WORKING PAPER 2116

Multiplicity and not necessarily heterogeneity: implications for the long-run degree of capacity utilization

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October 2021

POST-KEYNESIAN ECONOMICS SOCIETY

Multiplicity and not necessarily heterogeneity: implications for the long-run degree of capacity utilization

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September 2021

The paper discusses the implications of disaggregation within the theoretical debate on the long-run convergence of the degree of capacity utilization towards the normal one. To this end, we develop an Agent Based – Stock Flow Consistent version of a demand-led growth model based on the capacity adjustment principle, fixed normal rate of capacity utilization and non-capacity creating autonomous component of demand. We show that, once the implicit assumption on the centralized control over the aggregate productive capacity characterizing aggregate models is removed, the economy displays emergent properties: the fluctuations of the business cycle endogenously arise, and the long-run aggregate degree of capacity utilization fluctuates around a level lower than the normal one. To this extent, multiple equilibrium degrees of capacity utilization are possible. These proprieties help to explain some empirical evidence about the tendential under-utilization of productive capacity and confute both the traditional wisdom according to which there is only one degree of capacity utilization (the normal one) compatible with a stable accumulation and the neo-Kaleckian "closure". In this respect, we point out that the long-run growth path determined within a Supermultiplier model can be somehow characterized by neo-Kaleckian features but, differently from the last one, such "undesired equilibrium" does not present Harrodian Instability: in the quasi-steady state firms keep trying to restore the exogenously given normal degree of capacity utilization without succeeding in that. The emerging phenomena derive, precisely, from considering a multiplicity of firms rather than the aggregate macro firm, and not by their heterogeneity. In particular, for any given distribution of demand across firms, the decentralized control over aggregate productive capacity produces over-investment with respect to the normal growth path. Because of the autonomous component, the aggregate demand does not react proportionally and the long-run degree of capacity utilization results to be lower than the desired one.

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1. Introduction

In recent years, the discussion on the long-run degree of capacity utilization has represented one of the main arguments of contention within the post-Keynesian family. The central question can be traced back to which is the adjusting variable between the realized and the normal degree of capacity or whether the equilibrium degree of capacity utilization can be different from the desired or normal one.

On the one side, the baseline neo-Kaleckian model presents a *steady-state* degree of capacity utilization different from the normal one. On the other side, in the Supermultiplier model (SM), through the inclusion of a non-capacity creating autonomous expenditure and fully-induced investments, the long-run rate converges to the exogenously given normal rate.

The initial formulation of the neo-Kaleckian model has been criticized because of its failure to reconcile the actual and the normal rate (Committeri 1986, 1987; Cesaratto, 2015; Skott, 2012; Pariboni and Girardi 2018). According to many authors, this situation cannot be considered as an "equilibrium position", indeed a utilization rate different from the normal one would prompt firms to further revise their expectations and investment decisions (Palumbo and Trezzini, 2003). In other words, the constant divergence between the realized and normal degree of capacity utilization would be inconsistent with the capacity adjustment principle (Auerbach and Skott 1988, Shaikh, 2009). At this point, the main problem within the model would be that, as recognized by its proponents (e.g. Hein et al. 2012), the attempt to restore the desired degree via changes in accumulation would generate instability of the Harrodian type.

In order to avoid instability, neo-Kaleckian authors have proposed a "closure" of the model where the normal degree of capacity utilization endogenously adapts to the realized one. Amadeo (1986), Lavoie (1995,1996, 2010), Lavoie et al. (2004) and Dutt (1997, 2010) suggest a mechanism that assumes that the normal rate of capacity is influenced by past values of the actual rate of utilization. The traditional explanation argues that, in conditions of uncertainty, firms follow conventional rules by adjusting the desired degree to previous realizations (Hein et al. 2012).

In this regard, Skott (2012) asserts that it seems reasonable to assume the presence of some conventional elements in the notion of normal capacity utilization rate, but he contends that the neo-Kaleckian formulation requires not just some elements of adaptation in conventional behaviour, but also a process that is both quantitatively fast and unbounded in order to guarantee the functioning of the stabilizing mechanism[2].

More recently, other authors have justified this assumption by means of a microeconomic model in which firms minimize costs under the condition of increasing returns to scale (Nikiforos, 2013, 2016; Dàvila-

[2] If the normal rate does not adjust sufficiently fast with respect to the accelerator mechanisms Harrodian instability would still be there.

Fernàndez et al. 2017). In this scheme, the production level would have a positive effect on the desired degree of capacity utilization.

In any case, even these "reinterpretations" have been stumbled on some criticisms, both for an internal inconsistency and for the manner of the aggregation process from micro to macro. On the one hand, it is assumed that firms take prices as given when increasing returns should entail a certain degree of monopoly, on the other hand, it is assumed that the variation in the average output of individual firms depends on the discrepancy between the expected growth rate and the realized one while, when the growth rate of the economy is equal to the expected one, the variation in production for each firm is zero (Pariboni and Girardi, 2018).

Starting from the contribution of Serrano (1995a, 1995b), some Sraffian authors belonging to the so-called second Sraffian position (Cesaratto, 2015) have developed the Supermultiplier model (SM) which determines in the long-run a "*fully adjusted position*" (Vianello, 1985). Because of the presence of the autonomous component, investment variations do not proportionally modify aggregate demand and, through the adaptive expectations function, firms gradually incorporate the effect of investment decisions on the aggregate demand, leading to a progressive variation in the share of investments on total production. If the exogenous growth rate of the autonomous component remains constant for a sufficient number of periods, such mechanisms engender the convergence of expected and realized growth rate to that of the autonomous component and the degree of capacity utilization converge to the normal one.

Anyway, also this model ran into some criticisms (Palumbo and Trezzini 2003; Nikiforos 2018; Skott 2019). Some Sraffian authors belonging to the so-called first Sraffian position reject the analysis of growth through *steady-state* positions turning down the idea that the long run degree of capacity utilization can be, continuously or on average, equal to the normal one (Trezzini and Palumbo, 2016).

Recent contributions claim that the exogenous trend of the autonomous components of demand should be considered as a short- or medium-term phenomenon (Lavoie, 2016; Skott, 2017a, 2019; Nikiforos, 2018). In this regard, various authors have criticized the SM model regarding the incompatibility between the hypothesis of an exogenous trend of autonomous components of demand with a long-term analysis. Lavoie (2016) argues that "*in the long run there is no truly exogenous variable"* (p.194). In detail, this hypothesis would not be consistent with the role played by these components, namely as stabilizers of the model in the long run. Various arguments are supporting this thesis.

According to Nikiforos (2018), in the long run, the autonomous component cannot be considered independent from short and medium-run realization. In particular, the author points out that the hypothesis of an exogenous long-term trend of some autonomous component is contradictory from a stock-flow consistent point of view. Since, by definition, the autonomous component (consumer credit, residential investment, or public spending) must constitute an injection of purchasing power outside the pre-existing circulation of income, the financing of a given component would necessarily involve a change in the stock of debt.

> Stock-flow consistency implies that debt-financed "autonomous" expenditure increases the stock of liabilities of the related sector (Nikiforos 2018, p. 13)

In this sense, following the traditional mechanisms of financial instability (Minsky 1975, 1986; Kindleberger and Aliber 2011), the momentary expansion driven by the growth rate of the autonomous components would increase the debt-to-income ratio, making the financing process of these components unsustainable. This dynamic would modify the response mechanisms of the model and the same pattern of the autonomous component: in the long-term, the adjustment would not take place through variations in income and in the degree of capacity utilization but through changes in the autonomous component itself. At this point, the model would lose the key to its stability and the growth path would not converge to the steady-state.

Skott (2019) states that the hypothesis of long-term exogeneity of the autonomous components has no basis, both theoretically and empirically. The author asks whether the autonomous components of the SM, which can be considered as such only in the short term, can be used as stabilizers for an adjustment that takes place in the long run: for example, can real estate bubbles or shocks on military spending be seriously considered as a mechanism for stabilizing a Harrodian economy? More in detail, the author affirms that the implications on the stationary growth path predicted by the SM would be of little interest unless the convergence is fast enough. However, in this case, the theory would encounter a further problem: a sufficiently fast adjustment towards the steady-state would require an equal speed in the response of the accumulation process, so as to produce Harrodian instability[3]. Therefore, both paths would not be feasible to justify the long-run convergence towards the steady-state.

In this paper, taking the SM as the reference model for the aggregate version, we are highlighting the features that emerge in a market economy once the implicit assumption on the centralized control over the aggregate productive capacity characterizing the aggregate model is removed. Or, in other words, once the interaction between the multiplier and accelerator is explicitly reproduced within a multi-firm economy.

More in detail, we confute both Neo-Kalekcian and Sraffian positions and related critiques, pointing out that the aggregate equilibrium does not necessarily have to correspond with the realization of the desired state of individual firms. In this respect, we are not questioning whether the normal rate has to be associated with profit maximization, competitive requirements, spare capacity needed to match peaks in demand or conventional behaviours. Instead, we are claiming that, once the single firm has fixed its desired degree, no

[3] In addition, Skott (2017) argues that, for any plausible (in the sense of empirically verifiable) combination of parameters, the steady state solution is unlikely to be stable: the portion of aggregate demand regardless of current income should be exaggeratedly large for ensure the stability of the model.

mechanisms ensure that - on aggregate - such condition can be realized.

Developing an Agent Based – Stock Flow consistent (AB-SFC) growth model with an exogenously given normal rate and the autonomous component of demand, we show that a model based on the same features of the Supermultiplier can produce a sort of neo-Kaleckian "equilibrium", namely the normal degree of capacity can remain fixed without implying a process of gravitation toward it. Parallelly, unlikely to the neo-Kaleckian model, the constant attempt of firms to restore a normal degree of capacity utilization within the model does not generate Harrodian Instability: in the *quasi steady-state* firms keep trying to restore a normal degree of capacity utilization without succeeding in that and there is not a necessity to assume the endogeneity of the normal degree to the realized one.

Comparing the aggregate and disaggregated version of the model, we show that, in correspondence with the parameter setup for which the aggregate model determines a balanced growth path, the AB version produces endogenously the fluctuation of the business cycle, while the long-run aggregate degree of capacity utilization fluctuates around a level lower than the normal one.

In this respect, in contrast with the traditional wisdom according to which the fully adjusted position is the only compatible with a stable accumulation, we show that a degree of capacity utilization lower than the desired one can represent an "equilibrium position".[4] Or rather, the same attempt of single firms to restore a normal degree of capacity utilization has a counterproductive effect: the feedback loop between firms investment decisions and aggregate demand cause a "perverse" dynamic which does not allow the long-run convergence of the aggregate degree of capacity utilization to the desired one. In particular, multiple degrees of capacity utilization (different from the normal one) results to be compatible with a stable process of accumulation. The equilibrium level depends on the value of the accelerator and factors affecting the intertemporal variance of the demand distribution such as the number of firms in the economy or the degree of monopoly.

We demonstrate that this emergent phenomenon is due to the inclusion of the multiplicity of firms in place of the aggregate macro-firm characterizing the Supermultiplier model.

The rest of the paper is organized as follows. Section 2 presents the aggregate version of the model and resume briefly the main advantage with respect to the traditional version of the SM. The main features of the AB version are reported in Section 2.1. In Section 3 we discuss the results of the model and the empirical validation, also according to the different assumptions on firm heterogeneity, and rigid or dynamic networks. Section 4 concludes.

[4] An equilibrium characterized by undesired realizations.

2. Exogenous normal degree of capacity utilization and the capacity adjustment principle: The Supermultiplier and the monetary circuit based - growth model

The *demand-led* growth model developed in this paper is based on the monetary circuit framework (MC) and presents the same feature of the SM (Serrano 2015, Cesaratto et al. 2003): the capacity adjustment principle, the exogenously given normal rate, an autonomous component of demand and adaptive expectations.

The SM extends to the long-run principle of effective demand and combines the role of non-capacity creating autonomous components of demand with the accelerator mechanism. Firms try to adjust productive capacity to match the expected demand in correspondence with the normal or desired degree of capacity utilization. The long-run income is the result of the interaction between the multiplier and accelerator mechanisms and savings adjust to investments by variations in the level of production and the corresponding production capacity. In this approach, the distribution is determined exogenously starting from historical, institutional and social factors, inherent in the bargaining power of the classes and social norms regarding the fairness of remuneration (see, for example, Stirati, 1994 and Levrero, 2013). The main result of the model is that, in the long-run, the output growth rate converges towards that of the autonomous component while the degree of capacity utilization converges to the normal one.

The present model combines these features with a different economic structure regarding the "origins" of the aggregate demand taking as reference the monetary circuit theory[5]. To this extent, unlike the SM, wages and inputs are paid in advance and firms need to estimate both current and future demand[6]. Conversely, because of the economic structure built on the income/expenditure scheme, the SM implicitly assumes an on-spot economy: all firms know in advance current demand[7] and wages and profits are paid ex-post with respect to sales realization (production is constantly equal to demand)[8].

Thus, while loans finance only the anticipations in investments goods in the SM, they are intended to finance also the anticipations in terms of wages and circulating capital in the MC. Latest represent the initial injection of purchasing power in the MC, instead of the exogenous component of demand of the SM (usually,

[5] See Di Domenico (2020) for the reference model and a detailed discussion about.

[6] The future demand is the expected demand for the period in which the capital good would be available.

[7] They have to estimate only future demand in fixing investment decisions.

[8] The injection of purchasing power carried out in correspondence with the autonomous component of a given period triggers a multiplicative sequence in the periods to come which is intertwined with the multiplicative sequences triggered by the autonomous expenditure realized in the previous periods and to be realized in future periods. For instance, an autonomous demand in the period t equal to 50, generates a production of equal value and a downstream payment of incomes equal to 50. In the following period, a portion of this income will constitute the induced consumption demand generating, together with the value of the autonomous component of this period, a production and income of equal value. The income distributed at the end of that period will form the consumption base for the next period, and so on.

public spending or autonomous consumption).

At last, as in the Supermultiplier investments are completely induced and firms try to adapt productive capacity in order to maintain a normal degree of capacity utilization.

We choose to develop this model because it is immune to the critique addressed to the traditional version of the SM (Nikiforos 2018; Skott 2019), while it preserves its main features. Indeed, in this framework, there is no need to assume an exogenous growth rate of the autonomous component in the long run. In the SM the autonomous component represents the initial injection of money into the system and the original source of demand, without this the system results to be undetermined and the economic system could not be represented. Thus, such kind of assumption is unavoidable.

On the contrary, in the MC, aggregate demand is endogenously generated by firms' anticipations in financing production costs (wages and input), these take the place of the Supermultiplier exogenous injection of purchasing power realized through of the exogenous autonomous component. This makes it possible that all the components of demand, including the autonomous one, can be considered endogenous in the long run. For this reason, the system can be determined independently to the assumption on the long-run growth rate of the autonomous component. This differential approach is particularly relevant for the assumption of an exogenous long-term trend of autonomous consumption[9].

To this extent, the comparative results presented in Section 3 are referred to the aggregate and disaggregated version of the MCG model. Anyway, concerning the core argument of the paper, the same results can be reproduced adopting a disaggregated version of the SM model.

[9] To this respect, the consumption function can be formalized in various way, i.e. path dependent consumption function or traditional post-keynesian function where consumption depend both on income and wealth. The central issue is that these autonomous component of demand do not constitute the initial injection of money into the system but are originally financed by firm anticipations, thus, in monetary terms, by firms indebtedness themselves.

2.1 The model

The macroeconomy is populated by firms operating in the capital sector (K), firms producing the consumption good (C), households (H), Government (G), Central Bank (CB) and a commercial bank (B) interacting in four markets:

- Capital market;
- Consumption market;
- Labor market;
- Credit market

The economic system is described by the flow diagram of the following figure:

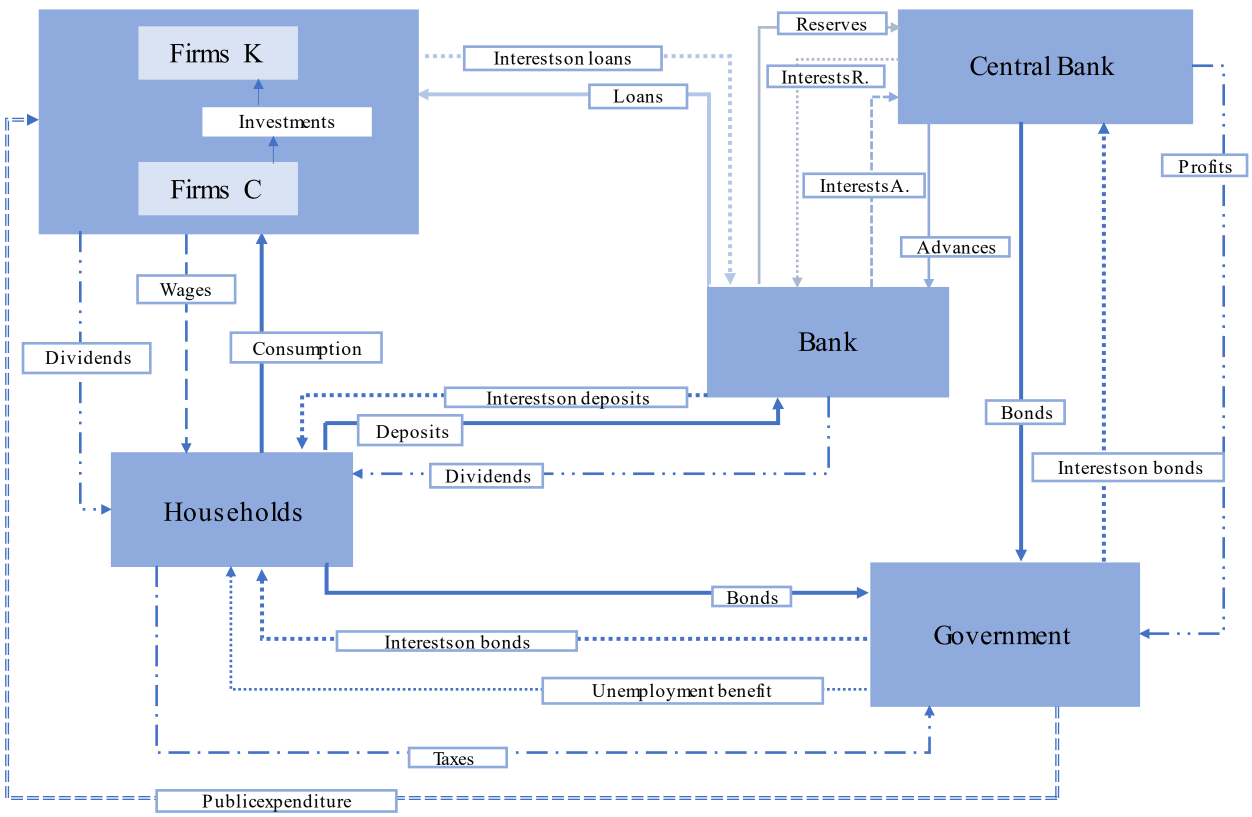

Figure 2.1: Diagram of the economic system

The household sector consists of workers and capitalists. Workers offer labor to firms and receive wages in exchange, each capitalist owns a single firm (the number of capitalists equals the number of firms) and consumes part of the dividends distributed at the end of the previous period[10]. The capitalists hold their savings in the form of deposits and public bonds, workers exclusively in the form of deposits.

In sector C, firms produce the consumer good by means of labor and capital, while the capital sector (K) is an integrated sector in which firms produce using only labor as external input.

Firms operating in sector C define the level of production for each period starting from the expectations on future demand and the desired level of inventories. They invest in order to match the expected demand in correspondence with a normal degree of capacity utilization. Moreover, they pay in advance wages and capital, while firms K produce on-spot based on orders received. The price of the goods is set according to the logic of production costs, while the markup evolves following the dynamics of market shares and/or the differential between realized and desired inventories (as a proxy for the competitiveness of goods).

The number of firms is fixed, while their size varies endogenously depending on the evolution of aggregate demand and its distribution. Firms, in their respective sectors, have the same technical conditions (capital/output, capital/labor ratio and normal degree of capacity utilization). Depending on the leverage target, firms finance production decisions through a mix of self-financing and loans. Firms with negative net wealth and that are unable to repay debts go bankrupt[11].

There is only one commercial bank that provides credit to firms and collects household deposits. The interest rate on deposits and loans depends on the rate set by the monetary authority.

Finally, the Government, based on tax revenues, profits redistributed by the CB and total current expenditure, issues government bonds to finance the deficit. The share of public bonds not acquired by households is held by CB which act as lender of last resort. The Government's direct public spending is distributed among C firms proportionally to their productive capacity. Below are the behavioural and accounting equations of the agents in the various sectors.

2.1 Consumer Sector

The production of the consumer goods uses as inputs labor and fixed capital:

$$l_c \oplus k_c \rightarrow C$$

Firms C fix current production ($y_{t,i}^d$) based on expected demand ($q_{t,i}^e$). This is determined through an adaptive expectation based on sales realized in previous periods. In addition, firms consider a store of inventories to address the discrepancies between expected demand and realized one.

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[10] Bank dividends are equally distributed across capitalists.

[11] The bankrupt firm is replaced by a new company with a smaller expected quantity to be produced.

$$q^e_{t,i} = q^e_{t-1,i} + \alpha(q^r_{t-1,i} - q^e_{t-1,i})$$

$$y^d_{t,i} = \max\{0, q^e_{t,i}(1+\sigma^T) - inv_{t-1,i}\}$$

Where σ^T is the desired ratio of inventory on sales and $inv_{t-1,i}$ is the amount of inventories from the previous period. The degree of capacity utilization in correspondence of the planned production is:

$$\omega^e_{t,i} = \min\left\{1, \frac{y^d_{t,i} v^*_{c_{t,i}}}{k_{t,i}}\right\}$$

Where $v^*_{c_{t,i}}$ is the capital/output ratio in correspondence with the full utilization of the productive capacity. Given the amount of capital needed to produce $y^d_{t,i}$ and the capital/labor ratio ($\alpha_{c_{t,i}}$) it is possible to determine the labor demand:

$$L^d_{t,i} = \frac{\omega^e_{t,i} k_{t,i}}{\alpha_{t,i}\, v_{t,i}\, h^m} = y^d_{t,i} l_{t,i}$$

Where h^m is the maximum amount of working hours that each worker can work in a single period, $k_{i,t}$ is the amount of fixed capital and $l_{t,i}$ is the amount of required working hours per unit of output.
The feasible production will be[12]:

$$y_{t,i} = \min\left(\frac{L_{t,i} h^m}{l_{t,i}}; \frac{k_{t,i}}{v^*_{t,i}}\right)$$ [13]

Investment function:
Firms C adjust productive capacity in order to satisfy expected demand with a normal (desired) degree of capacity utilization (in the period in which the capital will be available, that is in $t + dk$):

$$I_{t,i} = \max\{0; q^e_{t+dk,i}(1+\sigma^T) v^n_{t,i} - k_{t+dk,i}\}$$ [14]

[12] The production function is characterized by fixed coefficient of production (Leontieff technology).
[13] Where $l_{i,t} = \frac{v}{\alpha}$, that is the ratio between capital/output ratio and capital/labor ratio.
[14] It is worth noticing that this investment function is the general formulation of the investment function adopted in the SM, that is $I_t = v(\delta + g^e_t)Y_t$. To this respect, while the latest is valid only in the steady state and, thus, could not be used to demonstrate the convergence process towards normal utilization, this is also valid outside the balanced growth path. Indeed, the general corresponding formulation $I_t = vY_t(1 + g^e_{t+1}) - K_t(1-\delta)$ can take the form of SM investment function only if the degree of capacity utilization is already at the normal level. Only in this case it is possible to substitute $k_t = Y_t v$ and getting the SM formulation (See Di Domenico, 2020).

where v_c^n is the ratio between capital and normal output, $k_{t+dk,i}$ is the residual capital in the period in which the ordered capital would be installed if the investments were not made[15], $g_{t+1,i}^e$ is the expected growth rate of demand and dk is the number of periods needed to produce one unit of the capital good.

$$q_{t+dk,i}^e = q_{t,i}^e(1 + g_{t,i}^e)$$

$$g_{t,i}^e = g_{t-1,i}^e + \alpha\left(g_{t-1,i}^r - g_{t-1,i}^e\right)$$

The stock of capital in period t is composed by the residuals of capital goods installed in the previous z + 1 periods (vintage capital goods), with z representing the life span of the capital good:

$$k_{t,i} = \sum_{j=t-z+1}^{t} k_{j,i}^{ins}\left(\frac{j+z-t}{z}\right)$$

where $k_{j,i}^{ins} = I_{t-dk,i}$ is the amount of capital installed in period j and corresponds to the gross investment carried out dk previous periods. The total deterioration in each period is composed by the sum of the deterioration of capital goods installed in the previous z periods (including the current one):

$$deterioration_{t,i} = \sum_{j=t-z+1}^{t} \frac{k_{j,i}^{ins}}{z}$$

Amortization is needed to compute unit costs and profits. The amortization for computing unit cost includes both the cost of capital and the cost of debt service considering the realized leverage[16]:

$$amortization_{t,i} = \frac{1}{a\,z} \sum_{j=t-z+1}^{t} p_{i,indexK} k_j^{ins}(1 + r_j b l_j)(j + z - t)$$

where r_j e l_j represent, respectively, the interest rate in the period in which the debt was contracted and the *leverage* realized in purchasing the capital good.

$K_{j,i}^{ins}$ is the installed capital in period j from firm i and $p_{i,indexK}$ is its price (because z is the useful life of the capital, it goes back up to a maximum of z periods in the depreciation calculation). $a = \sum_{i=1}^{z} \frac{i}{z}$ e $b = \frac{1}{a\,z}\sum_{i=1}^{z} \frac{i^2+i}{2}$ are the multiplying factors for the computation, respectively, of the interest accrued on loan granted in a given period and of the (potential) cumulated production (in correspondence of the normal degree of capacity utilization) over the useful life of capital good. Because the capital good has a finite

[15] The capital good ordered in period t is installed in period $t + dk$.
[16] See Di Domenico (2020) for an explanation on amortization and unit cost computation.

useful life, a constant absolute depreciation of installed capital is adopted and, therefore, the related depreciation rate is increasing.

2.2 Capital sector

$$l_k \rightarrow K$$

Given the number of periods required to produce the K good (dk)[17], the quantities that firm i wishes to produce in each period is:

$$yd_{t,i} = \sum_{j=t-dk}^{t} \frac{orders_{j,i}}{dk}$$

Where the summation corresponds to the number of capital goods ordered to firms i, from previous dk periods to period t[18].

Given $yd_{t,i}$, it is possible to determine the labor[19] demand:

$$L_{t,i}^{d} = \frac{yd_{t,i} l_k}{h_{month}}$$

The unit cost of K good is:

$$c_{t,i}^{k} = w_{t,i} l_k$$

2.3 Price Setting

Prices are determined according to the normal-cost pricing (Andrews, 1949; Andrews and Brunner, 1975). The unit cost (which takes into account the different age of the capital goods) is defined in correspondence with the normal degree of capacity utilization and amortization is computed adopting the full cost methodology[20]. A markup is applied to the normal unit cost and it corresponds to the normal rate of profit.

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[17] dk is a key parameter in determining the magnitude of the interaction between multiplier and accelerator.

[18] In each period a portion of $1/dk$ of each order is produced.

[19]The inclusion of working hours is necessary since the worker is indivisible. Otherwise, because the number of hires is rounded up with respect to what is actually necessary, firms would structurally produce more than desired (or paying an higher amount of wages with respect to the actually used labor).

[20] According with the principle of opportunity cost, the interest rate is applied to all the inputs of productions or all the anticipations (See Pivetti, 1985, 1991). That is, a leverage equal to one is adopted to compute the unit cost.

The unit cost is:

$$c_{t,i} = \frac{\overline{w}_{t,i} * L_{n_{t,i}}}{y^n_{t,i}}(1 + ra_s z_s) + \frac{am_{t,i}}{y^n_{t,i}} =$$

$$\left(\overline{w}_{t,i} l_c (1 + ra_s z_s) + \frac{\frac{1}{a\,z}\sum_{j=t-z+1}^{t} p_{k_j} K_j^{ins}(1 + r_j b l_j)(j + z - t)}{\frac{\omega^n}{v^*_{t,i}}\sum_{j=t-z+1}^{t} K_j^{ins}\left(\frac{j + z - t}{z}\right)} \right)$$

where $L_{n_{t,i}}$ is the amount of working hours corresponding to the normal degree of capacity utilization, $y_{n_{t,i}}$ is the normal production, $\overline{w}_{t,i}$ is the nominal wage, $am_{t,i}$ is the amortization, p_{k_j} is the price of the capital acquired in period j, a_s is the multiplicative factor to compute the total debt service and z_s is the payback time of short loans (aimed at advancing wages). If p_{k_j}, r_j and l_j are constant over time and $l_j = 1$ (full-cost pricing), the equation of unit cost is reduced to:

$$c_{t,i} = \overline{w}_{t,i} l_c (1 + ra_s z_s) + \frac{v^*_c p_k}{a\omega^n}(1 + rb)$$

In tune with the aim of this paper, we adopt two different configurations regarding markup formation and supplier selection. To keep the same structure as in the Supermultiplier model, in Scenario A we assume a constant and exogenous distribution, thus markups are fixed and equal across all firms. In Scenario B, markups are formed endogenously. More in detail, in Scenario B, the evolution of markups depends on competitive mechanisms as follows.

Firms C increase markup ($\varphi^{uc}_{t,i}$) if the ratio between inventories and sales has been for a number of consecutive periods $\rho^{lim,inc}$ lower than desired and the realized degree of capacity utilization has been above the normal one. Vice versa, if the inventories-to-sales ratio has been for a number of consecutive periods $\rho^{lim,dec}$ higher than the target level, firms decrease markup. In all other cases, firms keep markups constant:

$$\varphi^{uc}_{t,i} = \begin{cases} \varphi^{uc}_{t-1,i}(1 - FN) \;\; if \;\; \rho^{r,dec}_{t-1,i} > \rho^{lim,dec} \\ \varphi^{uc}_{t-1,i}(1 + FN) \;\; otherwise\ if \;\; \left(\bar{u}^r_{t-1,\dots,t-s} > u_n \wedge \rho^{r,inc}_{t-1,i} > \rho^{lim,inc} \right) \\ otherwise \;\; \varphi^{uc}_{t-1,i} \end{cases}$$

where FN is the stochastic variation of markup starting from a normal distribution, $\rho^{r,dec}_{t-1,i}$ is the number of consecutive periods in which sales have been lower than expected, $\rho^{r,inc}_{t-1,i}$ is the number of consecutive periods where sales have been higher than expected, $\bar{u}^r_{t-1,\dots,t-s}$ is the weighted average with decreasing weight of the realized degree of capacity utilization in the last s periods.

Firms K fix markups based on the market shares evolution[21]:

$$\varphi_{t,i}^{uc} = \begin{cases} \varphi_{t-1,i}^{uc}(1 - FN) \quad if \ \rho_{t-1,i}^{r,dec} > \rho^{lim,dec} \\ \varphi_{t-1,i}^{uc}(1 + FN) \quad otherwise \ if \quad \rho_{t-1,i}^{r,inc} > \rho^{lim,inc} \\ otherwise \ \varphi_{t-1,i}^{uc} \end{cases}$$

$\rho_{t,i}^{r,dec}$ e $\rho_{t,i}^{r,inc}$ are computed according to the differential between the realized market share and the target one.

2.4 Supplier Selection

In the baseline model (Scenario A), prices are kept exogenously equal across firms (technology and markups are uniform), households and firms choose randomly their supplier. In Scenario B, they select the supplier which offers the homogeneous good at the minimum price. In the second case, the mechanism is as follows:

in each period, households and C firms pick out the supplier with the lowest price within a subgroup of potential suppliers. The probability of changing supplier (with respect to the supplier of the previous period) is a function of the price differential between such price and that of the supplier of the previous period (parameter ϵ express customer loyalty):

$$Pr_{t,i} = \begin{cases} 1 - e^{\frac{\epsilon\left(p_{t,index} - p_{t,index \ \ t-1}\right)}{p_{t,indexC}}} & if \quad p_{t,index} < p_{t,index \ \ t-1} \\ 0 & otherwise \end{cases}$$

Where ϵ is the elasticity for the price differential, $p_{t,index}$ is the price of the firm selected at time t and $p_{t,indexK_{t-1}}$ is the price offered by the supplier of the previous period. Given a specific price differential, as ϵ increases, the probability that the consumer or firm will change supplier increases.

2.5 Households

Consumption demand is a function of the income and wealth stock. The basic idea is that there is a target wealth-to-income ratio, which a consumer would like to attain over time (Godley and Lavoie, 2007):

$$\text{Workers: } c_{i,t}^{D,w} = YD_{t,i}c_{1,w} + V_{t-1,i}c_{2,w}$$

where:

[21] Firms in sector K produce on-spot, so they do not have a discrepancy between expected and realized sales (they cannot use the inventories/sales ratio as a proxy of the attractiveness of their goods).

$$YD_{t,i} = \begin{cases} \left(w_{t,i}h_{t,i}^{work} + M_{t-1}r_{t-1}^{m}\right)\left(1-\tau^{work}\right) \; if \; employed \\ \left(w_{gov} + M_{t-1}r_{t-1}^{m}\right)\left(1-\tau^{work}\right) \; otherwise \end{cases}$$

where $h_{t,i}^{work}$ are the monthly worked hours, w_{gov} is the unemployment benefit and τ^{work} is the tax rate on workers income. Workers hold all their wealth in the form of deposits: $V_{t,i} = M_{t,i}$.

The capitalist consumption function is:

$$c_{i,t}^{D,\pi} = \min\left(YD_{t-1,i}c_{1,\pi} + V_{t-1,i}c_{2,\pi}, YD_{t-1,i} + M_{t-1,i}\right)$$

Capitalists income is made up of dividends distributed by firms and the bank, the interest accrued on deposits and public bonds:

$$YD_{t-1,i} = \left(Div_{t-1,i} + M_{t-1,i}r_{t-1}^{m} + B_{t,i}^{h}r_{t-1}^{b}\right)\left(1-\tau^{\pi}\right)$$

$Div_{t-1,i}$ are dividends and τ^{π} is the tax rate on capitalists income.

The stock of capitalist wealth is made up of deposits and government bonds:

$$V_{t,i} = M_{t,i} + B_{t,i}^{h}$$

$$V_{t,i} = V_{t-1,i} + YD_{t-1,i} - C_{t,i}$$

The demand for government bonds is a function of the stock of wealth, disposable income and the interest rate (Tobin, 1982):

$$\frac{B_{t,i}^{d}}{V_{t,i}} = \lambda_0 + \lambda_1 r_t^{b} + \lambda_2\left(\frac{YD_{t,i}}{V_{t,i}}\right)$$

2.6 Commercial Bank

The banking sector consists of one single commercial bank. This plays a passive role, supporting the credit demand of firms and collecting household deposits. In determining the interest rate on loans, the bank sets a markup on the rate set by the central bank. The interest rate on loans is higher than that on deposits. The difference between loans and deposits is held as reserves at the CB (reserves accrue at an interest rate equal to that of deposits).

2.7 Government

The public sector has a direct and exogenous component of expenditure dependent on consumer goods demand and an endogenous component linked to unemployment benefits and the debt service. Direct public expenditure is constant, while unemployment benefits and debt service results to be countercyclical:

$$G_t = \bar{G} + Ubenefit_t$$

$$Ubenefit_t = U_t wgov_t$$

Where $G_{c,t}$ is direct public expenditure (demand for consumption goods), $g_{G,c}$ is the real growth rate of direct public expenditure, π is the inflation rate and U_t is the number of unemployed. The unemployment benefit ($wgov_t$) is a percentage of the expected average wage paid by the private sector:

$$wgov_t = \varepsilon_{gov}\bar{w}_t^e$$

$$\bar{w}_t^e = \beta\bar{w}_{t-1} + (1-\beta)\bar{w}sign_{t-1}$$

$$\bar{w}sign_{t-1} = \beta\bar{w}_{t-1} + (1-\beta)\bar{w}sign_{t-2}$$

Government accounting is:

$S_g = G_t - \theta Y_t + r_b B_{-1} - F_t^{cb}$ where F_t^{cb} are distributed profits by CB, θ is the tax rate, B_t is the stock of public debt.

The supply of public bonds is:

$$B_t = B_{t-1} - S_g$$

$$B_t = B_{h,t} + B_{cb,t}$$

2.8 Central Bank

Central bank profits depend on interest earned on public bonds (B_{t-1}^{cb}), advances *(A_{t-1})* and from interests paid on reserves (H_{t-1}^{cb}).

$$\pi_t^{cb} = B_{t-1}^{cb} r_{t-1}^b - H_{t-1}^{cb} r_{t-1}^h + A_{t-1} r_{t-1}^a$$

CB acts as the lender of last resort in the public bonds market:

$$B_t^{cb} = B_t - \sum_i^{ncap} B_{t,i}^d$$

Where $\sum_i^{ncap} B_{t,i}^d$ is the amount of bonds held by capitalists.

Since households hold their savings in the form of deposits or public bonds, the amount of bonds purchased by the CB is equal to the amount of households deposits.

See Appendix 1 for all the equations regarding the stock-flow consistency check, financing of production decisions, bankruptcy and accountancy.

3. Findings: The equilibrium can be "undesired"

To analyze the properties of the model and the processes that characterize the co-evolution of the micro and macro variables, the model is solved through simulations. In order to eliminate the stochastic variability across these and to test the robustness of the model, the following results correspond to the median values of the Monte Carlo analyzes. In the initialization of the model, to minimize the variability of the output, stocks are taken equal to zero, except for the initial endowment of capital. The initial capital stock is such as to allow to produce the quantity initially desired at the normal degree of capacity utilization. The other stocks, such as debts, bonds and deposits are zero. Trivially, this type of initialization complies by construction with Copeland's principle of four entries and, therefore, the economic system starts from a condition of stock-flow consistency.

To keep all features as in the traditional SM, the propensity to consume out-of-wealth, interest rates, and unemployment benefits are set to zero[22]. As it is implicitly assumed in the SM, firms do not retain profits to finance investments, thus firms distribute all profits to capitalists[23]. Public expenditure is the only autonomous non-capacity creating component.

In this section, we depict the different implications for the long-run trend of the degree of capacity utilization (and the possibility or not of studying the long-term growth according to *steady-state* positions) deriving from an analysis based on disaggregated models. The following results are referred to the baseline model with no heterogeneity across firms and, in tune with the traditional AB approach, with local interactions[24]. In this sense, the setup of the disaggregated version simply consists of a redistribution of the initial aggregate productive capacity of the macro-model across many firms. As we are going to point out, the implications depend exactly on the fact that the control over the aggregate productive capacity is split across different agents that takes uncoordinated decisions.

In Figure 3.1, the results of the aggregate and disaggregated models are reported. Given the same setup of parameters[25] for which the aggregate model determine a *balanced growth path* with a normal degree of capacity utilization, in the disaggregated model the fluctuations of the business cycle emerge, the level of GDP results to be higher and the long-term (aggregate) degree of capacity utilization persistently fluctuates around a level lower than the normal one ($u_n = 0.7$). As we will subsequently see in the empirical

[22] Households do not generate income from the stock of savings and the public debt is totally held by CB.
[23] The leverage to finance investment is equal to one.
[24] In the baseline model, in order to keep the general feature as close as possible to the aggregate version, prices are constant and equal across firms (same technology and markups) and household choose randomly their supplier (Scenario A):
[25] Setup of parameters stand for both technical conditions and values of variables as public expenditure, tax rates and interest rates. See Appendix 2 for the table reporting the parameter setup.

validation of the model (Section 3.1), the bottom-up reproduction of the features of the macro-model is capable to reproduce many stylized facts.

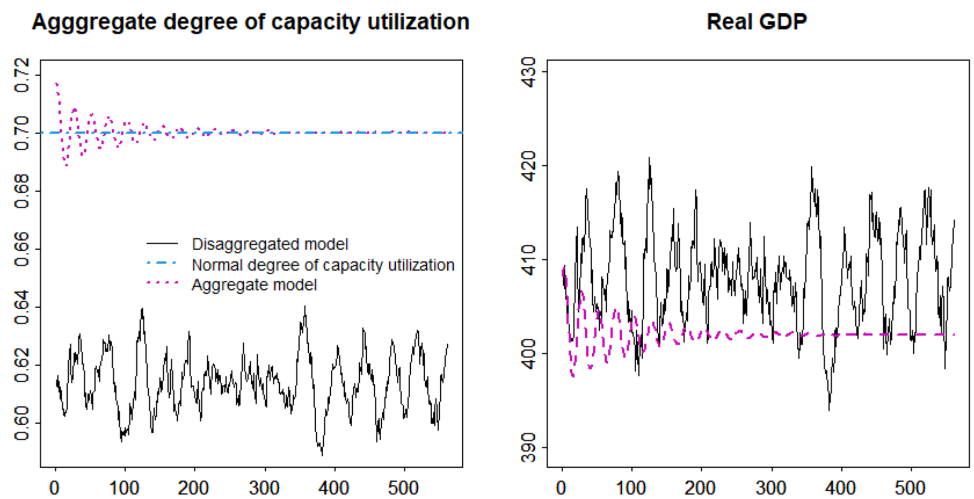

Figure 3.1: (Aggregate) degree of capacity utilization and GDP in the two versions of the model. Averages for 50 MC runs in the period [200, 800]

The core of the difference in the mechanisms between the one-firm economy and AB version is the following: since we consider a multitude of firms in place of the traditional single macro-firm, the rigid *ping-pong* between investment decisions, changes in aggregate demand, and variations in the degree of capacity utilization is lost. The lack of this feature implies that it is not possible to describe the convergence towards a *fully adjusted position*, on the contrary, the degree of capacity utilization, in the long term, shows a fluctuating pattern. This is the result of two properties that necessarily emerge when a number of firms higher than one is considered:

i) The dynamic instability in the differential between the contribution share that each firm gives, as a result of its production, to the formation of the aggregate demand and the share of demand that "flows back" to the firm itself through sales realization.

ii) The interplay, via investment channel, between the level of aggregate demand and the way it is distributed across firms. That is, given the same level of aggregate demand, a different distribution across firms produces different reactions in terms of investments, thus different changes in the aggregate demand itself.

The first one is responsible for the persistence of fluctuations and the endogeneity of the business cycle, the second one is for the lower level around which the (aggregate) degree of capacity utilization fluctuates.

Regarding the first issue, in each period, firms contribute differently to feed aggregate demand through the purchase of capital goods, payment of wages and distribution of dividends. At the same time each firm, through sales realization, benefits with a different share from the overall demand. While in the aggregate version, each variation in investments and production decisions has a rigid and constant relationship with changes in demand collected by the same macro-firm that finances it[26], the disaggregation in the production sector implies a dynamic (or intertemporal) instability in the differential (ξ) between the share with which each firm contributes to the creation of aggregate demand and the share of it that "flows back" in terms of sales realization[27]. This feature implies that the investment growth rate at the micro and macro level never stabilizes. In this regard, the realization of a *steady-state* with a normal degree of capacity utilization requires that, in the long run, during the inter periodical process of revising expectations, ξ remains constant on average. Such condition is verified by construction in an aggregate model such as the SM.

On the contrary, in the disaggregated model, through the matching mechanism and changes in the incomes of single agents the differential between the two shares varies with the succession of periods and the fluctuations persist also in the long term.

In this regard, Figure 3.2 shows the pattern of ξ in the two versions of the model[28].

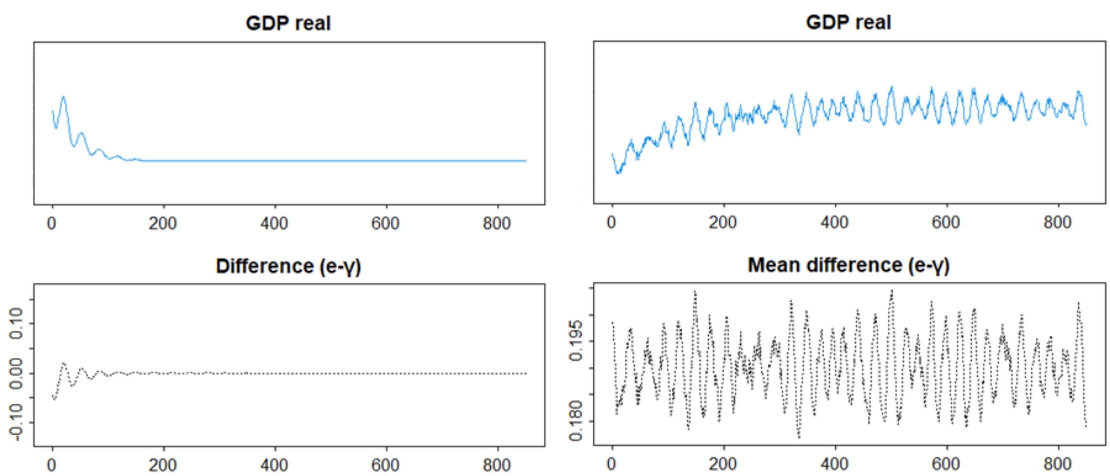

Figure 3.2: Dynamic of the Real GDP and ξ in the two versions of the model

Regarding the second point, the emergence of an aggregate degree of capacity utilization lower than the normal one is due to the dispersed nature of investment decisions with respect to the aggregate productive capacity. Since each firm observes - with multiple degrees of differentiation – a higher or lower share of

[26] In dynamic terms, in the aggregate model every production and investment decision is transformed into demand for the same macro-firm in sector C through the wages and dividends paid directly to its workers and capitalists and the dividends and wages paid indirectly through the purchase of the capital good.

[27] Trivially, for example, wages paid by a firm in sector C can turn into demand, via the consumption of workers, for another company in the same sector.

[28] The disaggregated version shows the average of the differentials between firms C. The equation of the single differential is: $\xi_{t,i} = \varepsilon_{t,i} - \gamma_{t,i} = \frac{wb_{t.i} + \mathrm{div}_{t-1.i} + \frac{\sum_{t-dk+1}^{t} Kd}{dk(1+\varphi)} + \sum_{t-dk}^{t-1} Kd \frac{\varphi}{dk(1+\varphi)}}{Gf_t + C_t} - \frac{sales_{i,t}}{Gf_t + C_t}$

the demand than that generated by itself, in each period, each firm can have a different degree of capacity utilization and, in particular, there can be firms with a lower than normal degree of utilization and others with a higher degree. This entails a significant variability in the intensity with which the aggregate acceleration process reacts to variations in the effective demand: the same level of demand, depending on the modalities of distribution across productive capacities, generates a different aggregate level of investments. More in detail, given the same level of aggregate demand, the decentralized control over the shares of aggregate productive capacity that characterize the disaggregated version necessarily causes a higher level of investments with respect to the aggregate macro-firm. Figure 3.3 is useful to explain the intuition behind this mechanism.

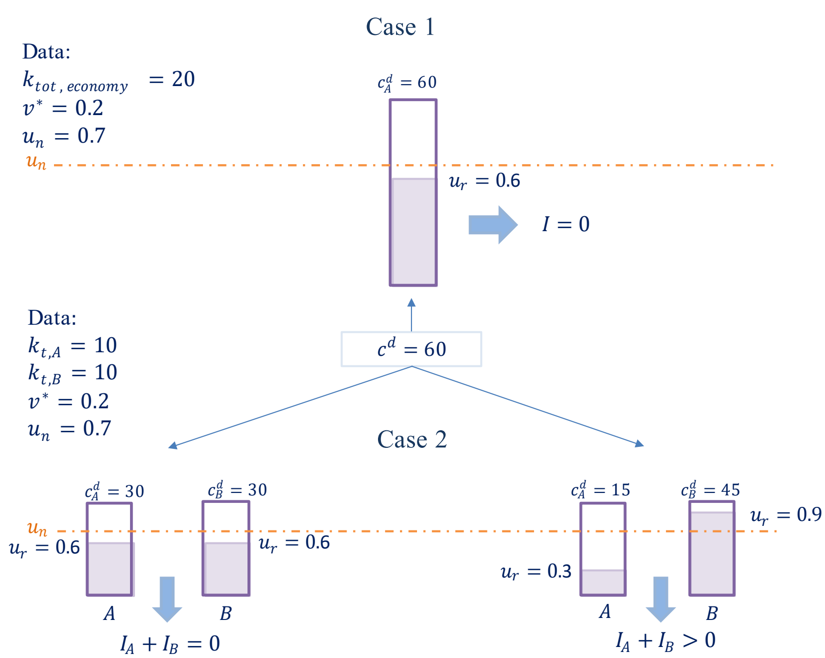

Figure 3.3: Case 1: Aggregate model – Case 2: Aggregate productive capacity is equally split among two firms

Given the same values of aggregate productive capacity, effective demand and the same coefficients of production, in the one-firm economy the level of investment is zero (Case 1), while in the two firm – economy, through the channel of demand distribution, it results to be positive (Case 2.2). More in general, because of the non-linearity of investments[29], in correspondence of the aggregate demand that produces a normal degree of capacity utilization and zero net investment in the one-firm economy, for each possible combination in the distribution of demand across firms the multi-firm economy cause a higher level of

[29] When the expected degree of capacity utilization is lower than desired one, investment are non-negative.

investments. The only special case in which the level of investments can remain unmodified is when the distribution of aggregate demand is kept constantly equal across firms and proportionally to each specific productive capacity (as in case 2.1).

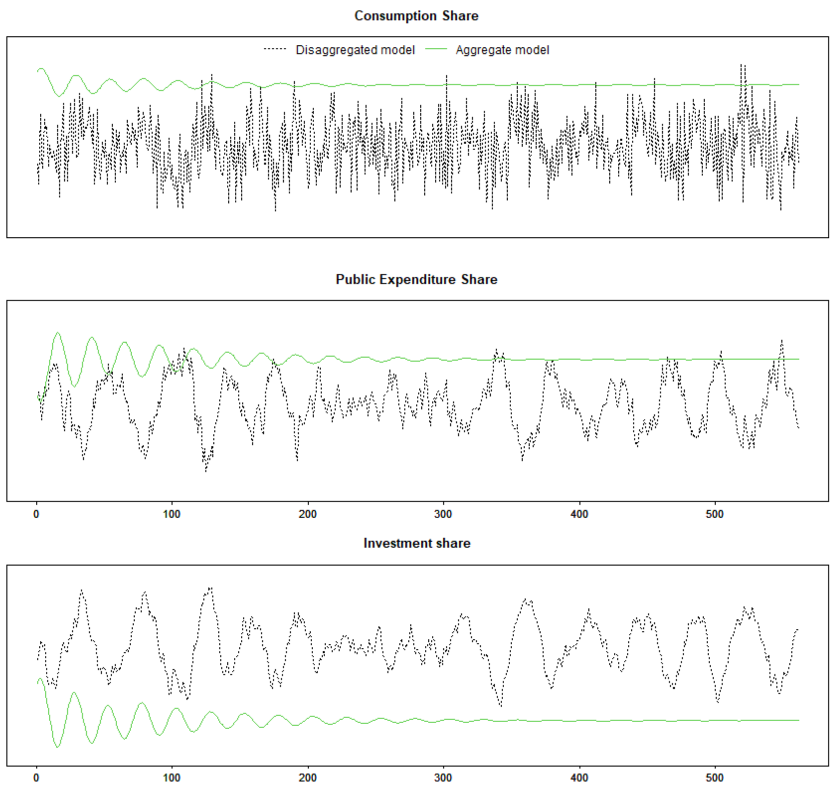

Figure 3.4: Consumption, Investments and public expenditure shares in the two versions of the model

As we can see in Figure 3.4, this dynamics is explained by a higher share of investments on aggregate demand in the disaggregated model (black lines) compared to the aggregate model (green lines). Due to the presence of the autonomous component, the aggregate demand does not react proportionally to the changes in capital stock, hence the equilibrium degree of capacity utilization results to be lower than the normal one.

Through these channels, the value of the difference in terms of GDP and long-run degree of capacity utilization between the aggregate and disaggregate model depends on the number of firms and on the value of the accelerator (that measure the degree of responsiveness of firms with respect to the divergence in the degree of capacity utilization). The results of the simulation in changes in the number of firms and the parameter expressing the accelerator (β) are reported in Table 1.

	Parameter	GDP	u_r	Investment share	u_r Volatility
Number of Firms in each sector ($\boldsymbol{\beta = 0.5}$)	1	372	0.7	0.19	0.0
	50	387	0.628	0.22	0.024
	100	388	0.614	0.25	0.021
	150	391	0.613	0.28	0.017
	200	390	0.613	0.28	0.018
$\boldsymbol{\beta}$ $\boldsymbol{(NF = 200)}$	0.41	388	0.63	0.26	0.016
	0.44	389	0.625	0.27	0.019
	0.47	388	0.618	0.27	0.015
	0.5	389	0.613	0.28	0.018

Table 1: Comparison between different model setups: Variation in the number of firms and the value of the accelerator (β). Averages for 50 MC runs in period [200, 800].

Higher is the number of firms, higher is the asymmetry in the concentration of demand across firms-specific productive capacity, and the higher will be the effect of the interplay between aggregate demand and demand distribution. For the same reason, the dimension of such effects are negatively correlated with the degree of market concentration: the higher the degree of monopoly in the economy, the more close the growth path will be to that of the aggregate model. Thus, the value of the (super) multiplier does not depend only on the propensity to consume, the tax rate, the capital intensity and the propensity to invest of firms, but also on the features that affect the variance of the demand distribution across firms. Latest affect the accelerator mechanism.

These results highlight that "in equilibrium" there may be multiple degree of capacity utilization compatible with a stable accumulation.

Thus, conversely to the standard conclusion of the Supermultiplier model, in the long run, the degree of capacity utilization can be persistently different from the desired one while the economy reaches a stationary state.

Although this outcome apparently evokes the results of the neo-Kaleckian model, it is intrinsically different: in the quasi-steady-state firms keep trying to restore the desired degree. On the contrary, in such a model, the persistency would imply Harrodian instability and it becomes necessary to hypothesize the normal degree as the adjusting variable[30]. In this respect, also in the neo-Kaleckian model, as in the Supermultiplier model, the long run is characterized by a fully adjusted position.

To some extent, such aggregate models evoke the reductionist approach of neoclassic models in which the functioning of the aggregate system is directly derived from the proprieties of single elements: the

[30] Unless the autonomous non-capacity creating component is introduced in the model (Nah and Lavoie, 2018).

equilibrium necessary have to correspond to the realization of the desired state of agents. Conversely, the proposed analysis goes in the direction of considering an economy as a complex system where the aggregate is not the sum of its component (Anderson, 1972), but emerge from the interactions across the components themselves. These systems are characterized by scale-invariant phenomena where the statistical equilibrium is spontaneously reached and, while the single elements are not in equilibrium, the aggregate is.

Finally, this depiction somehow warns about the attempt to infer the normal rate from the time series on capacity utilization. In this sense, this demonstration goes in the direction of supporting the argument of authors such as Nikiforos (2016) who argues that a constant utilization over time in empirical data can be misinterpreted as constant normal utilization[31]. At the same time, the negation of such an argument does not necessarily represent proof of the adaptation in conventional behaviour. To this respect, some neo-Kaleckian contributions estimate the normal degree of capacity utilization using a moving average of the average capacity utilization (Bassi et al. 2020) or the Hodrick-Prescott filter (Lavoie, 2004) [32]. As we have seen, a similar exercise would lead to an incorrect estimate.

[31] As shown, the degree of capacity utilization can persistently fluctuate around a constant value, although this value is not the normal one.

[32] The same apply to the methodology proposed by Botte (2019) who criticize Lavioe and Bassi et al. contribution. Such methodology consist of a weighted average of past values with exponentially decaying weight.

3.1 Empirical Validation

The macro-dynamic depicted by the AB version is capable to reproduce some stylized facts. In this regard, the so-called Method of Simulated Moments has been adopted to calibrate the model (Chen et al. 2012): the vector of parameters is chosen in the space of possible combinations by comparing the moments generated by each vector with those of the real data[33]. The selected vector is the one that minimizes the distance between the moments of the real and simulated time series, that is it minimizes the following objective function:

$$argmin\ \Gamma\ (\mathrm{X}^{\mathrm{r}}, X^{s}, \theta)^{34}$$

The space of the values of the parameters used by the multivariate analysis is generated by the following combinations:

$$\alpha \in (0{,}01{:}\,4;\ 0.01)$$
$$v \ \in (0.01{:}\,4; 0.01)$$
$$z \ \in (10{:}\,40;\ 1)$$
$$dk \ \in (1{:}\,10; 1)$$
$$\beta \ \in (0.1{:}\,0.8; 0.1)$$
$$l_k \ \in (0.01{:}\,4; 0.01)$$

The main results of the model show that the disaggregation and inclusion of local interaction are sufficient to generate a model able to reproduce the principal stylized facts.

The cyclical components of macro variables such as GDP, consumption and investments, in accordance with the Dickey-Fuller texts show a *unit root* and have the usual *roller-coaster* characteristics (Stock and Watson, 1999; Napoletano et al., 2006).

[33] The moments are the autocorrelations and cross correlations of GDP, consumption and investments.
[34] X^{r} e X^{s} are, respectively, simulated and real time series. θ represents the set of vectors describing the entire space of possible combinations. As in Caiani et al. (2016), the results are compared with the US historical series of FRED from 1947-01-01 to 2017-10-01 (FRED codes: PCECC96, GPDIC96 and GDPC1).

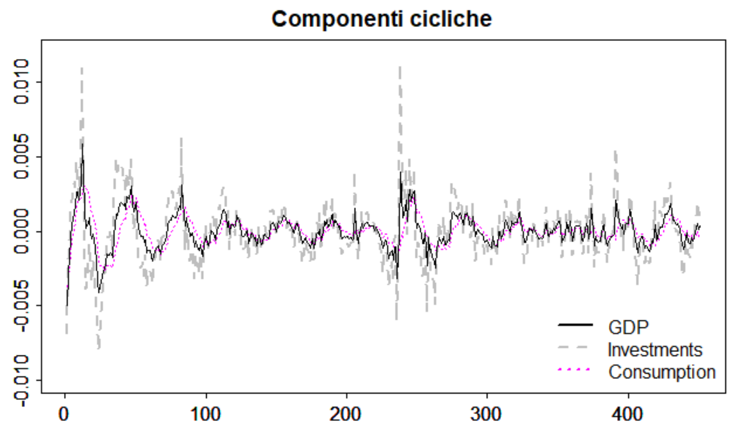

Figure 3.1.1: Cyclical component of GDP, Investments and Consumption

The following are the real and artificial series of autocorrelations and cross-correlations (up to 20 and 10 lag respectively), after having detrended the series with the Hodrik-Prescott filter. Investments, consumption, inventory changes and GDP are pro-cyclical with investments characterized by higher volatility.

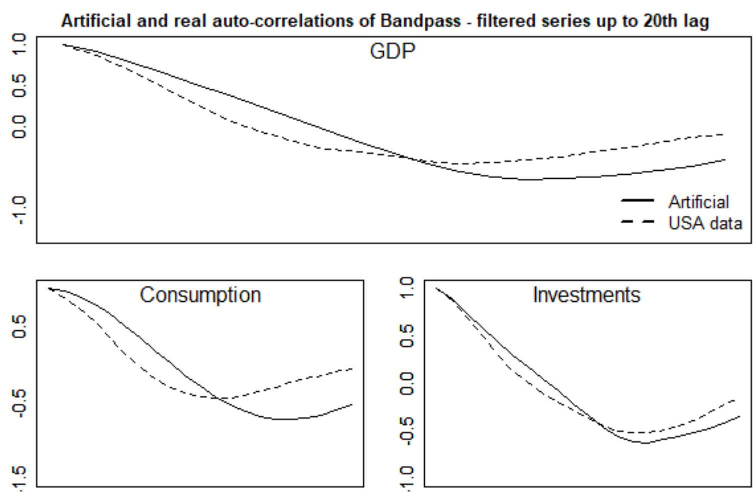

Figure 3.1.2: Autocorrelation up to 20 *lag* of artificial and real time-series (detrended)

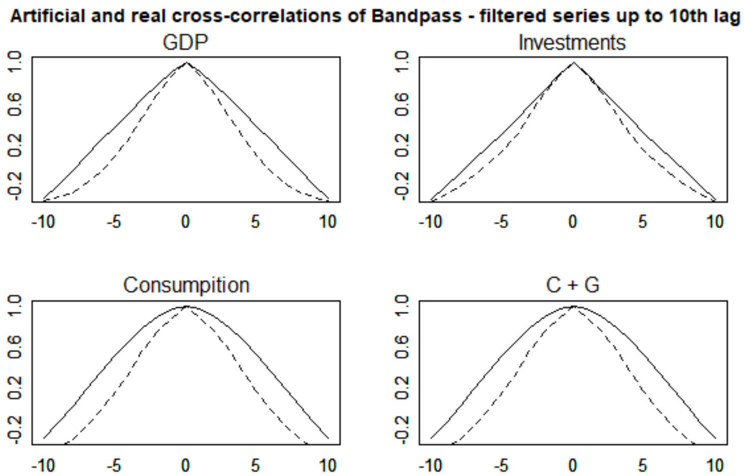

Figure 3.1.3: Cross-correlations of artificial and real time-series (detrended)

Unlike the mainstream models based on the Walrasian general equilibrium, which have been criticized - among other things - for their inability to explain and reproduce the autocorrelation observed in real time-series, in this system the autocorrelation in aggregate variables emerges from the micro-level without the need to introduce any exogenous shock.

Unlike standard macro post-Keynesian models, the model can reproduce endogenous cycles and crises. More specifically, without “disturbing” the financial dimension, in this model period of crises can be reproduced just considering the real dimension: because of the evolution of the distribution of demand among firms, the downturns of the cycle can turn into crisis phases due to the domino effects of shocks realized at the micro-level. The dynamic is the following: if the share of demand that 'flows back' to the single firm remains for a sufficient number of periods at a level below that of “historical” participation to cause bankruptcy[35], the individual failure can trigger a contagion dynamic. On the one hand, the loss of the latter's contribution to the financing of aggregate demand increases the probability of bankruptcy for firms that were close in the distribution of ξ differentials to the bankrupted firm. On the other hand, this dynamic undermines the revenues and debt sustainability of firms further to the right of the distribution, i.e. those that have benefited from a positive differential between contribution share and market share. Indeed, the larger size of these firms in terms of installed capacity is justified by this differential, i.e. by the fact that they manage to capture for a sufficient number of periods the demand previously generated by other firms (i.e. those that later go bankrupt). As soon as the share of demand created by the bankrupt firms is lacking, the revenue flows necessary to pay the debt quotas relating to the installed capacity are missing and a sequence of bankruptcy is triggered, giving rise to the phase of crisis.

[35] This means that the firm register for an extend period of time a degree of capacity utilization lower than the normal one, thus it is not able to payback the loan.

3.2 Rigid, dynamic network and heterogeneity

In order to trace the roots of the micro-phenomena that affect - through the distributive channel – the macro dimension, we compare the results of the model in different scenarios regarding the typology of network and the heterogeneity of firms. Four scenarios come out from the combination of a rigid or dynamic network with the case of an economy with homogeneous or heterogeneous firms.

In the case of a rigid network, we are taking the extreme assumption of customers that never change suppliers in the long-run[36]. Thus we impose exogenously the supplier of each household and firm, and we keep it constant along with all the simulations[37]. The heterogeneity is referred to the expectation formulation, that is the parameter β expressing the intensity of the accelerator process[38]. In the dynamic network scenario households and firms select randomly their supplier (the related results are referred to the baseline model already presented). Table 2 is reporting the results.

	Homogeneous firms				Heterogenous firms			
	log(GDP)	u_r volatility	Mean u_r	M*	log(GDP)	u_r volatility	Mean u_r	M*
Rigid network	8.41	0.005	0.675	0.033	8.41	0.005	0.678	0.04
Dynamic Network	8.43	0.002	0.615	0.003	8.43	0.002	0.615	0.003

*M: Market concentration

Table 2: Comparative results in four scenarios: Homogeneous firms/Rigid Network, Homogeneous firms/Dynamic Network, Heterogenous firms/Rigid Network and Heterogeneous firms/ Dynamic Network

When we exclude local interactions imposing an exogenous and constant network, namely an extremely low variance in the long-run distribution of demand across firms, the long-run fluctuations remain while the emergence of a lower degree of capacity utilization is quite debased. This rigidity strongly affects the variance in the intertemporal concentration of demand across firms, lowering the interplay between aggregate demand and investments. Indeed, the variance of demand depends on two mechanisms:

- Probability to lose or acquire new customers;
- Swing in individual consumption patterns;

While both mechanisms characterize the dynamic network, only the second one is active in the rigid network.

[36] Anyway, this do not imply that market shares are constant.
[37] In the initialization, each firm has an equal number of customers. Customers can change supplier only if theirs has exhausted its production.
[38] The value of each β_i is randomly extracted from a normal distribution with mean equal to the value of the homogenous case and $sd = 0.05$.

In this case, the persistence of the business cycle is due to the oscillations of individual consumption patterns and always pass through the investment channel. Indeed, the variance of the demand for each firm is not only a function of the variability in the supplier selection but also a function of the evolution of the disposable income of existing customers. Indeed, also in the aggregate model, the process of convergence towards the steady state is characterized by short-term fluctuations with consequent variations in the level of employment and distributed profits[39]. In the multi-firm economy, these individual variations modify the status of every single firm and prevent the gradual damping of short-term fluctuations until the convergence towards the fully adjusted position

In the AB version, the distributional dimension linked to the short-run variation in the employment status and dividends of capitalists maintains the instability of the differential ξ and do not allow that the transition phase is such: no phase of transition exists. An example of the mechanism is as follows: a change in the demand of a firm in sector K (K^{a}) changes the employment status of workers and the dividends distributed by sector K and, with it, the consumption pattern of these households. This change will also affect the revenues of the C firms ($C^{a....c}$) which have in their network these customers, thus also the profits and wages paid by these firms change. Subsequently, also the revenues of firms $C^{f....j}$ that has the capitalists and workers of firms $C^{a....c}$ in their network will change, reproducing the same cascade effect on the suppliers of their capitalists and workers. Contemporary, also the $K^{b...d}$ suppliers of $C^{a....c}$, $C^{f....j}$ and of all other firms will register a change in their orders, thus also the C firms that have $K^{b...d}$ capitalists and workers in their network will be subject to a variation in the revenues.

Considering that not only does each of these effects produce a cascading impact on the other firms and ultimately on the firm itself, but that the same type of dynamics are simultaneously triggered by changes in the sales realized by the other firms, the result of these mechanisms produce a positive variance in the distribution of demand across firms and prevents the realization of a fully adjusted position. These cascade effects take place contemporarily for all the firms of the economy and their magnitude expands with the increase in the number of sectors and firms.

The inclusion of heterogeneity across firms does not affect significantly the long-run results. In particular, in the dynamic network scenario, it does not change the results at all. In this sense, given the same average β and an equal probability across firms to capture demand, the effect of heterogeneous firm decisions compensate each other on aggregate.

Finally, it is worth noticing that the higher degree of capacity utilization in the rigid network scenario pass also through the higher degree of monopoly. Indeed a higher market concentration lowers the variance of

[39] However, the presence of the single macro-firm, not modifying the differential ξ, causes the expected growth rate of the demand to converge to that of the autonomous component and, therefore, the fluctuations to slowly dampen.

demand and degrades, through the investment channel, the magnitude of the interplay between aggregate demand and investments. In this sense, the increase in the degree of market concentration has the same effect as a decrease in the number of firms: in the extreme case, the maximum degree of monopoly is reached by the single-firm economy, that is the aggregate model[40].

In conclusion, the multi-firm economy is the root of the endogeneity of the business cycle while local interactions (thus a non-constant long-run network) are the most accountable for the emerge of a degree of capacity utilization lower than the normal one. Indeed, the variance of demand across firms is affected by both the variability in the supplier selection and the instability of the single pattern of consumption. While both channels are active in the case of the dynamic network, only the second one is active in the rigid network scenario. Thus, the variance in the distribution of demand is higher in the dynamic scenario and, subsequently, the emergent phenomenon is more pronounced.

4. Conclusions

The concept of normal capacity utilization has assumed a crucial role in the debate within the analyses of demand-led growth, becoming the focus of a growing body of literature. In this regard, the demonstration of this paper contributes to the debate between neo-Kaleckian and Supermultiplier positions. We point out that, within a demand-led growth model with non-capacity creating autonomous component of demand, the normal degree of capacity can be fixed without implying a process of gravitation toward it. Unlike the neo-Kaleckian model, this is not the result of an entrepreneurial feature, namely the realization of a conventional behaviour at the firm level, but an emergent phenomenon. In this sense, the equilibrium is not a *fully adjusted position* and does not correspond to the fulfilment of an endogenous adjustment in the desired degree of capacity utilization, neither continuously, nor on average.

This outcome derives, precisely, from considering a multiplicity of firms rather than the aggregate macro firm. Indeed such features necessarily bring along two mechanisms:

i) The dynamic instability in the differential between the contribution share that each firm gives, as a result of its production, to the formation of the aggregate demand and the share of demand that "flows back" to the firm itself through sales realization. In this sense, a necessary condition to achieve a *steady-state* with a normal degree of capacity utilization, and verified by construction in an aggregate model, is that, during the

[40] This is not claiming that an SM-like aggregate model is implicitly describing an all-round monopoly economy. But that while it is possible to make the model compatible with the description of a competitive economy as regards the assumptions on prices and distribution (which are precisely taken as exogenous), it is not possible to do the same as regards the representation of the feedback loop between investments and aggregate demand.

inter-periodical process of revising expectations, this differential remains constant.
ii) The interplay, via investment channel, between the level of aggregate demand and how it is distributed across firms. That is, given the same level of aggregate demand, a different distribution across firms produces different reactions in terms of investments, thus different changes in the aggregate demand itself. In particular, given the normal level of aggregate demand for which the aggregate model generates zero net investments, whatever distribution of such demand in the multi-firm economy produce a positive level of net investments. In short, the multiplicity causes over-investment with respect to the normal growth path and multiple degrees of capacity utilization result to be compatible with a stable accumulation.

The first one is responsible for the endogeneity of the business cycle. The second one is responsible for the emergence of a lower (aggregate) degree of capacity utilization: because the control on the aggregate productive capacity is split across different identities, the share of investments on aggregate demand always results to be higher than the one determined in the case of aggregate macro – firm. Due to the presence of the autonomous component, the aggregate demand does not react proportionally to the changes in capital stock, hence the trend of the degree of capacity utilization results to be lower than the normal one.

Finally, it is worth noticing the robustness of this model regarding the independence of stability conditions with respect to the assumption on firms' behaviour in determining the normal degree of capacity utilization. In this regard, conversely to the neo-Kaleckian approach, the eventual inclusion of a "hysteric" normal rate of capacity utilization does not take on the semblance of an *ad hoc* assumption required to avoid Harrodian instability: it can represent just one of the possible setup that, consistently with empirical analysis, can be adopted in modelling firms behaviour, au pair of the exogenously given normal degree of capacity utilization. To this extent, whether it is included the conventional element, the model is immune to the second critique addressed to neo-Kaleckian (an in particular to Amadeo-Dutt-Lavoie formulation) according to which this requires not just some elements of adaptation in conventional behaviour, but also a process that is both quantitatively fast and unbounded in order to guarantee the functioning of the stabilizing mechanism.

Concerning the difference with respect to the traditional SM, on the one side, the macrostructure does not need to assume a long-run exogenous trend of autonomous components. On the other side, the micro-founded dimension highlights how there does not necessarily exist a single degree of capacity utilization (the normal one) compatible with a stable process of accumulation.

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Appendix 1

1.1 Check of the stock-flow consistency

The redundant equation is:

$$M_t = L_t + B_{cb,t}$$

The redundant equation expresses the indirect relationship between public bonds purchased by CB and the share of savings held in the form of deposits. The difference between aggregate deposits and bank loans corresponds to the government bonds held by CB, in turn, equal to the reserves held by the commercial bank at the CB:

$$M_t - L_t = B_{cb,t} = R_{cb,t}$$

Including bankruptcy and Non-performing loans, the *check-consistency equation* becomes:

$$M_t = L_t + B_{cb,t} + NPL_t + A_t$$

where NPL_t are non-performing loans and A_t are the advances from CB to the commercial bank.

1.2 Loan Demand and debt service computation

Loan demand is defined as follows:

$$L_{t,i}^{d,long} = K_{t,i}^{df} l^T$$

$$\begin{cases} if\ cash_{t.i} \geq WB_{t,i} + K_{t,i}^{df}(1 - l^T):\ \ L_{t,i}^{d,long} = K_{t,i}^{df} l^T;\ l_{t,i}^w = 0;\ l_{t,i}^k = l^T \\ else\ if\ cash_{t.i} \geq WB_{t,i}:\ L_{t,i}^d = K_{t,i}^{df} l_{t,i}^k;\ l_{t,i}^w = 0;\ l_{t,i}^k = \dfrac{K_{t,i}^{df} - cash_{t,i} + WB_{t,i}}{K_{t,i}^{df}} \\ else\ L_{t,i}^{d,short} = wb_{t,i} l_{t,i}^w;\ L_{t,i}^{d,long} = K_{t,i}^{df} l_{t,i}^k;\ l_{t,i}^w = \dfrac{WB_{t,i} - cash_{t,i}}{WB_{t,i}};\ l_{t,i}^k = 1 \end{cases}$$

$$L_{t,i}^d = L_{t,i}^{d,short} + L_{t,i}^{d,long}$$

where $L_{t,i}^{d,long}$ is the long-term loan to finance the purchasing of the capital good, l^T is the leverage target, $l_{t,i}^k$ is the realized leverage to finance the purchasing of capital good, $L_{t,i}^{d,short}$ is the short-term loan to finance the wage bill and $l_{t,i}^w$ is the relative realized leverage.

Calculation of debt service:

Since the interest rate may vary across the periods in which the debt was incurred, the payment of interest rates for each period is calculated using the historical composition of the residual debt stock. The evolution of debt instalments (related to the purchase of the capital good) is decreasing, consistently with the trend of capital amortization. Total debt service is inclusive of the debt instalments of short-term and long-term loans and *Ponzi* loans, including the respective interest rates:

$$servicedebt\_tot_{t,i} = servicedebt\_capital_{t,i} + servicedebt\_short_{t,i} + servicedebt\_ponzi_{t,i}$$

$$service\_debt\_tot_{t,i} =$$

$$= \frac{1}{a\,z}\sum_{j=t-z}^{t-1} l_{i,j}K_{i,j}^{d}\left(1 + b^{long}r_j\right)(j + z - t) + \frac{1}{z^{short}}\sum_{j=t-z^{short}}^{t-1} l_j WB_{j,i}\left(1 + a^{short}r_j\right)(j + z^{short} - t)$$

$$+ \frac{1}{z^{ponzi}}\sum_{j=t-z^{ponzi}-1}^{t-2} L_{j,i}^{ponzi}\left(1 + a^{ponzi}r_j\right)(j + z^{ponzi} - t)$$

$$service\_debt_{t,i} = service\_debt\_tot_{t,i} - interestpayment_{t,i}$$

$$stock\_debt_{t,i} = stock\_debt_{t-1,i} + L_{t,i}^{d,short} + L_{t,i}^{d,long} + Ponzidebt_{t-1,i} - service\_debt_{t,i}$$

$$NW_{t,i} = am_{t,i}^{residual} + \left(cashF_{t,i} + serviceDebtTot_{t,i}\right) - D_{t,i} + inv_{t,i}uc_{t,i}^{h}$$

$$Rv_{t,i} = ResidualValue_{t,i} = am_{t,i}^{residual} + inv_{t,i}uc_{t,i}^{h}$$

Granting of the *ponzi* loan (loan necessary to pay off the negative cash at the end of the period, i.e. to repay the outstanding debt):

$$if\ cashF_{t,i} < 0 \begin{cases} if\ NW_{t,i} > 0\ \vee\ n_{t,i}^{ponzi} < lim^{ponzi}\colon Ponzidebt_{t,i} = -cashF_{t,i}\ ;\ n_{t,i}^{ponzi} = n_{t-1,i}^{ponzi} + 1 \\ otherwise\ bankrupcy_{t,i} = 1\ \begin{cases} if(M_{t,cap_i} \geq Rv_{t,i}\colon\ Loss_{t,i}^{bank} = D_{t,i} - Pdr_{t,i} - Rv_{t,i} \\ \quad else:\ \ Loss_{t,i}^{bank} = D_{t,i} - Pdr_{t,i} - M_{t,cap_i} \end{cases} \end{cases}$$

$$Pdr_{t,i} = PartialDebtRepayment_{t,i} =$$
$$= cashF_{t-1,i} + revenues_{t,i} + L_{t,i}^{d,short} L_{t,i}^{d,long} + Ponzidebt_{t-1,i} - WB_{t,i} - \sum p_{indexk,t} k_{i,t}^{D}$$ [41]

1.3 Accounting and bankruptcy

At the end of the period, the financial resources of firms C are equal to:

$$cashF_{t,i} = cashF_{t-1,i} + revenues_{t,i} + L_{t,i}^{d,short} + L_{t,i}^{d,long} + Ponzidebt_{t-1,i} - WB_{t,i} - \sum p_{indexk,t} k_{i,t}^{D} - SD\_tot_{t,i}$$

where $cashF_{t,i}$ it is the cash available to the firm, $L_{t,i}^{d,short}$ is the loan to finance the wage bill, $L_{t,i}^{d,long}$ is the loan to finance the purchasing of capital good, $Ponzidebt_{t-1,i}$ is the loan to finance the repayment of the outstanding debt rate, $WB_{t,i}$is the wage bill, $\sum p_{indexk,t} k_{i,t}^{D}$ is the expenditure to acquire the capital good and $SD\_tot_{t,i}$ is the total debt service including financial charges. In the event that, at the end of the period, the cash net of the debt service is negative, the film could ask for an additional loan to pay the outstanding debt. This possibility, within the same window of the debt repayment issuing another debt, is allowed for a maximum number of periods lim^{ponzi}. If the net wealth is positive or the number of periods of (over) indebtedness is less than lim^{ponzi} the firm is granted a further loan; otherwise, it goes bankrupt. If capitalist deposits (relating to the bankrupt firm) are at least equal to the residual value of physical capital and inventories, the firm is "recapitalized" for that value and, therefore, the non-performing loan corresponds to the debt stock of firm net of residual value. If the deposits are lower, the bank loss is equal to the difference between the debt stock and the deposits of the owner of the firm.

[41] $Pdr_{t,i}$, being equal to the value of cash flows gross of debt service, it is certainly positive. In fact, all costs have already been covered and pre-financed through the cash from the previous period or, if necessary, through the specifically dedicated loan demand.

1.4 Sequence of events within each period

1. Update of the capital stock;
2. Computing unit costs and markups fixation;
3. Firms C set desired production, labor and capital demand;
4. Matching in the capital market;
5. Firms K, based on the percentage of completion of semi-finished products and new orders, set the desired production and labor demand;
6. Matching in the labor market;
7. Production start:

   Sector K:

$$\begin{cases} if\ L^d_{t,i} = employees_{t,i}: \quad y_{t,i} = y^d_{t,i}\ ;\ \ h^{work}_{t,i} = \dfrac{L^d_{t,i}}{h_{month}} \\ otherwise: y_{t,i} = \dfrac{employees_{t,i} h_{month}}{l_c}\ ;\ \ h^{work}_{t,i} = h_{month} \end{cases}$$

   If labor demand has been satisfied, the working hours are distributed among the respective employees in such a way as to produce exactly the desired quantity[42]. In case labor demand has remained unsatisfied, workers will work full time h_{month}.

   Sector C:

$$\begin{cases} if\ Ld_{t,i} = employees_{t,i}: \quad y_{t,i} = \min\left(y^d_{t,i}; \dfrac{k_{t,i}}{v}\right)\ ;\ \ h^{work}_{t,i} = \dfrac{Ld_{t,i}}{h_{month}} \\ otherwise: u^l_{t,i} = \dfrac{employees_{t,i}\ h_{month}\ \alpha}{k_{t,i}}\ ;\ y_{t,i} = \min\left(u^l_{t,i} \dfrac{k_{t,i}}{v}; \dfrac{k_{t,i}}{v}\right) h^{work}_{t,i} = h_{month} \end{cases}$$

8. Based on the quantity produced in sector K in current and last dk periods, the (previous) capital goods demand is satisfied;
9. Credit demand, payment of capital goods and wages (unemployed workers receive the subsidy);
10. Matching in the consumer market;
11. Cash flows computation. Some firms, if necessary, can apply for additional financing, those that do not meet the requirements go bankrupt;

[42] This derives from the fact that 1,3 workers cannot be hired. Therefore, in order to produce the amount of goods corresponding to 1,6 workers, firm hire 2 workers and the working hours of each employee are reduced.

12. Profits computation and dividends payment;
13. CB profits computation and public bonds are sold.

The balance sheet and the transaction matrix describing the economy are reported in the following tables.

Balance sheet

Assets	Workers	Capitalists	Firms K	Firms C	Banks	Government	CB	$\sum$
Check deposits [43]	$+M1_w$	$+M1_{cap}$	$+M1_k$	$+M1_c$	$-M1$			0
Time deposits	$+M2_w$	$+M2_{cap}$			$-M2$			0
Reserves					$+H_b$		$-H$	0
Advances BC					$-A$		$+A$	0
Loans			$-L_k$	$-L_c$	$+L$			0
Non-performing loan	$+NL_w$	$+NL_c$			$-NL$			0
Fixed capital				$+K_f$				$+K_f$
Inventories				$+INV_f$				$+INV_f$
Public bonds		$+B_{h,cap}$				$-B$	$+B_{cb}$	0
Net Wealth.	$-V_{h,w}$	$-V_{h,cap}$	$-V_k$	$-V_c$	0	$+Deb$	0	$-K_f$
$\sum$	0	0	0	0	0	0	0	0

[43] The distinction between check deposits and time deposits is required since the income distributed to capitalists at the end of the period (from which the demand for consumer goods in the following period is generated) does not represent savings. Time deposits, on the other hand, are the portion of income actually saved and held in the form of deposits. These, unlike deposit accounts, accrue interests in each period.

	Workers	Capitalists	Firms K	Firms C	Government	Bank		CB		∑
						Current	Capital	Current	Capital	
Consumption	$-C_w$	$-C_{cap}$		$+C$						0
Investments			$+I$	$-I$						0
Public expenditure				$+G$	$-G$					0
Unemp. Benefit	$+U$				$-U$					0
Wages	$+W$		$-W_k$	$-W_c$						0
Tax	$-T_w$	$-T_{cap}$			$+T$					0
Dividends Firms		$+Div_F$	$-Div_k$	$-Div_c$						0
Dividends Bank		$+Div_B$				$-Div_B$				0
Profits CB					$+F_{cb}$			$-F_{cb}$		0
Recapitalization		$-K_r$		$+K_r$						0
Int. Deposits	$+r_m M2_{w,t-1}$	$+r_m M2_{c,t-1}$				$-r_m M2_{t-1}$				0
Int. Loans			$-r_l L_{k,t-1}$	$-r_l L_{c,t-1}$		$+r_l L_{t-1}$				0
Int. Bond		$+i_{t-1} B_{h,t-1}$			$-i_{t-1} B_{t-1}$			$+i_r B_{bc,t-1}$		0
Int. Reserves						$+r_{r-1} H_{t-1}$		$-r_{r-1} H_{t-1}$		0
Int. Advances						$-r_{a,t-1} A_{t-1}$		$+r_{a,t-1} A_{t-1}$		0
Δ Time deposits	$-\Delta M2_w$	$-\Delta M2_{cap}$	$-\Delta M2_K$	$-\Delta M2_C$			$+\Delta M2$			0
Δ Check deposits	$-\Delta M1_w$	$-\Delta M1_w$					$+\Delta M1$			0
Δ Loans			$+\Delta L_k$	$+\Delta L_c$			$-\Delta L$			0
Δ Bond		$-\Delta B_h$			$+\Delta B$				$-\Delta B_{bc}$	0
Δ Non-performing loan	$-\Delta NL_w$			$-\Delta NL_c$			$+\Delta NL_c$			0
Δ Reserves							$-\Delta H$		$+\Delta H$	0
Δ Advances							$+\Delta A$		$-\Delta A$	0
∑	0	0	0	0	0	0	0	0	0	0

1.5 Table of parameters in the baseline scenario

Description	Symbol	Value
Montecarlo replications	MC	50
Time sample	T	800
Number of firms in the capital-good sector	F_k	70
Number of firms in the consumption-good sector	F_c	300
Capital-good firms markup	φ_k	0.2
Consumption-good firms markup	φ_c	0.2
Normal degree of capacity utilization	u_n	0.7
Capital/output	v	0.35
Capital/labor	α	0.2
Reciprocal of labor productivity in capital-good sector	l_k	0.55
Capital-good lifetime	z	40
Number of periods to produce the capital good	dk	3
Desired inventories-to-sales ratio	σ^T	0.02
Expectation parameter	β	0.5
Tax rate	θ	0.2
Unemployment subsidy rate	ρ	0
Fixed interest on loans	r_l	0
Fixed interest on public bonds	r_b	0
Interest on deposit	r_d	0
Interest on reserves	r_r	0
Interest on advances	r_a	0
Payback time of long term loans	z_z	40
Payback time of short term loans	z_s	10
Dividends distribution rate	ω	1
Desired leverage	l^T	1
Initial public expenditure rate	$\bar{\tau}$	0.1
Public expenditure growth rate	g_G	0
Propensity to consume out or income of workers	c_w^y	0.8
Propensity to consume out of wealth of workers	c_w^V	0
Propensity to consume out or income of capitalists	c_π^y	0.5
Propensity to consume out of wealth of capitalists	c_π^V	0

Table 3: Parameters