w,t} - i^l_{w,t} + pb_{w,t} & \text{if worker } w \text{ is employed} \\ u + i^a_{w,t} - i^l_{w,t} + pb_{w,t} & \text{otherwise} \end{cases} \tag{9}$$

$$pb_{w,t} = \zeta M^l_{w,t} \tag{10}$$

where $\mathcal{W}_{w,t}$ denotes the wage paid to worker w in period t, $i^a_{w,t}$ denotes interest received for assets, $i^l_{w,t}$ interest paid on loans, $pb_{w,t}$ the repayment of current loans and $M^l_{w,t}$ the current loans.

3.4 Price setting

After jobs are assigned, firms compute their actual production $q^{realized}_{f,t}$ as the minimum of desired and possible production $q^P_{f,t}$, given the current labor supply:

$$q^{realized}_{f,t} = min(q^*_{f,t}, q^P_{f,t}) \tag{11}$$

$$q^P_{f,t} = min(L^S_{f,t} * A^L, K_{f,t} * A^K) \tag{12}$$

Prices are set as a mark-up $\mu_{f,t}$ over labor 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 $e_{f,t} > \theta$ (where θ is an exogenously set threshold value) 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 $e_{f,t} < -\theta$ and $p_{f,t-1} > \bar{p}_{t-1}$. In all:

$$p_{f,t} = (1+\mu_{f,t})\frac{(L_{f,t}^{S,high} w_{f,t}^{high} + L_{f,t}^{S,low} w_{f,t}^{low})}{q_{f,t}^{realized}} \tag{13}$$

$$\mu_{f,t} = \begin{cases} (1+\delta^{\mu})\mu_{f,t-1} & \text{if } (\Omega \wedge Q^{D+}) \vee (e_{f,t} > \theta \wedge p_{f,t-1} < \bar{p}_{t-1}) \\ (1-\delta^{\mu})\mu_{f,t-1} & \text{if } e_{f,t} < -\theta \wedge p_{f,t-1} > \bar{p}_{t-1} \wedge \neg(Q^{D+} \wedge \Omega) \\ \mu_{f,t-1} & \text{otherwise} \end{cases} \tag{14}$$

3.5 Market for capital goods

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 amount of capital goods. Each firm's new capital stock can then be computed as

$$K_{f,t+1} = I_{f,t}^{realized} + (1-\delta)K_{f,t}, \tag{15}$$

where $I_{f,t}^{realized}$ denotes the actual amount of capital products purchased by firm f in period t. Since the model does not feature technical change or process innovation, capital productivity remains constant.

3.6 Computation of profits and income

Bank profits. Bank 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 debt cancellation t_t^{cancel}:

$$\Pi_{b,t} = (1-\tau_b)(-i_t^a + i_t^l - t_t^{cancel}) \tag{16}$$

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

$$i_t^d = \sum_{x=1}^{n_x} i_{x,t}^d \tag{18}$$

Since the bank is assumed to be owned by all capitalists in equal shares, the bank will distribute its profits equally among them, while eventual losses are borne by the bank:

$$\Pi_{b,t}^{dist} = \begin{cases} \Pi_{b,t} & \text{if } \Pi_{b,t} > 0 \\ 0 & \text{else} \end{cases} \tag{19}$$

Capitalist income. Capitalists are assumed to hold equal shares of all firms and the bank. Their respective disposable income $y_{c,t}$, therefore, consists of an equal share of distributed firm and bank profits $\Pi_{F,t-1}^{dist}$ and $\Pi_{B,t}^{dist}$, respectively (where capital letters denote the sum of all agents in the respective agent-class). 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 contemporaneous profits have not been realized yet:

$$y_{c,t} = (1-\tau_c)(\frac{\Pi_{B,t}^{dist} + \Pi_{F,t-1}^{dist}}{n_c} + i_{c,t}^a) - i_{c,t}^l - pb_{c,t} \tag{20}$$

$$pb_{c,t} = \zeta M_{c,t}^l \tag{21}$$

Government income. The government levies taxes on wages, capitalist income and firm and bank profits:

$$y_{g,t} = t_{W,t} + t_{C,t} + t_{B,t} + t_{F_t} + i^a_{g,t} - i^l_{g,t} - pb_{g,t} \tag{22}$$

$$pb_{g,t} = \zeta M^l_{g,t} \tag{23}$$

Since the government pays an unemployment benefit to all unemployed workers and spends a fixed sum on public investment, it might run a public deficit, which would be financed by the banking sector which, in turn, receives interest payments.

3.7 Consumption demand and private debt

Workers' consumption behavior. One distinctive 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. More precisely, 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 previous period $C^{higher}_{w,t-1}$. Consumption demand $C^D_{w,t}$ of each worker w is, then, computed as

$$C^D_{w,t} = \rho C^{higher}_{w,t-1} + (1-\rho)(s_t + m^{income}_w (y_{w,t} - s_t) + max(0, m^{wealth}_w \cdot M^a_{w,t}) \tag{24}$$

where s_t denotes subsistence consumption, m^{income}_w and m^{wealth}_w denote marginal propensity to consume out of income and wealth of workers, respectively, $y_{w,t}$ is the income of worker w and $M^a_{w,t}$ are the assets of worker w. 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 through 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 Minsky (1986), we assume that the banking system considers a household credit-worthy if its income exceeds a margin of safety $marg_{b,t}$. Like 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. At the same time, once bankruptcies eventually start to occur, bankers 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, thereby, the margin of safety:

$$marg_{b,t} = \sigma \cdot marg_{b,t-1} + \gamma \cdot n^{bankrupt}_{t-1} + \nu \cdot \Delta L_t \tag{25}$$

where $\sigma \in (-1, 0)$ denotes the perceived stability parameter that causes the margin of safety to slowly decline, whereas the distress parameter γ causes the margin to quickly increase with the number of new bankruptcies in the past period $n^{bankrupt}_{t-1}$. L_t denotes the leverage ratio of workers, that is, the total amount of household loans relative to bank equity. An increase in the leverage ratio 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. As long as workers are considered to be credit-worthy, each worker will be granted as much credit as desired. If they do not fulfill that condition and cannot repay outstanding loans, they will be filed bankrupt.

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. Here we assume that for the next five years (i.e. 20 periods), the worker concerned will be obliged to return any income exceeding subsistence consumption to the bank and is barred from taking on any additional credit. In return, the bank will cancel the worker's debt after those five years of insolvency.[11]

Capitalist consumption. For the sake of simplicity and transparency, we assume that only worker households are affected by conspicuous consumption and that individual capitalist consumption can simply be computed as

$$C^D_{c,t} = a_t + m_c^{income}(y_{c,t} - a_t) + max(0, m_c^{wealth} \cdot M^a_{c,t}) \tag{26}$$

where a_t denotes the 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 consumption demand. In order to avoid that in case of supply shortages (i.e. firms underestimating actual demand) some agents end up with zero consumption goods due to the excessive spending by a small number of capitalist households, workers enter the market first.

Ranking Parameter. Each household ranks the consumption good firms based on their price- and non-price competitiveness: similar to Caiani *et al.* (2018) the model takes into account non-price criteria of the consumers (such as geographical distance, consumption habits, etc.) via a circular Hotelling-like model inspired by Salop (1979). To this end, each household and each consumption good firm is positioned on a circle, on which all members of the same agent-class x are located equidistantly:

$$interval_x = \frac{360}{n_x} \tag{27}$$

$$positions_x = [\frac{interval_x}{2}, \frac{interval_x}{2} + interval_x, \frac{interval_x}{2} + 2 \cdot interval_x, ..., \frac{interval_x}{2} + n \cdot interval_x] \tag{28}$$

Their position remains the same throughout all periods and the distance between a household and a firm can, then, be computed as the shortest distance on the 360 degree circle:

$$d_{h,f} = min(abs(pos_f - pos_h), 360 - abs(pos_f - pos_h)) \tag{29}$$

Then, firms are 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 and the firm with the highest ranking parameter will be the highest on the respective household's preference list:

$$rank = \frac{\bar{p_t}}{\eta \cdot d_{h,f} + (1 - \eta)p_{f,t}} \tag{30}$$

The household will try to satisfy its entire demand with its highest ranked firm. If the firm does not offer sufficient supply or is already sold out, the household will turn to the next-highest ranked firm.

[11] This corresponds, e.g., to proceedings prescribed by the Austrian bankruptcy law as of 2020.

Firm profits. After the interaction on the consumption and capital good market, respectively, has created revenues, the firms' profits can be computed as

$$\Pi_{f,t} = (1 - \tau_f)(p_{f,t} q^{sold}_{f,t} - \mathcal{W}_{f,t} + i^a_{f,t} - i^l_{f,t}) \tag{31}$$

Firms like to keep a constant share ι of wage and interest costs paid in the previous period as retained profits in order to reduce the risk of future illiquidity. Once investment has been paid for, any remaining profits and excess retained earnings will be distributed to their capitalist owners:

$$\Pi^{dist}_{f,t} = \begin{cases} \Pi_{f,t} - I^{realized} + M^a_{f,t} - \iota(\mathcal{W}_{f,t-1} + i^l_{f,t-1}) & \text{if positive} \\ 0 & \text{else} \end{cases} \tag{32}$$

3.9 Update of accounts

Agent accounts are updated as soon as a transaction takes place. At the end of each period, overall stock-flow consistency is checked by testing whether the following condition holds:

$$\Delta(M^A_x - M^L_x) = T_{x,t} \tag{33}$$

where T is the sum of transactions of agent x. All transactions for each respective agent are listed in Table A.4. After ensuring the consistency of all single accounts, we test whether indeed all aggregate flows and accounts add up to zero, as shown in Table A.4 in the appendix.

4 Simulation results

We conduct a series of simulation exercises that investigate the relationship between capitalist saving, the evolution of net financial wealth and unemployment. The results of these different scenarios are summarized in table 1, which compares mean values of various parameters for the final 10 periods of each scenario.

In what follows, we first provide a reference scenario that – after a suitable burn-in phase of 50 periods (not reported in the respective figures) – yields a stationary state (scenario 1). In order to derive the corresponding initial conditions, we solved a simplified aggregated version of the model by imposing the two conditions that, first, aggregate demand equals aggregate supply and, second, all changes in financial net wealth are equal to zero except for capitalists and the government. We except capitalists because we want to allow for positive capitalist net saving in the initial state. Since, by definition, the changes in financial net wealth have to sum up to zero, we have to allow for non-zero changes in net wealth in at least one additional sector, hence the exception of the government. The respective parameter values as well as a sensitivity analysis can be found in the appendix.

Each of the upcoming scenarios introduces one additional change to this stationary scenario until we finally arrive at scenario 5, which incorporates all of these changes. In order to keep everything tractable and to single out the effect that each parameter change brings about, we compare each scenario with its respective predecessor. All parameter changes are implemented in period 50, once the burn-in phase is over, meaning that in $t = 0$ every simulation run starts with the same initial conditions.

Variable	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
GDP	1.00	1.03	1.05	1.00	1.00
Unemployment rate	1.00	0.68	0.43	1.02	1.03
Account government	-1.00	-6.72	-6.96	-6.19	-6.13
Capitalist consumption	1.00	1.08	1.11	1.03	1.04
High-wage worker consumption	1.00	1.00	1.00	0.93	0.93
Low-wage worker consumption	1.00	1.00	0.99	0.94	0.93
Capitalists consumption out of income	1.00	1.10	1.12	1.05	1.06
Capitalists consumption out of wealth	1.00	1.03	1.05	0.96	0.97
Investment	1.00	0.99	1.04	0.99	0.97
Average wage	1.00	1.00	1.00	1.00	1.00
GDP deflator	1.00	1.00	1.01	0.98	0.98
Account high-wage worker	1.00	0.99	0.96	0.64	-0.37
Account low-wage worker	1.00	1.01	0.97	0.54	-35.85
Account capitalists	1.00	5.15	5.34	4.72	4.71
Account firms	-1.00	-1.09	-1.13	-0.93	-0.94
Avg. disposable income low-wage worker	1.00	1.03	1.05	0.91	0.90

Table 1: A comparison of all scenarios. All are in reference to the reference scenario 1. Signs indicate whether the value in the scenario considered is positive or negative. The absolute value represents the relative absolute value as compared to the reference scenario. All values compare the means of the ultimate 10 periods.

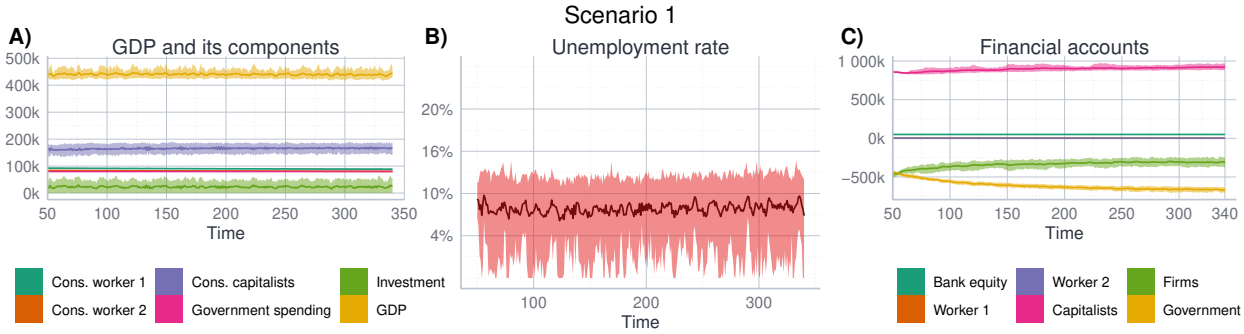

Figure 1: Model dynamics for Scenario 1. Bold lines represent the mean, shaded areas the range between the 10 and 90 percent quantile of the 50 simulation runs. Worker 1 correspond to high-wage workers, worker 2 to low-wage workers.

4.1 Scenario 1: Baseline

Figure 1 shows our baseline scenario in which we assume that capitalist propensity to consume out of wealth is 5% and households only receive loans if they are unable to finance subsistence consumption.[12] After the already mentioned 50 period burn-in phase (not reported in the figure), GDP and its components converge on a 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 downwards tendency in public sector net financial wealth finds its mirror image in slightly upward trending net financial wealth positions of capitalists and firms.

4.2 Scenario 2: Higher saving rates

In scenario 2, capitalists' propensity to consume out of wealth gets reduced from 5% to 1%, which is more in line with empirical evidence.[13] 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

[12] The latter assumption gets relaxed in scenario 5, where the effect of a liberation of consumer credit gets illustrated.

[13] See on this Mian *et al.* (2021), Arrondel *et al.* (2019), Garbinti *et al.* (2020) and Di Maggio *et al.* (2020).

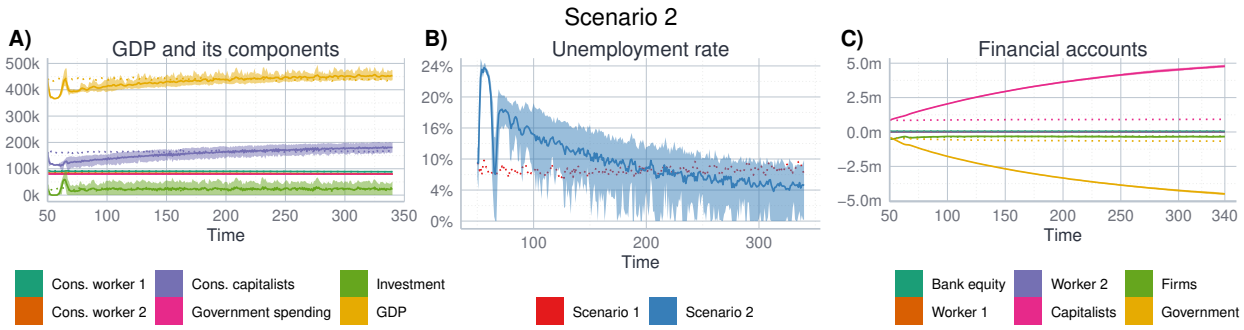

Figure 2: Model dynamics for Scenario 2. Bold lines represent the mean, shaded areas the range between the 10 and 90 percent quantile of the 50 simulation runs. The dashed lines refer to Scenario 1 (see also Figure 1). Worker 1 correspond to high-wage workers, worker 2 to low-wage workers.

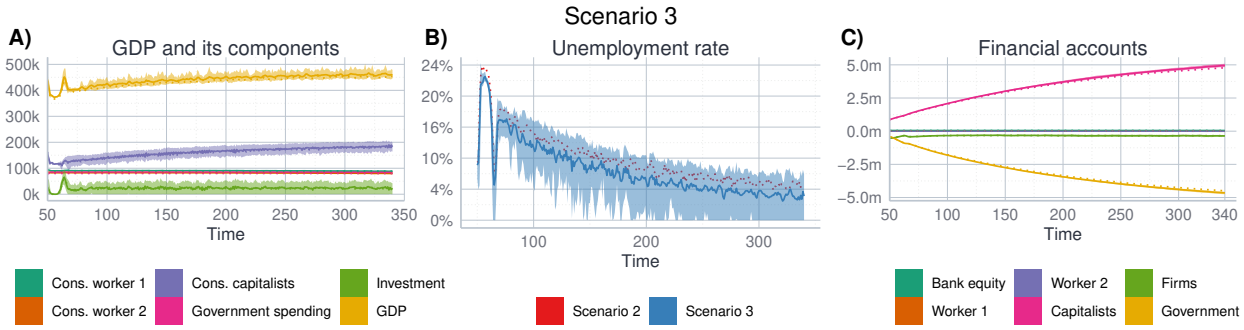

Figure 3: Model dynamics for Scenario 3. Bold lines represent the mean, shaded areas the range between the 10 and 90 percent quantile of the 50 simulation runs. The dashed lines refer to Scenario 2 (see also Figure 2). Worker 1 correspond to high-wage workers, worker 2 to low-wage workers.

payments and lower tax revenues take their toll on government finances. However, after some time, a reverse in output and unemployment dynamics takes place: As capitalists accumulate further financial wealth (since, eventually, unemployment benefits and interest payments by the government 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: the increased capitalist consumption in the long run spurs investment and leads to a lower level of unemployment and higher GDP. Capitalist accounts end up being massively higher than in the previous scenario, with the corresponding massive surge in government debt providing the indispensable precondition.

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. Now the government reacts to rising unemployment by raising government expenditure by an exogenous amount. As expected, this dampens the increase in unemployment and 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. Looking at Table 1 it can be seen that in the long run this scenario results in the highest values for investment and GDP, accompanied by the lowest unemployment rate. Moreover, it produces the highest level of capitalist financial wealth, necessarily going along with the highest level of government debt.

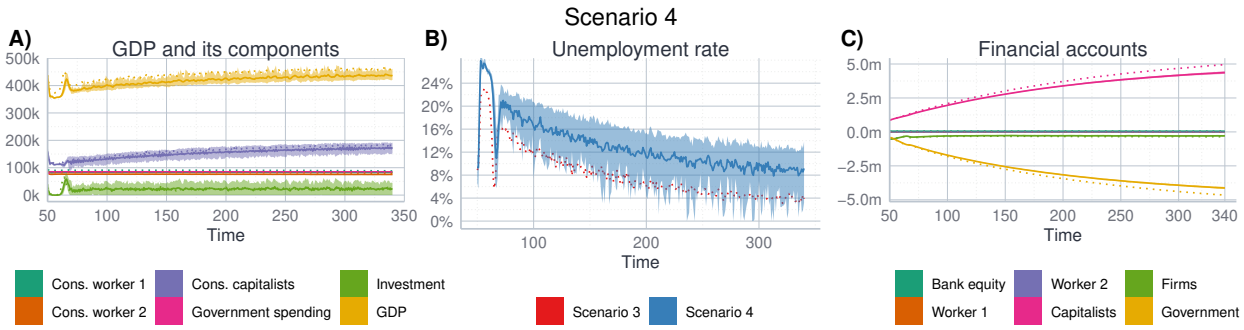

Figure 4: Model dynamics for Scenario 4. Bold lines represent the mean, shaded areas the range between the 10 and 90 percent quantile of the 50 simulation runs. The dashed lines refer to Scenario 3 (see also Figure 3). Worker 1 correspond to high-wage workers, worker 2 to low-wage workers.

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. Government debt turns out somewhat lower than in Scenario 4.3, though it is still much higher compared to the scenario in 4.1 (see Table 1).

4.5 Scenario 5: Liberation of consumer credit

The final scenario is motivated by a development that only recently took center stage in the run-up to the Great Recession: household credit. In particular, the banking sector is now willing to provide credit to households as long as they are deemed credit-worthy (the assessment of which takes place in the Minskyan way presented in Section 3). This new development is followed by a decline in net financial wealth, especially of low-wage workers, but also of high-wage workers as worker households are now able to take up loans in order to keep up with those slightly above them (see Figure 5). As a result, consumption is slightly higher compared to the previous scenario, initially transmitting into slightly higher GDP and a lower unemployment rate (Figure 6). However, the effect is rather short-lived, since, once household credit starts to expand, the banking sector's margin of safety is rising too (Figure 7), eventually denying access to credit for an increasing number of households and resulting in growing household bankruptcies. Moreover, the margin of safety remains around this higher level throughout the remaining period of analysis, thwarting the idea of periodically reoccurring consumption booms observed in Kapeller and Schütz (2014) and Kapeller *et al.* (2018).

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 7 shows that due to their level of debt, average disposable income of low-wage 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 capitalist wealth accumulation, as consumption expenditures ultimately end up in their accounts.

5 Conclusion

This paper 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 could not be matched by rates of capital

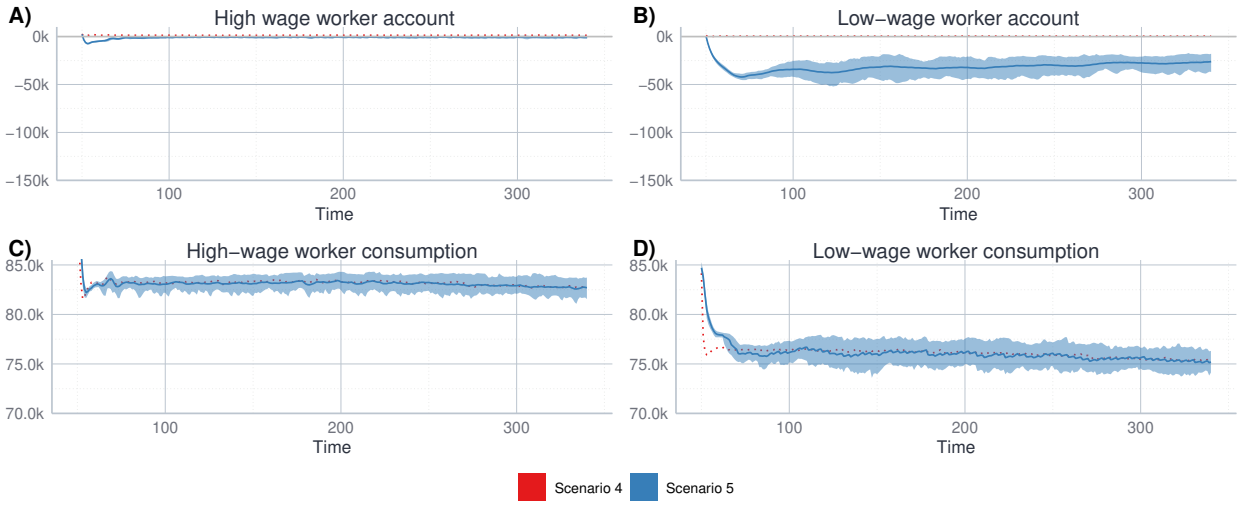

Figure 5: Model dynamics for Scenario 5. Bold lines represent the mean, shaded areas the range between the 10 and 90 percent quantile of the 50 simulation runs. The dashed lines refer to Scenario 4 (see also Figure 4).

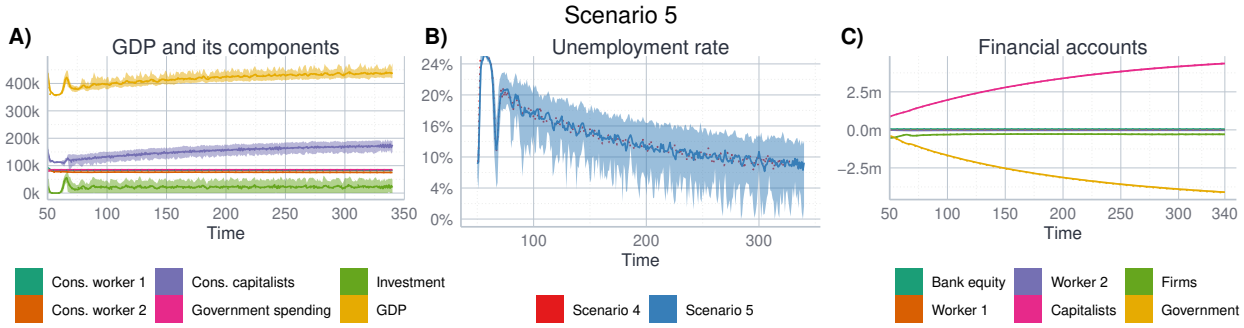

Figure 6: Model dynamics for Scenario 5. Bold lines represent the mean, shaded areas the range between the 10 and 90 percent quantile of the 50 simulation runs. The dashed lines refer to Scenario 4 (see also Figure 4). Worker 1 correspond to high-wage workers, worker 2 to low-wage workers.

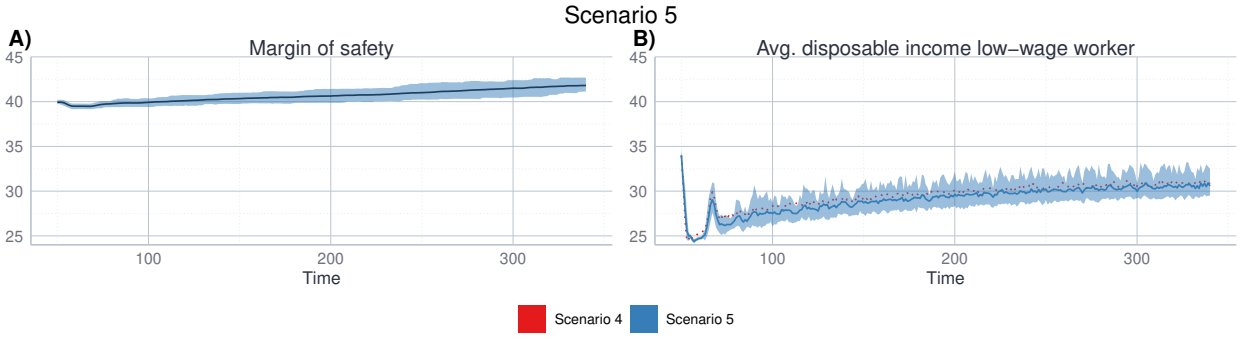

Figure 7: Model dynamics for Scenario 5. Bold lines represent the mean, shaded areas the range between the 10 and 90 percent quantile of the 50 simulation runs. The dashed lines refer to Scenario 4 (see also Figure 4).

accumulation any more (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.

To study the internal consistency and plausibility of this claim, we developed an agent-based stock-flow consistent model that allows to set income inequality between different groups of agents explicitly and through which we can mimic the stylized fact that members of the high income group tend to have much higher saving rates. Moreover, the model takes into account status consumption as an important element for consumption choices, meaning that households tend to aspire the consumption level of those perceived slightly above them in the income distribution.

The resulting model suggests 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 one also observes 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 unemployment 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, and in which the government keeps 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 expense of an 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 remain consistently high.

Finally, we complemented these considerations motivated by Keynes' original thought by also considering a look at whether the liberation of household credit could compensate for the initial rise in the saving rate triggered by the very rich, an avenue not theorized by Keynes at his time. It turns out that households taking loans to 'keep up with the Joneses' only provide a very limited remedy, as their effect is not very large and can only be sustained for a short time: debt quickly accumulates, leading to lower household consumption and less access to credit afterwards. Hence, our agent-based model does not reproduce the kind of periodically reappearing consumption boom cycles reported by Kapeller and Schütz (2014) and Kapeller *et al.* (2018), despite sharing many of their models' features. Instead, consumer debt seems to a be a permanent burden to the economy once the initial boom is over, a finding more in line with the empirical evidence provided by Mian *et al.* (2021). This different finding seems to be due to the agent-based nature of the present model model, if compared to the structural models of Kapeller and Schütz (2014) and Kapeller *et al.* (2018).

This leaves us with the conclusion that Keynes might indeed have been right in arguing that, as societies grow richer, they might have to choose between consistently high unemployment or chronic government deficits. However, due to the very narrow focus 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. He was of the opinion that the first one is only a temporary solution due to the limits to which this can be done, so 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: while this strong abstraction makes sense for the present endeavor of exploring the theoretical consistency and implications of Keynes' original thought experiment, any further investigation of its practical relevance would need to take into account the role of technological change. This is an important avenue for further research and it would be particularly interesting to see how different assumptions about the evolution of technological progress would modify the original results and, thereby, impact on Keynes' original conjecture.

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Appendix

A Parameters and model matrices

All variables used throughout the model are listed in Table A.1 and A.2. Table A.3 and A.4 provide a representation of all stocks and flows of the model (see Godley and Lavoie, 2007).

		Description	Value
A	A^L	Labor productivity	100
	A^K	Capital productivity	0.63
	m_w^{income}	Workers' marginal propensity to consume out of income	0.9
	m_w^{wealth}	Workers' marginal propensity to consume out of wealth	0.9
	m_c^{income}	Capitalists' marginal propensity to consume out of income	0.7
	m_c^{wealth}	Capitalists' marginal propensity to consume out of wealth	0.05, 0.01
A	α	Adjustment to expectation error $e_{f,t}$	0.25
B	β^q	Inventory buffer parameter	0.1
	β^K	Capital buffer parameter	0.2
Γ	γ	Distress parameter	0.15
Δ	δ	Depreciation rate of capital	0.025
	δ^μ	Change in mark-up value	0.005
E	ϵ^{high}	Critical value for high employment	0.5
Z	ζ	Installment rate	0.05
H	η	Weight on distance parameter	0.75
Θ	θ	Critical error threshold	0.1
I	ι	Reserve share of firms	1.05
Λ	λ	Share of low-income workers	0.5
N	ν	Influence of the change in the leverage ratio on the margin of safety	0.05
R	ρ	Conspicuous consumption parameter	0.8
Σ	σ	Perceived stability parameter	-0.0025
T	τ_b	Tax rate on banking sector profits	0.1
	τ_c	Tax rate on capitalist income	0.2
	τ_f	Tax rate on firm profits	0.1
	τ_w	Tax rate on worker income	0.12
Φ	ϕ_F	Wage revision factor of firms	0.04
	$\phi_{w,t}$	Reservation wage revision factor of worker w in period t	$(0.01, 0.04)$
Ω	Ω	Quasi full employment parameter	0.98

Table A.1: Parameters

Table A.2: Variables

		Description	Starting value
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	$L^{D}_{f,t}$	Labor demand of firm f in period t	
	$L^{D,low}_{f,t}$	Demand for low-income labor of firm f in period t	
	$L^{D,high}_{f,t}$	Demand for high-income labor of firm f in period t	
	$L^{S}_{f,t}$	Labor 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	$K_{f^C,t}$	Capital stock of capital good firm f^C in period t	12190.4762
	$K_{f^K,t}$	Capital stock of firm f in period t	190476.19
L	L_t	Leverage ratio of workers in period t	
M	$M^{a}_{x,t}$	Assets of agent x in period t	
	$M^{l}_{c,t}$	Assets of capitalist c in period t	200
	$M^{l}_{f^C,t}$	Assets of consumption good firm f^C in period t	1944
	$M^{l}_{f^K,t}$	Assets of capital good firm f^C in period t	57600
	$M^{l}_{g,t}$	Assets of government in period t	0
	$M^{l}_{w,t}$	Assets of worker w in period t	0
	$M^{l}_{x,t}$	Loans of agent x in period t	
	$M^{l}_{c,t}$	Loans of capitalist c in period t	0
	$M^{l}_{f^C,t}$	Liabilities of consumption good firm f^C in period t	0
	$M^{l}_{f^K,t}$	Liabilities of capital good firm f^C in period t	0
	$M^{l}_{g,t}$	Loans of government in period t	304800
	$M^{l}_{w,t}$	Loans of worker w in period t	0
P	$p_{f,t}$	Price of firm f in period t	1
	$\bar{p}_t$	Average price for consumption or capital goods, respectively, in period t	
	$pb_{x,t}$	Amount of credit payback 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	
	$q^{sold}_{f^C,t-1}$	Number of goods sold by consumption good firm f^C in period $t-1$	6400
	$q^{sold}_{f^K,t-1}$	Number of goods sold by capital good firm f^K in period $t-1$	100000
	$q^{*}_{f,t}$	Desired production of firm f in period t	
	$q^{inv}_{f,t}$	Inventory of firm f in period t	$q^{sold}_{f^C,t-1}\beta^q$
	$q^{realized}_{f,t}$	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	$false$
S	s_t	Subsistence consumption in period t	30
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	
U	U_t	Number of unemployed workers in period t	
W	$w^{low}_{f,t}$	Wage offered to low-income workers by firm f in period t	47.5
	$w^{high}_{f,t}$	Wage offered to high-income workers by firm f in period t	$0.9 \cdot w^{high}_{f,t}$
Y	$y_{w,t}$	Income of worker w in period t	
M	$\mu_{f,t}$	Price mark-up of firm f in period t	1.2222
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	
Ξ	$\Xi_{w,t}$	Insolvency payment of worker w in periot t	
Ψ	$\Psi_{w,t}$	Debt of worker w cancelled in period t	

Table A.3: Stock matrix

	Households			**Firms**	**Government**	**Banks**	$\sum$
	Worker 1	Worker 2	Capitalists				
Money deposits	$+M_{W,high}$	$+M_{W,low}$	$+M_C$	$+M_F$	M_G	$-M_B$	0
Capital				$+K_F$	$+K_G$		K
Balance (net-worth)	$-V_{W,high}$	$-V_{W,low}$	$-V_C$	$-V_F$	$-V_G$	$-V_B$	$-K$
$\sum$	0	0	0	0	0	0	0

Note that $M = M_{W,high} + M_{W,low} + M_C + M_F + M_G$ 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 A.4: Flow matrix

	Households			**Firms**		**Government**		**Banks**		$\sum$
	Worker high	Worker low	Capitalists	Current	Capital	Current	Capital	Current	Capital	
Consumption	$-C_{Whigh,t}$	$-C_{Wlow,t}$	$-C_{C,t}$	$+C_t$						0
Priv. investment				$+I_t$	$-I_t$					0
Gov. investment				$+G_t$		$-G_t$				0
[Production]				Y_t						
Wages	$+\mathcal{W}_{Whigh,t}$	$+\mathcal{W}_{Wlow,t}$		$-\mathcal{W}_{Whigh,t}$ $-\mathcal{W}_{Wlow,t}$						0
Taxes	$-T_{Whigh,t}$	$-T_{Wlow,t}$	$-T_C$	$-T_F$		$+T_{Whigh,t}$ $+T_{Wlow,t}$ $+T_C$ $+T_F$ $+T_B$		-T_B		0
Unempl. Benefits	$+u \cdot U_{Whigh,t}$	$+u \cdot U_{Wlow,t}$				$-u \cdot U_{Whigh,t}$ $-u \cdot U_{Wlow,t}$				0
Interest	$+i^A_{Whigh,t} - i^L_{Whigh,t}$	$+i^A_{Wlow,t} - i^L_{Wlow,t}$	$+i^A_{C,t} - i^L_{C,t}$	$+i^A_{F,t} - i^L_{F,t}$		$+i^A_{G,t} - i^L_{G,t}$		$-i^A_{Whigh,t} + i^L_{Whigh,t}$ $-i^A_{Wlow,t} + i^L_{Wlow,t}$ $-i^A_{C,t} + i^L_{C,t}$ $-i^A_{F,t} + i^L_{F,t}$ $-i^A_{G,t} + i^L_{G,t}$		0
Repayment	$+\zeta \cdot M^L_{Whigh,t-1}$ $-\zeta \cdot M^L_{Whigh,t-1}$	$+\zeta \cdot M^L_{Wlow,t-1}$ $-\zeta \cdot M^L_{Wlow,t-1}$	$+\zeta \cdot M^L_{C(t-1)}$ $-\zeta \cdot M^L_C(t-1)$	$+\zeta \cdot M^L_{F(t-1)}$ $-\zeta \cdot M^L_{F(t-1)}$		$+\zeta \cdot M^L_{G(t-1)}$ $-\zeta \cdot M^L_{G(t-1)}$				0
Insolv. Payments	$-\Psi_{Whigh,t-1}$ $+\Psi_{Whigh,t-1}$	$-\Psi_{Wlow,t-1}$ $+\Psi_{Wlow,t-1}$								0
Debt Cancellation	$+\Xi_{Whigh,t-1}$	$+\Xi_{Wlow,t-1}$						$-\Xi_{Whigh,t-1}$ $-\Xi_{Wlow,t-1}$		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	$-\Delta M_{Whigh,t}$	$-\Delta M_{Wlow,t}$	$-\Delta M_{C,t}$		$-\Delta M_{F,t}$		$-\Delta M_{G,t}$		$+\Delta M_t$	0
$\sum$	0	0	0	0	0	0	0	0	0	0

Note that $C = C_{Whigh} + C_{Wlow} + C_C$ and $M = M_{Whigh} + M_{Wlow} + M_C + M_F$. All rows and columns add up to zero, assuring the model's stock-flow consistency. See Godley and Lavoie (2007) for further details. The conditions for stock-flow consistency are tested in each period of the simulation runs.

B Sensitivity analysis

To test whether the model behaves reasonably with regard to changes in crucial parameters we run a number of sensitivity experiments. Since these experiments are meant to merely illustrate the robustness of the findings, they only consider the first 100 time steps after the burn-in period of 50 time steps. The following experiments are all based on 20 model runs and test the implications of changes in the following parameters (with standardized deviations of $\pm 5\%$):

- adjustment to the expectation error (α)
- high employment threshold (ϵ^{high})
- marginal propensity to consume out of income of capitalists (m_c^{income})
- marginal propensity to consume out of income of workers (m_w^{income})
- marginal propensity to consume out of wealth of workers (m_w^{wealth})
- relevance of status consumption for workers (ρ)
- perceived stability parameter (σ)
- leverage ratio parameter (ν)
- distress parameter (γ)

In general, these exercises show that the basic model setup is quite robust with respect to these deviations.

B.1 The adjustment to expectation error

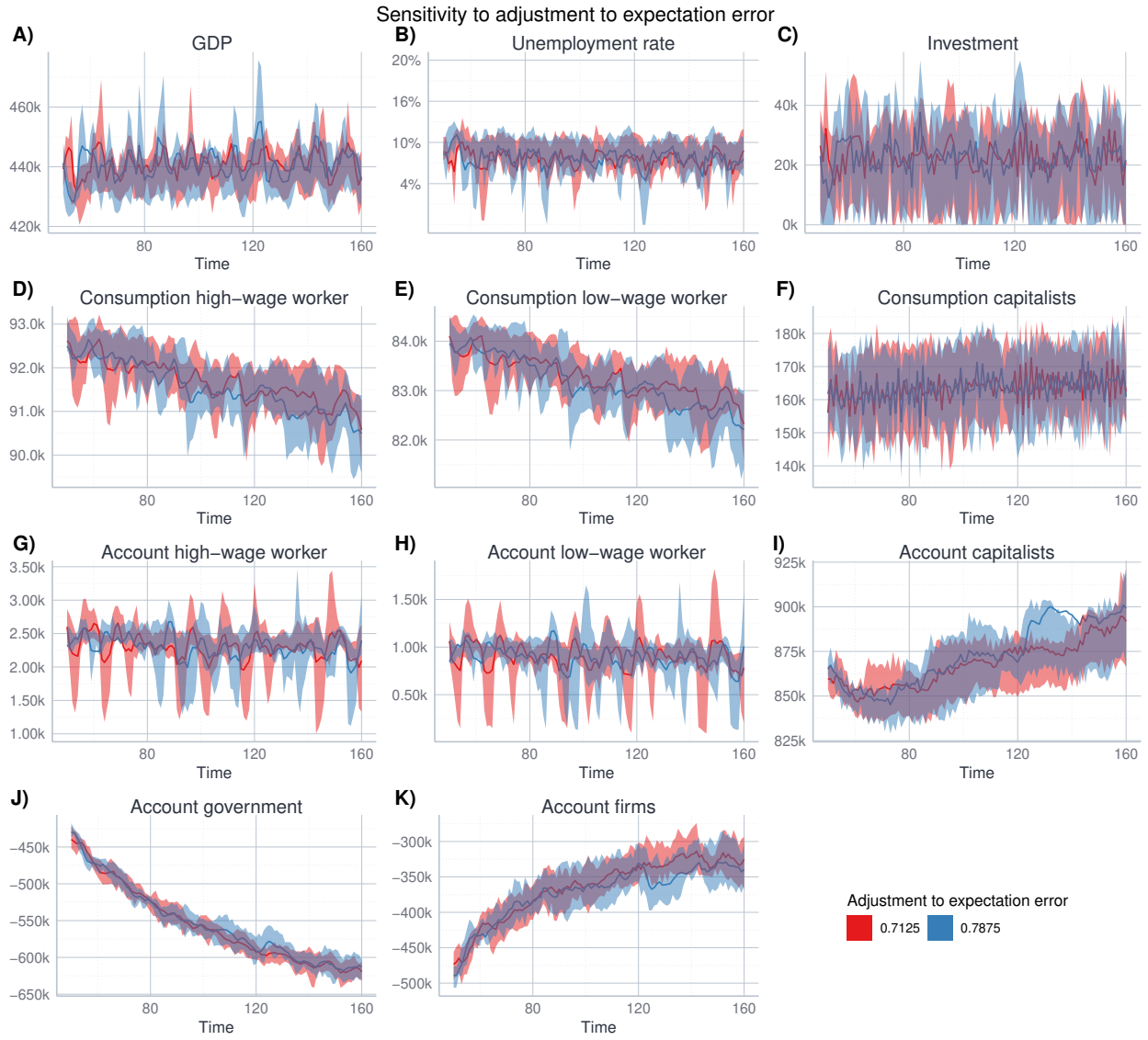

Figure A.1: Sensitivity experiment for the adjustment to expectation error α.

B.2 The high employment threshold

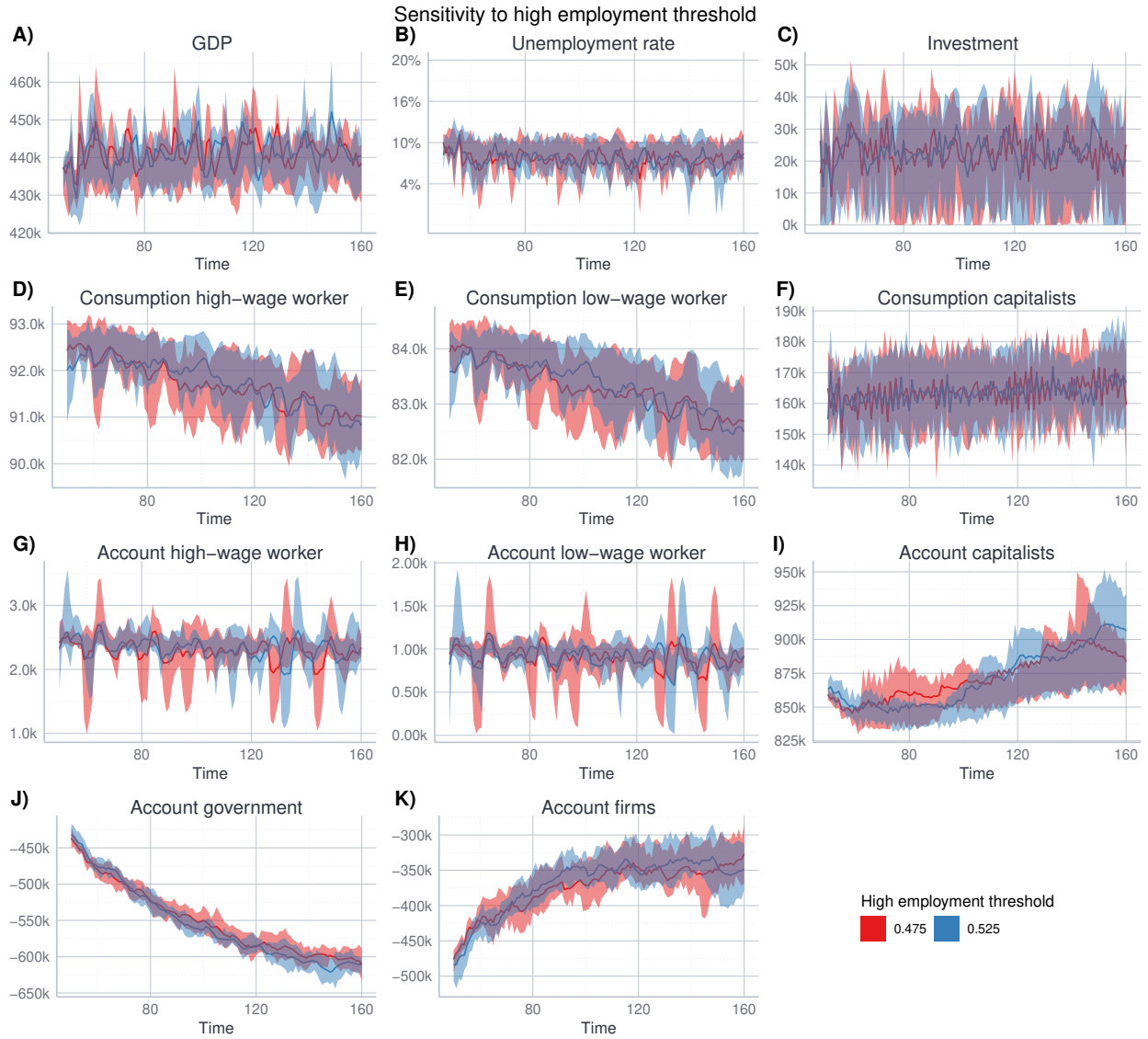

Figure A.2: Sensitivity experiment for the high employment threshold.

B.3 Marginal propensity to consume out of income (capitalists)

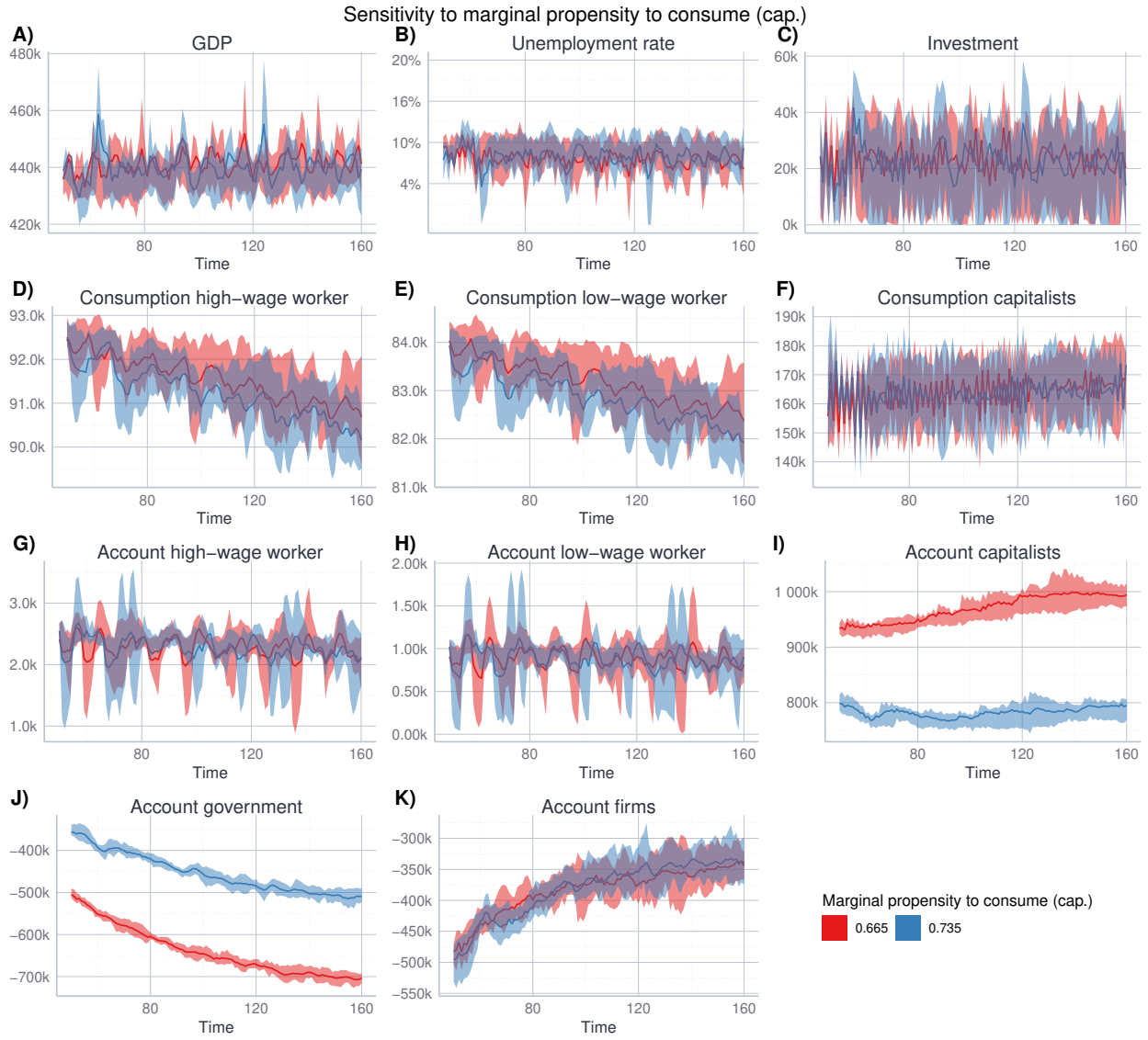

Figure A.3: Sensitivity experiment for the marginal propensity to consume out of income (capitalists).

B.4 Marginal propensity to consume out of income (workers)

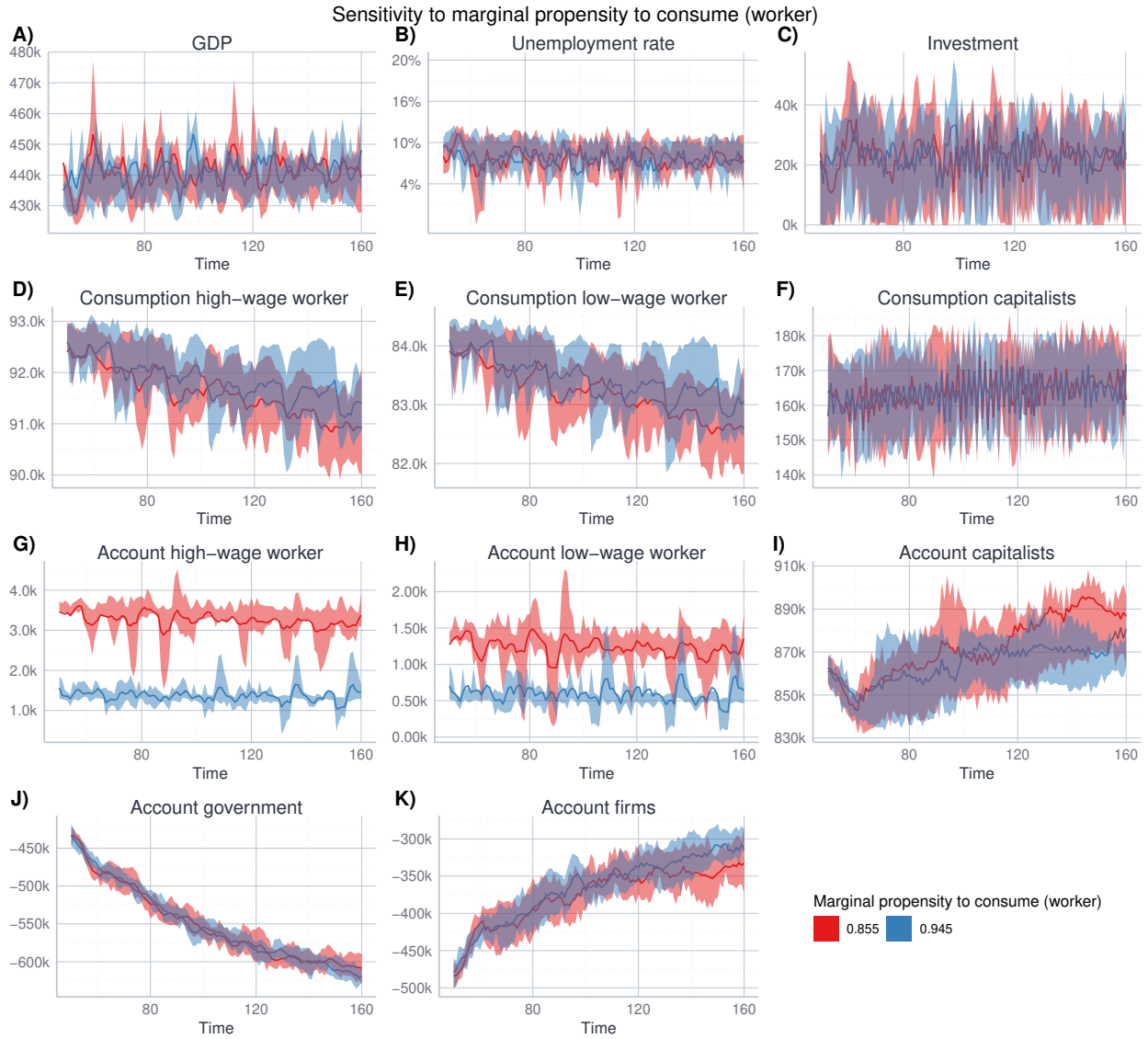

Figure A.4: Sensitivity experiment for the marginal propensity to consume out of income (workers).

B.5 Marginal propensity to consume out of wealth (workers)

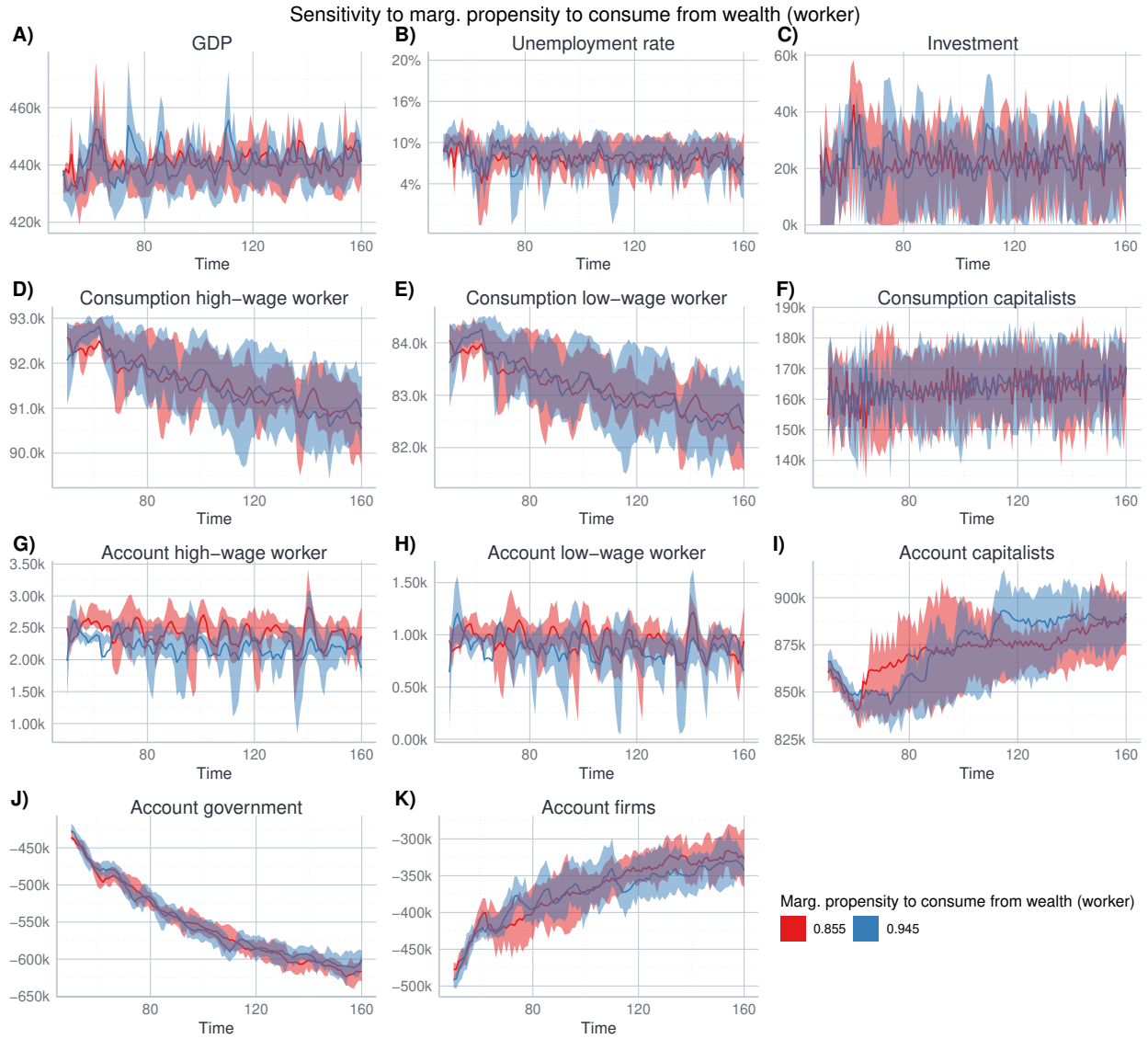

Figure A.5: Sensitivity experiment for the marginal propensity to consume out of wealth (workers).

B.6 Relevance of status consumption

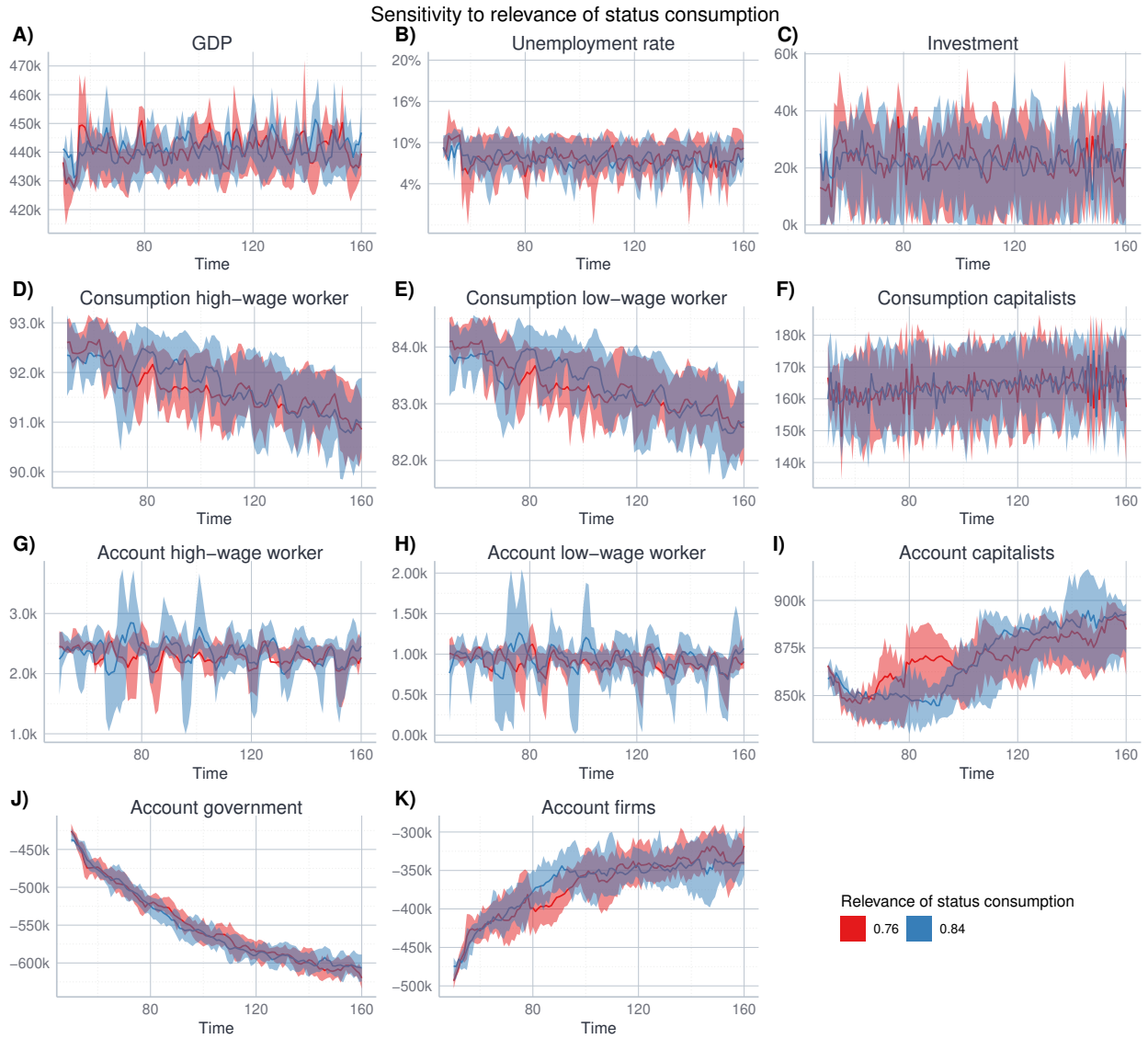

Figure A.6: Sensitivity experiment for the relevance of status consumption in the consumption decision of the households.

B.7 Perceived stability parameter

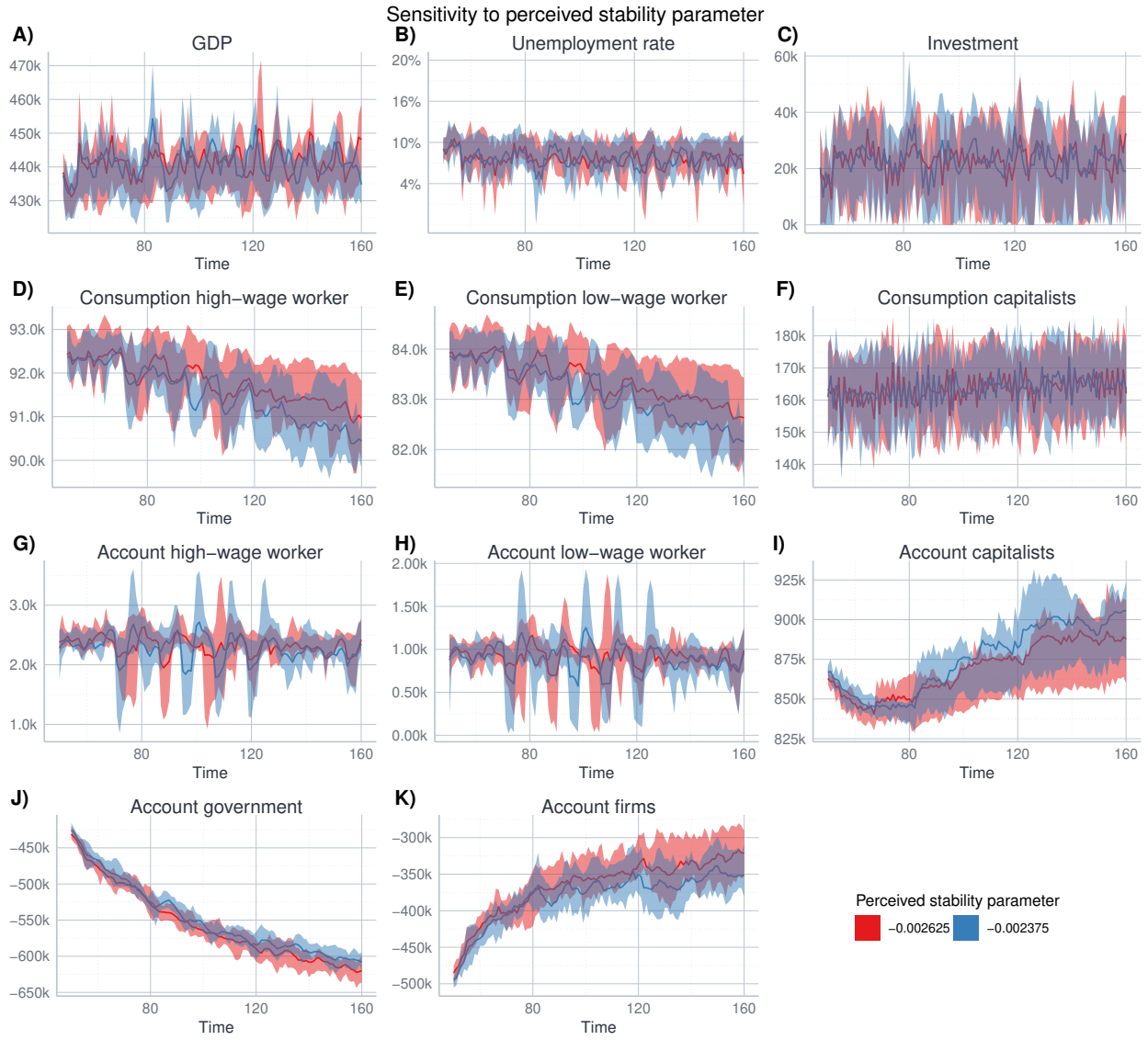

Figure A.7: Sensitivity experiment for the relevance of the perceived stability parameter.

B.8 Leverage ratio parameter

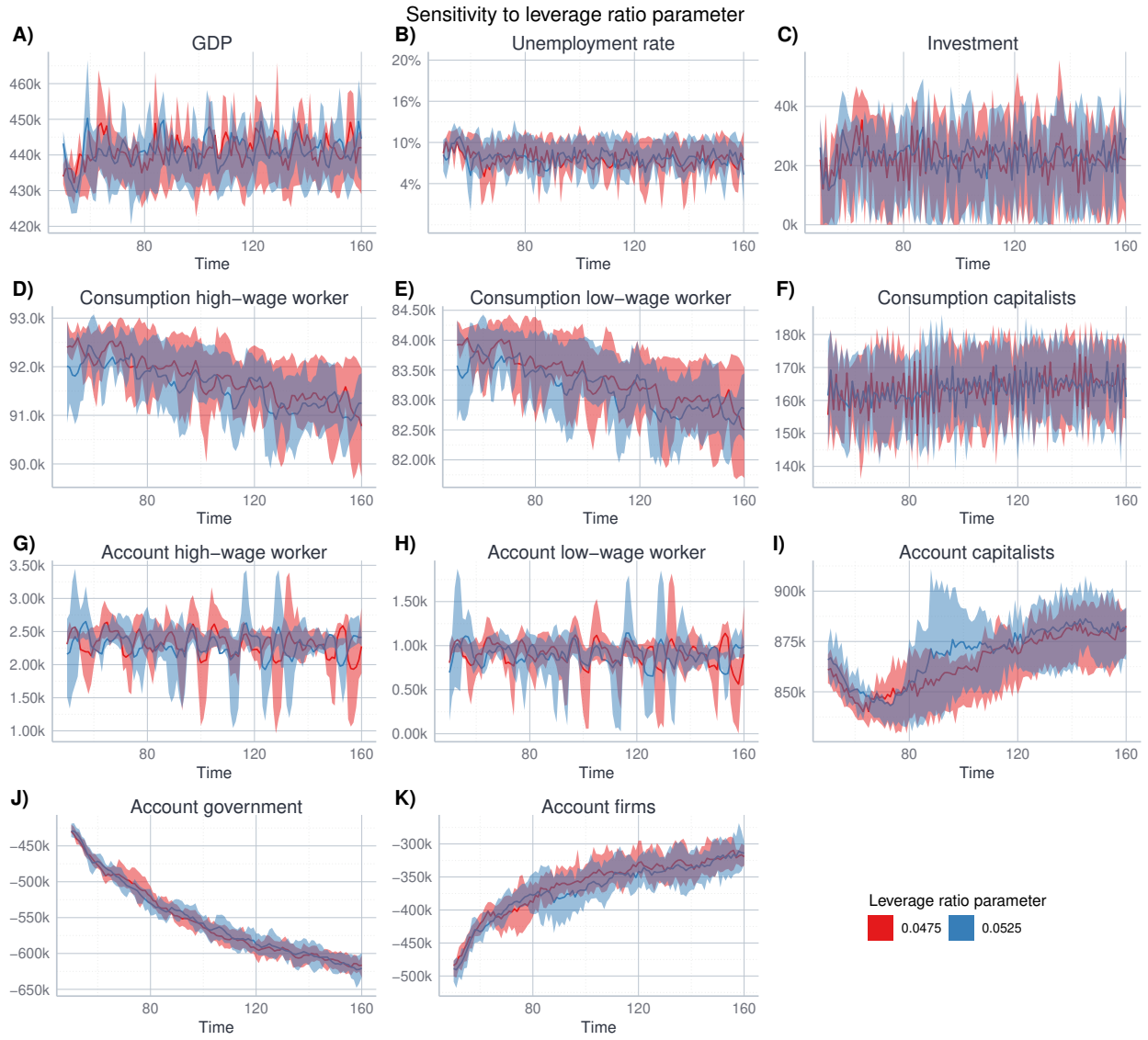

Figure A.8: Sensitivity experiment for the relevance of the leverage ratio parameter.

B.9 Distress parameter

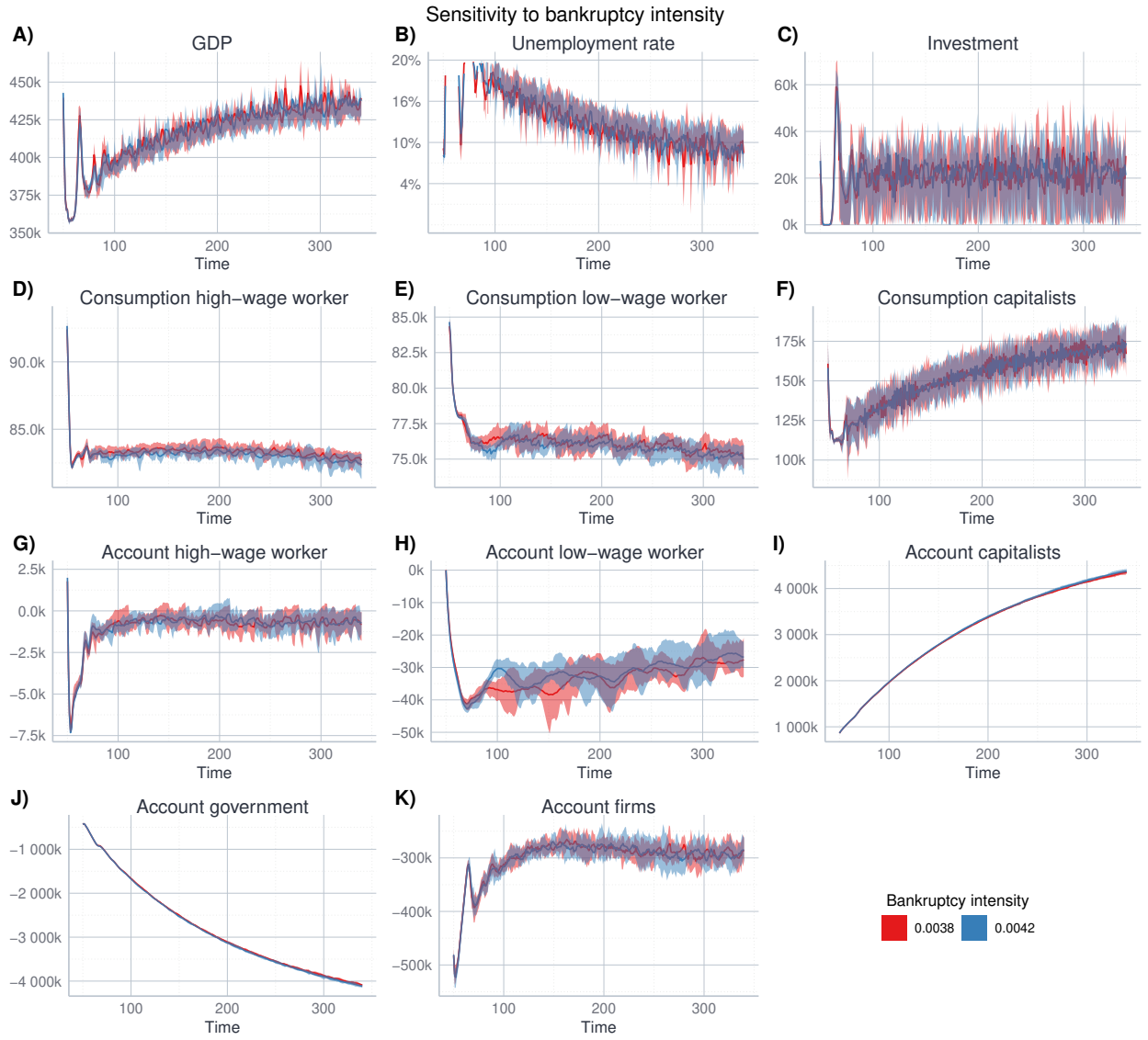

Figure A.9: Sensitivity experiment for the relevance of the distress parameter.