Financial Instability and Income Inequality: why the connection Minsky-Piketty matters for Macroeconomics

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Abstract

The paper addresses the relationship between financial instability and wealth inequality in a twofold perspective. First it is an attempt to explain why the two phenomena, despite being nowadays equally relevant as empirical concerns, do not attract equal attention from researchers and are usually studied separately or conceived as independent levers affecting cycles or growth. We suggest the adoption of implicit methodological paradigms, instead of "historical momentum" as likely reason. Second, we present a theoretical framework grounded on Ferri (2016) with a medium-run dynamic demand-led model set for a monetary economy of production, where corporate debt is introduced into the financial account of firms. Minsky and Piketty come instrumentally to support the two perspectives: on one side they become our opposite representatives of heterodox and orthodox method; on the other side, as the model specification makes Piketty (2014) and Financial Instability Hypothesis directly comparable, our exercise sheds light on the dynamic role of retention rates and capital share during the cycle phases, qualifying the conditions under which financial instability may lead inequality. Connecting the implications of the two argumentative lines, the call emerges for a significant rethinking in macroeconomics studies.

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1 Introduction

Since the beginning of the New Millennium macroeconomic dynamics showed the consolidation of two phenomena that are both in contrast with mainstream predictions and are usually treated as separate pieces of economic theorizing. We refer to the increase of economic inequality (Piketty 2014a; Stiglitz 2015a) and to the rise of financial instability episodes (higher recurrence, persistence and diffusion of financial crises) (Galbraith 2012; Ferri 2016).

Indeed, mainstream framework conceives globalization as a welfare enhancing process: on the one hand it should trigger convergence processes and therefore reduce distributive inequality or at least not worsen it (Aghion and Williamson 1999; Sala-i-Martin 2000; Quah 1996a; 1996b); while on the other hand, financial markets integration should lead, at least, not to contradict the idea of long run financial neutrality, which goes hand in hand with monetary neutrality (Causevic 2017; Kandil et al. 2015; Seven and Coskun 2016). Though the possible link between finance and growth had been matter of inquiry since the end of nineteenth century, both nature and strength of such relationship remain controversial (Levine 2004); more than that, contentious is the link between growth and distribution (Bertola 2000) or inequality (Demirguc-Kunt and Levine 2009; Rochon and Monvoisin 2019).

The fronts of literature having a critical attitude towards the stabilizing/converging properties of increasingly integrated free markets share the idea that growing inequality and instability are not accidental events being in contrast the effect of endogenous changes and adjustments; nevertheless, such endogeneity again is not typically explained treating the two issues together.

The literature focusing on growth and inequality, taking its cue from Piketty's (2014a) recent contribution, looks at the accumulation of capital at the aggregate level and keeps its attention on the real dimension of the economy; principal aim of this research is the explanation of a new stylized fact of more recent years: the decline in growth accompanied by the growth of the share of capital in aggregate wealth. It usually comes combined with the adoption of a standard aggregate production function à la Solow. Thus, it cannot be considered a research project meant to address any radical or paradigmatic change in macroeconomics.

Conversely the literature centering on financial instability recognizes the fundamental role of financial assets and more in general of finance; it was at the core of Minsky's theory who elaborated the so-called Financial Instability Hypothesis (FIH) (Minsky 1985; Minsky 1986). After the financial crisis of 2007-2008, the importance of Minsky's theory has been rediscovered in academia; the endogenous nature of this process is explained as the evolution of complex networks of economic agents' debt position whose financial leverage is doomed to become inconsistent with the possibility to service outstanding debt. In this case, the endogeneity of instability is not simply a matter of process representation, it is rather the instrument making evident the nature of monetary economies of production (which are incompatible with money neutrality). Financial instability is therefore the channel through which the need is justified to change the reference paradigm, at least implicitly (Galbraith 2012; Fazzari et al. 2008; Skott 2013).

Then, the two strands of literature are separate because: a) they refer to questions focusing on different objects; b) they tackle different levels of economic theory: the first epistemological, the second ontological; whereas the growth-inequality literature usually embeds just a theoretical conflict of representation, the finance-instability literature involves a conflict of economic visions too.

But are these two streams truly independent? Some authors argue not and to highlight the point they either refer to a particular class of growth models (i.e. aggregate demand led), or they refer to a particular time horizon (i.e. medium run) (Ferri 2011; Ferri et al. 2015). Doing so they question the theoretical

independence of growth and cycles due to independence of time spans; in other words, they emphasize that conventional macrodynamic representation, treating growth as separable from cycles, may lead to oversee their interaction actually evident in a time horizon whose frequency span is neither short, nor long run.

This paper takes exactly this peculiar, though unconventional, perspective. Starting from the above considerations and in line with the idea that economic inequality is sensitive to the presence of financial instability processes, this essay aims to reconsider the economic inequality problem dealing not only with the real component, as in Piketty's model, but also with the financial one. This study is motivated by the need to increase our knowledge about the relationship between wealth inequality and financial instability processes and offers a contribution to the understanding of the interactions between them. We believe that this is particularly important given the changes in our economy over recent decades, especially in the face of transformations that have been determined not by the autonomous changes of the markets, but by specific changes of policy and institutional set-ups (which in turns are sensitive to the theoretical mainstream in economics).

Though the final purpose of the paper is meant at contributing to paradigmatic discussion, the analytical structure is kept quite simple. This seeming contradiction is justified by a threefold motivation. First, the idea to build a structure as close as possible to the one proposed by Piketty (2014a). Second, the need to have a model capable to capture the evolution of inequality: the use of increasing capital share on income as an aggregate sign of increasing inequality is not a satisfactory measure but serves this more limited scope. Third, the idea to build a model which could be easily connected to Minsky's ideas. And this track goes through the explicit consideration of the role debt into macro-dynamics.

The first motivation derives from the consideration that Piketty's model not only represents a "momentum" emblematic piece of work, but it also belongs to a class of models which constitute a tradition in macroeconomics, namely "pedagogical" models (like Solow for growth, or AD-AS or IS-LM). These models can be either used to build/compare macroeconomic narratives or to evaluate/estimate empirical parameters, hence becoming the essential starting point in the process of validation of economic theories. Thus, these models are not relevant because of their intrinsic realism, but as they contain the best shortcuts to connect the highest level of economic abstraction (the realm of economic visions) to the lowest level of scientific inquiry (the observation of facts). Then, the question is whether Piketty's model is appropriate to represent the macroeconomic dynamic relationship between growth and inequality.

Through other two motivations, taking Minsky's work as a reference theoretical foundation, we aim to suggest that finance not only creates an interdependence among cycles and growth, but it also determines an integration among growth and inequality. The most appropriate analytical framework to test these propositions would require the use of complexity; to maintain a direct comparability with Piketty's we use instead a recursive model which we expect to give us only indirect support. Specifically, we expect our model to exhibit integration between cycles (short-run) and growth (long-run) through the evidence of cycles persistence and procyclical inequality due to procyclical financial instability. Furthermore, procyclical financial instability is expected to show up together with procyclical aggregate indebtedness.

The theoretical framework proposed in this paper builds on that developed by Ferri (2016), who presents a class of demand-led models analyzing various aspects of the link between instability and inequality. Using investment as a key-variable connecting these two fundamental aspects of macroeconomic dynamics, our model introduces corporate debt into the financial account of firms.

Because of the non-linearity of the model, we explore its dynamic properties with numerical simulations.

Such simulations are also performed to assess the parameters enabling to support the Financial Instability Hypothesis. Aiming at deepening the comprehension of robustness properties, we also explore analytic results from a linearized version of the model.

The structure of the paper is the following. Section 2 focuses on the literature and methodological aspects supporting the observations just made. Section 3 illustrates the model. Section 4 identifies the steady state conditions. Section 5 shows and discusses the results obtained by means of numerical simulations. Section 6 derives the linearized version of the model and examines the robustness of the model. Summary and perspective considerations close as customary the paper.

2 Financial Instability vs. Income Inequality: recent literature and methodological issues

This part is going to circumstantiate the introductory reflections through a short review of the literature and some methodological observations functional to justify the theoretical model we will formalize in the next section.

It is articulated in three steps. Firstly, we address the literature considering the frequency of research focus selection in the light of possible contrast of underlying paradigmatic views. Second, we quote the literature enabling to support the connection Minsky-Piketty. Then, we draw attention on specific aspects of this peculiar theoretical niche which still constitute puzzles to be explained, becoming a sort of motivational-explanatory background of our model.

The results of our first step of inquiry are summarized in Figure 1 and Table 1.

[Figure 1]

[Table 1]

The numbers have been collected searching on EconLit database and selecting four keywords: growth, finance, income inequality and financial instability.[1]

Though the first year of the sample is 1887, more than 90% of publications are concentrated after 1988, which is the year where all possible combinations of our selected keywords become simultaneously

[1] The numbers do not restrict on the type of publication, nor they come after a check of double entries. The last count was made on January 4th 2022, and ends on December 31st 2021. So, any evidence is to be considered as gross qualitative measure of the observed "popularity" of each issue among Economists. Furthermore, we are aware of the likely incompleteness of the database, especially for oldest publications (ante 1980) which may not yet be indexed. We think this limit does not invalidate our considerations, as our theoretical concerns matter especially for the last forty years, where most of the counted literature is concentrated. We have checked other four keywords: income distribution, instability in general, money and credit. These further counts reinforce the considerations we are going to put forward, then we decided to omit comments just for the sake of length self-containment.

present. There is a striking difference in the absolute number of items: whereas growth alone overcomes 212.000 matches, financial instability barely ranges around 3.900 (despite the keyword finance reaches the highest peak with more than 255.000 entries). The historical path of appearance of each issue goes together with popularity: it took almost a century before finance became financial instability, whereas income inequality traces back the same years as growth and finance. As a matter of fact, Figure 1 also shows that the frequency of publications considering just one keyword at time surmounts the ones where two or more keywords are jointly present at exponential rate.

In the introduction we depicted years 2007 and 2014 as likely critical passages, in the evolution of economic literature. Indeed, the rate of publications per year surged after 2007: each topic more than doubled considering the overall production split in two subperiods ranging respectively from 1991-2007 and 2008-2021, symptom of a possible change in research/editorial strategies (see Table 1). While growth and finance are sort of evergreen research themes, both financial instability and inequality seem to be affected by moment. Growth of publications focusing on financial instability peaked in the period 2008-2014; but this increase is exceeded by inequality which represents the absolute primacy and happened in the period 2015-2021. In this respect saying that Piketty's (2014a) Capital in the Twenty First Century put the question of economic inequality back in the center of economic studies does not seem an overstatement. To the very least Piketty choose the perfect timing to focus on inequality.

In our view, the evidence shown by the simple count is compatible with the operation of two pervasive (though often implicit) conventions in economic research about the representation (and nature) of economic systems, namely: linear causation and stability. We are suggesting that precisely these conventions, acting as backbones of economic method, ultimately drive the choice of keywords, the way they are related, and eventually the success of paradigms in the history of economic thought. The justification of the statement is beyond the scope of this paper. Nevertheless, it explains why the attempt to bring together Piketty and Minsky is more relevant with respect to methodological considerations, than with respect to any analytical exercise we may present later.

About linear causation, we underline that it logically presupposes independence of cause from effect, but also leads to the habit to fragment complex theoretical matters into parts treated as independent one from the other. This standard of economic representation (Hicks 1980; Hoover 2001) [2] matches the numbers we collected (considered that money and credit respectively reach more than 61.000 and 55.000 entries) and indicates that real and financial sides of the economy are fundamental but dichotomized at theoretical level. It also provides an explanation of the lower absolute frequency of contributions using simultaneously a higher number of keywords (Figure 1). In contrast, circular causation, feed-back mechanisms, integration among forces though recognized as traits of reality do not sit comfortably in the literature, especially when dealing with analytical models, as they imply the representation of processes, which require dynamic set-ups to the very least.

This leads to the second cross-cutting convention for schools of thought: the search for stable components. Indeed, from the epistemological point of view, the dynamic nature of processes can be left outside of the analysis, without losing relevant pieces of explanation, only if stability conditions hold. But the notion of stability is complex per-se (like it happens with the notion of rationality) and does not fully overlap with that of dynamics (though mainly embedded into it). In this respect we emphasize three features affecting stability that we order according to the increasing analytical effort they convey:

[2] For a broader perspective, intersecting disciplines other than Economics, one may also see Bunge (1980) and Wallace (1974).

dynamics (and then equilibrium-disequilibrium considerations), information (and then stochastic dimension) and homogeneity (qualitative dimension). Strong stability implies no (significant role for) dynamics, full information, and homogeneity (which means no significant role for qualities). In contrast, weaker forms of stability may allow a nuance of alternative dynamic paths, and or informative limits, and or heterogeneities. Unfortunately, such weaker forms are neither easy to deal with analytically, nor they are parsimonious in representation. Then, there is no point in adopting them, unless they let to shed light on unsolved interpretative puzzles. Holding this line of reasoning in mind, we suggest a further interpretation to the evidence represented in Figure 1. The historical path of appearance of papers dealing with single or multiple keywords does not come by chance: it simply follows the constraints given by the existing conventions. Income inequality and financial instability alone have the minimum absolute frequency and come late in history because at least they imply a relevant qualitative dimension and cannot use strong forms of stability.

Though the attempts to overcome the limits due to linearity and homogeneity conventions are significantly represented by the use of Agent Based Modeling (ABM) and Stock and Flows Consistent (SFC) analysis, the methodological issues involved behind such use are still in need to be faced; as a result, complexity in Economics is far from being the conventional assumption.[3] Furthermore, with respect to the purpose of our paper, it is quite difficult to qualify these class of models as "pedagogical" ones. Anyway, nowadays orthodoxy still builds on stability-equilibrium assumptions (Maki 2001; 2002). Then no surprise that the main empirical contributions by Piketty showing an increasing inequality in developed countries from the 1980s (see also Piketty 2015; Piketty and Saez 2014), come together with a theoretical model meant to explain the rising share and concentration of capital, which is a supply-side macroeconomic model of real capital accumulation in a steady state equilibrium à la Solow (Piketty 2014b).[4] Then, Piketty's work represents a novelty, but not a radical innovation in the panorama of economic literature: it is the emblematic expression of the strongest conventions transversal to different schools of thought, and of the yet equally transversally and unsolved contradictions.

In contrast, from the methodological point of view, the Minskian approach is heterodox on each and all the conventions we cited. It involves circular causation, endogenous instability, and significant (still identifiable) heterogeneity (Vercelli 2010; 2011; Variato 2015). A more articulated explanation of such a methodological difference is contained in Variato (2019) who specifically suggests Minsky as fundamental author to refer to as a basis for building a paradigm of "financial economies of production". Without going into further details, we simply observe that minskian approach addresses the foundations of economic practice shifting the debate from the epistemological level of representation to the ontological one of reality notion (vision). Then, again no surprise to find that this line of research is the one which collects the absolute minimum of counts, being in the spotlight only when financial crises come and hit badly advanced economies. The point Minsky becomes more popular during adverse cyclical events, anyway, does not imply that his vision belongs to the short run (or that his ideas can be used as a technical-representative trick to add into an otherwise orthodox model): his arguments refer to the fundamental structure of capitalism (i.e. even during quiet times real and financial interactions are such to lead to integration between cycles and growth, but also to affect the distribution of income, and as a result, to create an integration between distribution and growth).

Having explored likely methodological reasons supporting the different popularity of literature address-

[3] See for example Delli Gatti et al. (2018) for ABM and Carnevali et al. (2019) for SFC analysis.

[4] For reviews of the book see for example Krugman (2014), Milanovic (2013), Solow (2014) and Summers (2014) among others.

ing growth-inequality as opposed to the one on financial instability-inequality, the last part of this sections briefly recalls examples drawn from the literature where the connection of these issues become evident.

We start mentioning the contributions that are themselves reviews of literature or studies with a historical perspective. Though different in many respects, they can be easily classified as heterodox. A specific survey on growth theory and distribution making a broad review of models that belong to different traditions of thought can be found in Blecker and Setterfiled (2019). Then we underline Skidelsky (2018) who addresses issues referring to method of Economics, as well as papers like Jackson (2019), Saith (2011) and Tiberi (2007) who deal on long-term empirical evidence. Skidelsky (2018) connects the collapse of 2008-09, to the development of macroeconomic doctrines proven deficient by the crisis and its aftermath. He gives the rationale for the emergence of what he calls "New Consensus" (a mixture of "new" classical and "new" Keynesian economics). This New Consensus belongs to the transversal conventions we just described. For the purpose to our paper, we point out that the author corroborates a complexity vision of macroeconomic dynamics where financial innovation and endogenous instability play a crucial role together with income inequality on the growth process. In doing so he basically expresses a critical position towards both theories and policy suggestions stemming from New Consensus.

A critical position emerges also from papers related to structuralist or institutionalist positions. Here the main motivation of analysis is the attempt to show that both inequality and financial instability negatively affected growth as secondary cause of a more radical (primary) reason which lies in political and economic policy choices eventually responsible of the direct or indirect transformation of the economic context (Aglietta 2017; Akyuz 2018; Petit 2010).

A milder methodological position, which does not differ with respect to policy implications, can be found in Galbraith (2012). Further empirical evidence is produced, among others, in the contributions of Berglof and Bolton (2003), Lim (2008), Morck et al. (2011). Aspects of constructive criticism are nicely emphasized in Skott (2011) and Solimano (2017).

We observe that, not surprisingly, the existing literature while simultaneously considering financial instability and inequality, does not do so with equal proportions in the choice of their causal link. In fact, consistently with the previous considerations, the examples where inequality is the cause of financial instability far outweigh those investigating the opposite causal link. We mention a few. Amountzias (2019) and Hauner (2020) are recent empirical exercises which, though seeking the causal link, admit difficulties of unambiguous identification. In contrast, Choi (2018) underlines financial crises are caused by inequality, therefore he does not recognize circularity. Then, we have other studies that whilst taking Minsky as a reference point, directly (Fernandez 2008; Kaboub et al. 2010) or indirectly (Dragoe 2016) paradoxically affirm that income inequality leads financial instability.

Even on the strand of literature where the causation link goes from financial instability to income inequality, we may find those who take a strong position (Balder 2018) and other contributions whose focus is more related to address specific peculiarities (or heterogeneities) of either geographical/territorial nature (Arestis and Phelps 2019; Inekwe et. al. 2020) or institutional (Tridico 2012).

Evidence of circularity in the relationship inequality/instability, arises among others in the articles of Botta et. al (2021), D'Orazio (2019), Garcia and Perez (2017) and Thioune (2017). All these papers share the emphasis on heterogeneity and qualitative aspects but differ in the empirical methodologies adopted (namely ABM and SFC, event studies and PVar).

Moving from general considerations towards specific remarks, we first emphasize that the idea to connect Minsky and Piketty came basically just after the publication of Piketty's book. In the review of

the book, Kappeler (2014) suggested Piketty was not considering explicitly the role of financial variables, on the same line goes Asensio (2015). But it is only by a couple of years later that we can find the first published papers where this connection is dealt in models, to emphasize the drawbacks induced by Piketty's reductionist equivalence between capital and wealth. In this line we mention Davila et al. (2016), Davila et al. (2017), Ferri et al. (2017).[5] Finally, we close this section drawing a few observations pointing out the crucial explanatory role of capital gains so to justify the choices leading to the model presented into this paper. This variable is indeed one of the keys connecting both growth to finance and financial instability to inequality. Rowthorn (2014) is emblematic in this respect, as he comes to the opposite implication with respect to the one reached by Piketty (2014a); namely the primary problem is not over-accumulation, but the converse: there has been too little real investment. In the same vein, Weil (2015) shows that if not for capital gains, the increase in the wealth/income ratio over the period 1989-2009 would have been 30%, rather than the 78% observed in the data. This implies that the observed rise in wealth/income ratio is not the result of over-accumulation of physical capital, as in Piketty, but it is primarily a valuation effect of assets, driven by financialization hence amplified by bubbles (Stirati 2016). These capital gains may arise from different channels on the asset side: through the capitalized value of rents (Stiglitz 2015a; Stiglitz 2015b), from the housing sector (Bonnet et al. 2014), or from stock market (Galbraith 2014). In this strand of literature, the increase of the value of financial assets and the presence of capital gains favors the process of inequality. Basically, portfolio choices of those who belong to bottom deciles of the distribution of wealth are qualitatively different from the ones of those who belong to the top decile (Skott 2013, Taylor 2016 and Madsen 2019).

This line of reasoning connects to Minsky and to the Financial Instability Hypothesis. As known, this theory explains how, during expansionary phases, the interaction between finance and investment eventually leads to more fragile financial structures (with speculative booms and euphoria as limit possibilities). During the process, asset prices evaluations affect investment and debt relationships resulting in economic fluctuations and instability (due to the impact of the divergence among ex-ante expectations and ex-post realizations). In this framework, capital gains, are always relevant, even when not realized, as they act as a measure of an implicit collateral for debt. One can refer to the survey made by Nikolaidi and Stockhammer (2017) to have a quite comprehensive explanation of the possible alternative theoretical set-ups and narratives supporting the dynamic process behind FIH.[6] Here we want to emphasize two aspects related to capital gains. First, that in this perspective, the expected value of capital gains is always more relevant than the fact they are realized (i.e. they mostly matter as an indirect source of liquidity, especially in the case we consider firms or households which are increasing their indebtedness). Second, this intrinsically dynamic-expectational perspective turns out to bring to opposite implication with respect to the one advanced by Piketty, who depicts a stable long-run capitalism exactly assuming in the aggregate unrealized capital-gains (Piketty 2014b).

The controversial role of capital gains become more evident when considering the model presented by Piketty, where a specific inconsistency shows-up between the definition of capital, the explanatory variable, and how it is used in the model (King 2016). Indeed, the dynamics of capital share (depending only upon physical productive capital) and the related rising income share of wealth-owners interpreted just as an

[5] The first two papers make the connection explicit using a modified version of Foley's (2003) neo-kaleckian model, whereas the third paper is a different specification of the model we are going to suggest in the next section. A further interesting contribution is Kirsch (2017).

[6] A growing body of literature has examined on a theoretical level the FIH. For a summary of these formalizations see also Nikolaidi (2017).

over-accumulation of capital through saving (Piketty and Zucman 2014; Piketty and Zucman 2015), is the result of specific simplifications (Piketty 2014a, p. 46) and not a general property of capitalistic dynamics, especially in a context of a financial economy (Solow 2014).

3 The model

In this section we present the macrodynamic model proposed by Ferri (2016, chapter 10). The aim of Ferri's work is to build a model where real aspects interact with financial ones in a medium-run dynamic monetary economy of production in line with the Keynesian tradition (Keynes 1933 [1963]). He presents a recursive demand-led growth model where the dynamics is driven by endogenous forces outside steady states equilibrium conditions. We then go a step further by introducing private debt in the model. In this context, we can study the relationships between income share and growth with the presence of capital gains and private debt.

The nonlinear nature of the model, which does not yield closed-form solutions, will be solved with numerical simulations. Firstly, we find the steady state conditions from the nonlinear model. Once we obtain the steady states values, the model will be simulated with the parameters that have been chosen in accordance to existing literature.[7] Second, to obtain information on the dynamics of the nonlinear system, the model will be linearized around the steady state. On the one hand, the local analysis from the linearized model allows to test the robustness of the model, that is whether changes in the values of the parameters alter the structural properties of the system. On the other, it identifies the role of the parameters.[8]

3.1 *Wealth/income ratio*

Let us start by examining the model. The dynamics equations of capital stock K_t and output Y_t, are respectively[9]

$$K_t = K_{t-1} + I_{t-1} \tag{1}$$

$$Y_t = (1 + g_t)\, Y_{t-1} \tag{2}$$

where g is the rate of growth of output and I is the investment in absence of depreciation. Indicating with v_t the capital/income ratio and with $i_{t-1} = I_{t-1}/Y_{t-1}$ the investment ratio, Eq. (1) is divided by Eq. (2) so as to obtain the intensive form of capital/income ratio

$$v_t = \frac{v_{t-1} + i_{t-1}}{(1 + g_t)}$$

Wealth (W_t) is divided into its real and financial component, which in turn is reflected by the value of financial equity assets. The wealth/income ratio $\beta_t = W_t/Y_t$ does not increase in the real component,

[7] The parameters chosen are within the range established by previous research according to the results of econometric studies. They reflect values estimated in the relevant literature.

[8] See also Fazzari et al. (2008; 2010); Ferri (2012); Ferri and Variato (2010); Ferri et al. (2011; 2015; 2016; 2019) for a similar exercise.

[9] Depreciation is neglected in the traditional capital accumulation equation for simplicity reason.

which is assumed to be fixed. Imposing the condition $v_t = v_{t-1} = v^*$, from the previous equation the output growth becomes

$$g_t = \frac{i_{t-1}}{v^*} \tag{3}$$

Vice versa, the wealth/income ratio is assumed to increase only through an evaluation effect of equity assets reflected by an increase in capital gains $(Q_t - Q_{t-1})$, where Q_t is the relative price of equity asset defined with the following equation

$$Q_t = Q_{t-1} + \xi \left(\frac{Er_t - r_0}{R_0 - \pi_0} \right) \qquad \xi > 0 \tag{4}$$

where Er_t is the expected rate of profit while $(R_0 - \pi_0)$ represents the real rate of interest in steady state, given by the differences between nominal rate of interest R and inflation rate π.[10] With $\xi > 0$ and when $Er_t > r_0$, the price at time t increases generating capital gains $(Q_t - Q_{t-1}) > 0$. When $Er_t < r_0$ the price at time t decreases generating capital losses $(Q_t - Q_{t-1}) < 0$. In other words, capital gains are realized when expected profit is higher with respect to the steady state value r_0, capitalized by the long-term real rate of interest.

With this specification, the increase in the value of wealth/income ratio can be generated by a rise in the expected rate of profit in a situation of low interest rate set by monetary policy

$$\beta_t = v^* \left(1 + (Q_t - Q_{t-1})\right) \tag{5}$$

3.2 *Investment equation*

Investment is the main behavioural element in the model and plays a dual role. Firstly, it is the main component of aggregate demand. Secondly, it is a source of economic growth: given v^*, the rate of growth is determined by Eq. (3). In a monetary economy of production, the investment is assumed to be driven by the difference between the expected rate of profit and the real rate of interest

$$i_t = i_a + \gamma \left\{ Er_t - [(R_t - \pi_t)] \right\} \qquad \gamma > 0 \tag{6}$$

where i_a represents the autonomous component and γ is the responsiveness of firm's investment to the difference between the expected rate of profit and real interest rate.

From Eq. (6), the expected rate of profit is formulated in the following adaptive way

$$Er_t = (1 - \rho)\, r_{t-1} + \rho r_0 \qquad \rho > 0 \tag{7}$$

where rate of profit is obtained from the accounting equation of capital share $\alpha_t = r_t v^*$

$$r_t = \frac{\alpha_t}{v^*} \tag{8}$$

[10] Hereafter the subscript 0 will refer to the steady state value of variables.

The inflation rate π_t is expressed à la Phillips where the rate of unemployment is replaced by the rate of growth of output using Okun's law plus a third term highlighting the effect of an increase in debt on the level of inflation[11]

$$\pi_t = \pi^* + \varphi_1 (\pi_{t-1} - \pi_0) + \varphi_2 (g_t - g_0) + \varphi_3 (d_t - d_0) \qquad \varphi_1, \varphi_2, \varphi_3 > 0 \tag{9}$$

where π^* is the target rate of inflation.

The nominal rate of interest R_t is defined in Taylor's form with parameter $\psi > 1$

$$R_t = R^* + \psi (\pi_t - \pi_0) \tag{10}$$

where R^* refers to the exogenous target value of the nominal rate of interest. With this specification, the Central Bank reacts to the divergence of inflation from its target value.

Finally, saving follows the Kaldor hypothesis (Kaldor 1956)[12]

$$s_t = (s_\pi - s_w) \alpha_t - c_\beta \beta_t + s_w \qquad c_\beta > 0, \quad 0 \leqslant s_w < s_\pi \leqslant 1 \tag{11}$$

where c_β is the propensity to consume out of wealth and s_w with s_π are the propensity to save out of wages and profits respectively. Finally, taking into account of the macro equilibrium between investment and savings ($s_t = i_t$), from Eq. (11), the capital share can be defined in the following way

$$\alpha_t = \frac{i_t + c_\beta \beta_t - s_w}{s_\pi - s_w} \tag{12}$$

From Eq. (12), it is possible to notice the positive influence of wealth/income ratio on the capital share.

3.3 *Debt dynamics*

To address Minsky's Financial Instability Hypothesis, we extend the model introduced in the previous subsections. As already pointed out, the FIH has been formalized in different ways. We will refer to models where the dynamics of asset prices and corporate debt is considered together in the analysis, and the cyclical dynamics is the consequence of the interaction between the real and financial aspects of the economy, with an emphasis of firm's side.[13]

In our model, debt D_t finances the difference between the sum of investment and consumption out of wealth ($c_\beta W$) minus retained profits ($\lambda \Pi$), where $0 \leqslant \lambda \leqslant 1$ is the retention rate

$$D_t = I_{t-1} + c_\beta W_{t-1} - \lambda \Pi_{t-1}$$

[11] The formula is constructed considering both the negative relationship between output and unemployment and the positive relationship between a higher credit growth with higher GDP growth.

[12] In the tradition of Kaldor's theory of growth and income distribution, savings are divided between savings that come from wages and from profits. The formula takes into account the assumption that the proportion of saving out of profits is larger than the proportion of saving out of wages, $s_w < s_\pi$.

[13] This does not exclude the possibility to focus on households debt, but it is closer to Minsky's original explanation of the FIH.

The higher is retention rate, the lower will be the issue of new debt for firms. Conversely, with low retention rate, investment and consumption out wealth must be financed by issuing debt loans.

Knowing that $\Pi_{t-1} = r_{t-1}K_{t-1}$, we obtain

$$D_t = I_{t-1} + c_\beta W_{t-1} - \lambda\left(r_{t-1}K_{t-1}\right)$$

In intensive form, with $\beta_{t-1} = W_{t-1}/Y_{t-1}$ and $v^* = K_{t-1}/Y_{t-1}$ we obtain

$$d_t = \frac{i_{t-1}}{(1+g_t)} + c_\beta \beta_{t-1} - \lambda\left(r_{t-1}v^*\right)$$

Finally, using Eq. (8), we substitute $r_{t-1}v^*$ with capital share a time $t-1$

$$d_t = \frac{i_{t-1}}{(1+g_t)} + c_\beta \beta_{t-1} - \lambda\left(\alpha_{t-1}\right) \tag{13}$$

The nonlinear deterministic system of eleven equations (Eq. 3 - 13) in eleven unknowns (g_t, r_t, β_t, Q_t, i_t, Er_t, π_t, R_t, d_t, s_t and α_t) does not allow closed-form solutions to be obtained. Therefore, the main results will be obtained by means of simulations. Moreover, a linearisation around the steady state makes it straightforward to understand the role of economic forces at the root of the behavioural movement of the system.

4 Steady state analysis

Taking as given the autonomous investment (i_a), the fixed capital/income ratio (v^*) and the nominal interest rate (R_0), we obtain the steady states of the other variables with the following recursive procedure. In steady state, the rate of profit is equal to the real rate of interest if the risk premium is zero and no-arbitrage condition holds. Then we obtain the steady state level of investment i_0 from Eq. (6)

$$i_0 = i_a$$

Using i_0, from Eq. (3) we obtain the steady state level of growth rate of output g_0

$$g_0 = i_0/v^*$$

In equilibrium the expected rate of profit is equal to the actual rate of profit and from Eq. (4) it then follows that $Q_t = Q_{t-1}$. Substituting this condition in Eq. (5), it turns out that the steady state value of wealth/income ratio is equal to the real capital/income ratio v^*

$$\beta_0 = v^*$$

This result is in line with Piketty's analysis where capital gains are zero in steady state. However, differently from Piketty, we will concentrate our analysis on a disequilibrium process. With β_0 and i_0, the steady state value of the capital share is obtained solving Eq. (12)

$$\alpha_0 = \frac{i_0 + c_\beta v^* - s_w}{s_\pi - s_w}$$

Using α_0, from Eq. (8) we solve for steady-state rate of profit

$$r_0 = \frac{\alpha_0}{v^*}$$

Given the nominal rate of interest R^* and the equality of the rate of profit with the real rate of interest in steady state, we obtain the steady state value of inflation π_0

$$\pi_0 = R^* - r_0$$

Considering the values of g_0, i_0, β_0 and α_0, from Eq. (13), we solve for steady state debt d_0

$$d_0 = \frac{i_0}{(1+g_0)} + c_\beta \beta_0 - \lambda(\alpha_0)$$

The positive value of d_0 assures the existence of steady-state debt in this framework, which is coherent with the idea of a financialized economy.

Finally, from Eq. (11), we obtain the steady state level of saving, not surprisingly finding the same value of the investment in equilibrium, $s_0 = i_0$.

The parameters and steady state values are reported in Table 2. The baseline parametrization in our model has been assigned in accordance with existing literature (see for example, Ferri 2016 and Ferri et. al. 2016) and with some minor adjustments from our side for parameters γ and ξ. These parameter values were chosen to provide results economically meaningful, although we do not pretend that we are calibrating a real economy. The baseline value for v^* is 3 in accordance with the value of capital/income ratio in absence of capital gains. The value of the coefficient of inflation target in Taylor equation is higher than the one assumed in the literature (see Woodford 2003 and Galí 2008). Along the lines of Kaldor tradition $s_\pi > s_w$. Moreover, we examine the effect of changing the retention rate over the range from near 0 to near 1.

[Table 2]

5 A disequilibrium analysis: simulation results and comparative study

In the model, variables are determined sequentially in a recursive way as the simulation solves for period t values based on period $t-1$ information. We shock the investment equation for one period to move the system recursively from the steady state condition. The positive shock can be interpreted as an increase in the expected rate of profit on equity assets in a situation of financial deregulation and low interest rate set by monetary policy. Simulations run for 1000 periods and the non-linearity of the system with the choice of parameters generate endogenous cyclical fluctuations, not allowing for explosive or implosive

paths. In Figures 2, 3 and 4 we can observe the last 50 runs of simulation of 1000 periods for our variables of interest.

[Figure 2]

[Figure 3]

[Figure 4]

In the model the persistence of fluctuations comes as the combined effect of two feedback loops: the positive one related to investment and the negative one due to monetary decisions in a context of increasing inflation.[14] The conflict between these two forces is in line with the characteristics described in Hyman Minsky's research.

In our model the process goes on as follows. Let us start with an increase in the expected rate of return on equity. It produces a threefold effect: primarily, it induces firms to invest more in equity, while increasing equity prices (hence increasing capital gains). The increase in capital gains pushes up the wealth/income ratio in the financial component and not in the real component, which remains fixed in the model. Second, the rise in equity prices increases investment, enabling higher profitability and further growth. Third, given a low growth of retention rate and in a framework of increasing credit expansion the increase in profitability allows a rise in the debt ratio.

This process cannot continue indefinitely because economic expansion also stimulates the inflation process. As a result, the Central Bank during the boom phase increases the nominal interest rate via the Taylor rule, generating a negative chain reaction. A higher nominal interest rate reduces investment and sets the stage for the bust phase of the cycle, characterized by the decline of growth along with the wealth/income ratio and debt. The decline in economic activity ultimately leads to a reduction in the interest rate, allowing the economy to recover and to restart the process. In other words, when the expected rate of profit becomes sufficiently high with respect to the interest rate, a new upward movement of the system is induced.

We now compare the results of the proposed model with those of Piketty. To study the strength and the direction of the relationship between variables we use the Pearson correlation coefficient.

With respect to the original model, where the rate of saving and profit are exogenous and not influenced by the change of growth, now they are both positively correlated with growth. The positive correlation between saving and growth contradicts the "second fundamental law of capitalism".[15] The positive correlation between profit and growth challenges "the great contradiction of capitalism". With these results, the decreasing rate of growth assumed by Piketty would be accompanied by a contemporaneous decrease in the rate of profit, breaking the link between the difference $r - g > 0$ and the increasing concentration of capital. Besides, we find not only a positive correlation between wealth/income ratio and capital share but also, differently from Piketty, for capital share and growth. Results are summarised in Table 3.

[14] These forces act as thwarting forces to runaway situations (see for example Ferri and Minsky 1992). See also Section 5.

[15] Theoretical support for the results obtained can be found in Homburg (2015) and Krusell and Smith Jr. (2015).

[Table 3]

As we can observe in Figure 5, the positive correlation between wealth/income ratio and growth is in contrast with Piketty's model, but at the same time, with the pro-cyclicality of the debt ratio, it is coherent with Minsky's Financial Instability Hypothesis. Moreover, in Figure 6 we observe the same co-movement of variables with that of capital share during the oscillatory process. This highlights the fact that during the expansion phase of the growth process, there is an influence on the functional distribution of income in favor of capital, emphasizing a fundamental non-neutrality of finance on the level of inequality. In other words, the boom phases are characterized not only by an increase in instability à la Minsky with the pro-cyclicality of the debt ratio but also by an increase in the degree of inequality reflected in an increase in capital share. These results provide clear support for the Stiglitz's argument (2015a; 2015b). In recent years, through financial deregulation and low interest rates, an increase has been observed in the value of land and other financial assets which could be used as collateral for borrowing. As stressed in the introduction, these financial instruments are available to those who belong to the wealthiest classes (Taylor 2016); those who hold financial assets become wealthier compared with those who do not have this financial wealth, a situation which generates increasing inequality. In this case, economic growth is stimulated by policies accompanied by lower interest rates, but at the same time, the process is a source of financial instability and economic inequality.

[Figure 5]

[Figure 6]

It is important to stress that the pro-cyclicality of debt ratio depends exclusively on the fact that retained profits have to grow more slowly than the sum of investment and consumption out of wealth.[16] In this sense, the retention rate plays the same role in the cyclical process of debt as discussed by Lavoie and Seccareccia (2001). The authors underline the need of assuming that retained profits grow more slowly than investment; in our model the condition is more articulated, but equal in nature. Pointing out this similarity of implications, we are not subscribing the generality of the authors' critique to the drivers of FIH dynamic process: indeed, the cyclical behavior of aggregate leverage cannot be fully ascertained if different types of borrowers are assumed to be independent at aggregate level; but this is a limit that we cannot overcome either with the present contribution (given the fact we have just indebted firms and we do not dig into the different types of firms, as in contrast Minsky's FIH does).

As shown in Figure 7, when the retention rate diminishes to a threshold value of $\lambda = 0.6$, the debt increases in the boom phase, validating Minsky's descriptive analysis of macro-cycles. With a retention

[16] In the model the condition leading to leverage increase is: retention rate growth lower than investment growth rate plus consumption out of wealth growth rate. See equation 13.

rate higher than 0.6, the debt dynamics tend to have counter-cyclical paths with respect to the other variables, validating the Steindl regime.[17]

[Figure 7]

Finally, as emerges from the analysis, when we change the value of the retention rate, the model is robust because changes in the values of the parameters maintain the main structural properties of the system. Only the amplitude and the frequency of the oscillations are affected. As can be seen in Table 4 and Figure 8, a lower λ increases the model's volatility because it accelerates the cyclical process: the initial shock causes the debt ratio to rise and decline more with shorter cyclical periods.

[Table 4]

[Figure 8]

As shown in Table 5, this is true not only for the debt dynamics but also for the dynamics of the other variables, like capital share, growth rate, rate of profit and the wealth/income ratio. Overall, a reduction in the retention rate reduces the period and increases the frequency instability phenomena of all system components.[18] At the same time, we observe high synchronization between the macro variables.

[Table 5]

One last observation can be made about the retention rate. Changes in retention rate can be induced by changes in fiscal policy when higher income taxes are imposed for profit distribution than for retained profits. This could be a kind of tax policy for a simultaneous reduction of financial instability and income inequality. For this reason, introducing the public sector in the model and their redistribution process with taxation policy could be an interesting path for future research. At the same time, the introduction of fiscal policy would require a substantive change of the theoretical setting. We leave this analysis for future work.

[17] These results are in line with the work of Charles (2015): the counter-cyclicality of the debt ratio is less likely when the retention rate of firms is low.

[18] The period P is the nonzero real value for which $f(x+P) = f(x)$ and the frequency is $1/P$.

6 Local analysis

To better understand the economic mechanism underlying the oscillatory movement of the system, we present a linearized version of the model. Equations of the nonlinear system are linearized with Taylor expansion and variables are expressed as a variation from the steady state level. Constant terms are omitted and capital letters, K_1 with K_2, refer to the multiplier of the linearization. With this procedure, we can analytically evaluate the stability properties of the linearized model for given parameter values. Henceforth, the variables are expressed as a variation from the steady state level.

$$\tilde{\beta}_t = \nu^* \left(\tilde{Q}_t - \tilde{Q}_{t-1} \right) \tag{14}$$

$$\tilde{Q}_t - \tilde{Q}_{t-1} = \xi \left(\frac{1}{R_0 - \pi_0} \right) \tilde{E}r_t \tag{15}$$

$$\tilde{g}_t = \frac{\tilde{i}_{t-1}}{v^*} \tag{16}$$

$$\tilde{r}_t = \frac{\tilde{\alpha}_t}{v^*} \tag{17}$$

$$\tilde{i}_t = \gamma \left\{ \tilde{E}r_t - \left[\left(\tilde{R}_t - \tilde{\pi}_t \right) \right] \right\} \tag{18}$$

$$\tilde{\pi}_t = \varphi_1 \left(\tilde{\pi}_{t-1} \right) + \varphi_2 \left(\tilde{g}_t \right) + \varphi_3 (\tilde{d}_t) \tag{19}$$

$$\tilde{R}_t = \psi \left(\tilde{\pi}_t \right) \tag{20}$$

$$\tilde{E}r_t = (1 - \rho)\, \tilde{r}_{t-1} \tag{21}$$

$$\tilde{\alpha}_t = \frac{\tilde{i}_t + c_\beta \tilde{\beta}_t}{s_\pi - s_w} \tag{22}$$

$$\tilde{s}_t = (s_\pi - s_w)\, \tilde{\alpha}_t - c_\beta \tilde{\beta}_t \tag{23}$$

$$\tilde{d}_t = (K_1)\, \tilde{i}_{t-1} + (K_2)\, \tilde{g}_t + c_\beta \tilde{\beta}_{t-1} - \lambda \tilde{\alpha}_{t-1} \tag{24}$$

where

$$K_1 = \frac{\partial d_t}{\partial i_{t-1}} = \frac{1}{(1 + g_0)}$$

$$K_2 = \frac{\partial d_t}{\partial g_t} = -\frac{i_0}{(1 + g_0)^2}$$

Using the linearised equations, the system can be reduced of dimensionality. With Eq. (16), the dynamics of inflation becomes

$$\tilde{\pi}_t = \varphi_1 \left(\tilde{\pi}_{t-1}\right) + \varphi_2 \left(\frac{\tilde{\tilde{\imath}}_{t-1}}{v^*}\right) + \varphi_3 \left(\tilde{d}_t\right) \tag{25}$$

With Eqs. (17), (20) and (21), investment can be rewritten in the following way

$$\tilde{\tilde{\imath}}_t = \frac{\gamma\left(1-\rho\right)\tilde{\alpha}_{t-1}}{v^*} + \gamma\left(1-\psi\right)\tilde{\pi}_t \tag{26}$$

Using Eqs. (14) and (15), the capital share becomes

$$\tilde{\alpha}_t = \frac{\tilde{\tilde{\imath}}_t}{s_p - s_w} + \frac{c_\beta}{s_p - s_w}\left[v^*\xi\left(\frac{1}{R_0 - \pi_0}\right)\right]\tilde{E}r_t$$

With Eqs. (18) and (20) we rewrite the expected rate of profit in the following way

$$\tilde{E}r_t = \frac{\tilde{\tilde{\imath}}_t}{\gamma} + \left(\psi - 1\right)\tilde{\pi}_t$$

which then is substituted in the equation of capital share

$$\tilde{\alpha}_t = \frac{\tilde{\tilde{\imath}}_t}{s_p - s_w} + \frac{c_\beta}{s_p - s_w}\left[v^*\xi\left(\frac{1}{R_0 - \pi_0}\right)\right]\left[\frac{\tilde{\tilde{\imath}}_t}{\gamma} + \left(\psi - 1\right)\tilde{\pi}_t\right]$$

from which

$$\tilde{\alpha}_t = \frac{\tilde{\tilde{\imath}}_t}{s_p - s_w} + \frac{c_\beta}{s_p - s_w}v^*\xi\left(\frac{1}{R_0 - \pi_0}\right)\frac{\tilde{\tilde{\imath}}_t}{\gamma} + \frac{c_\beta}{s_p - s_w}v^*\xi\left(\frac{1}{R_0 - \pi_0}\right)\left(\psi - 1\right)\tilde{\pi}_t$$

i.e.

$$\tilde{\alpha}_t = \left[\frac{1}{s_p - s_w} + \frac{c_\beta}{s_p - s_w}v^*\xi\left(\frac{1}{R_0 - \pi_0}\right)\frac{1}{\gamma}\right]\tilde{\tilde{\imath}}_t + \left[\frac{c_\beta}{s_p - s_w}v^*\xi\left(\frac{1}{R_0 - \pi_0}\right)\left(\psi - 1\right)\right]\tilde{\pi}_t \tag{27}$$

Using Eq. (16) and Eq. (22), the dynamics of debt becomes

$$\tilde{d}_t = \left[\frac{1}{\left(1 + g_0\right)} - \frac{i_0}{\nu^*\left(1 + g_0\right)^2} - 1\right]\tilde{\tilde{\imath}}_{t-1} + \left[\left(s_\pi - s_w\right) - \lambda\right]\tilde{\alpha}_{t-1} \tag{28}$$

We obtain Eqs. (25), (26), (27) and (28) which represent the following four-dimensional system in four equations.

$$\begin{cases} \tilde{\pi}_t = \varphi_1\left(\tilde{\pi}_{t-1}\right) + \varphi_2\left(\frac{\tilde{i}_{t-1}}{v^*}\right) + \varphi_3\left(\tilde{d}_t\right) \\ \\ \tilde{i}_t = \frac{\gamma(1-\rho)\tilde{\alpha}_{t-1}}{v^*} + \gamma\left(1-\psi\right)\tilde{\pi}_t \\ \\ \tilde{\alpha}_t = \left[\frac{1}{s_p - s_w} + \frac{c_\beta}{s_p - s_w} v^* \xi \left(\frac{1}{R_0 - \pi_0}\right) \frac{1}{\gamma}\right] \tilde{i}_t + \frac{c_\beta}{s_p - s_w} v^* \xi \left(\frac{1}{R_0 - \pi_0}\right)(\psi - 1)\,\tilde{\pi}_t \\ \\ \tilde{d}_t = \left[\frac{1}{(1+g_0)} - \frac{i_0}{\nu^*(1+g_0)^2} - 1\right] \tilde{i}_{t-1} + \left[(s_\pi - s_w) - \lambda\right] \tilde{\alpha}_{t-1} \end{cases}$$

This four-dimensional system can be further reduced to a two-dimensional system.

Eq. (28) can be substituted in Eq. (25) obtaining

$$\tilde{\pi}_t = \varphi_1 \tilde{\pi}_{t-1} + \varphi_2\left(\frac{\tilde{i}_{t-1}}{\nu^*}\right) + \varphi_3 \left\{ \left[\frac{1}{(1+g_0)} - \frac{i_0}{\nu^*(1+g_0)^2} - 1\right] \tilde{i}_{t-1} + \left[(s_\pi - s_w) - \lambda\right] \tilde{\alpha}_{t-1} \right\}$$

from which

$$\tilde{\pi}_t = \varphi_1 \tilde{\pi}_{t-1} + \left(\frac{\varphi_2}{\nu^*}\right) \tilde{i}_{t-1} + \left[\frac{\varphi_3}{(1+g_0)}\right] \tilde{i}_{t-1} - \left[\frac{\varphi_3 i_0}{\nu^*(1+g_0)^2}\right] \tilde{i}_{t-1} - \varphi_3 \tilde{i}_{t-1} + \varphi_3\left(s_\pi - s_w\right) \tilde{\alpha}_{t-1} - \varphi_3\left(\lambda\right) \tilde{\alpha}_{t-1}$$

i.e.

$$\tilde{\pi}_t = \varphi_1 \tilde{\pi}_{t-1} + \left[\frac{\varphi_2}{\nu^*} + \frac{\varphi_3}{(1+g_0)} - \frac{\varphi_3 i_0}{\nu^*(1+g_0)^2} - \varphi_3\right] \tilde{i}_{t-1} + \left[\varphi_3\left(s_\pi - s_w\right) - \varphi_3\left(\lambda\right)\right] \tilde{\alpha}_{t-1}$$

Indicating with A and B the term inside the graph parentheses, we obtain

$$\tilde{\pi}_t = \varphi_1 \tilde{\pi}_{t-1} + (A)\tilde{i}_{t-1} + (B)\tilde{\alpha}_{t-1}$$

With

$$A = \frac{\varphi_2}{\nu^*} + \frac{\varphi_3}{(1+g_0)} - \frac{\varphi_3 i_0}{\nu^*(1+g_0)^2} - \varphi_3$$

and

$$B = \varphi_3\left(s_\pi - s_w\right) - \varphi_3\left(\lambda\right)$$

In the previous equation, $\tilde{\alpha}_{t-1}$ is substituted one period lag with Eq. (27). To simplify the terminology, we call

$$X = \frac{1}{s_p - s_w} + \frac{c_\beta}{s_p - s_w} v^* \xi \left(\frac{1}{R_0 - \pi_0} \right) \frac{1}{\gamma}$$

and

$$Y = \frac{c_\beta}{s_p - s_w} v^* \xi \left(\frac{1}{R_0 - \pi_0} \right) (\psi - 1)$$

from which

$$\tilde{\alpha}_t = (X)\, \tilde{i}_t + (Y)\, \tilde{\pi}_t \tag{29}$$

so to obtain

$$\tilde{\pi}_t = \varphi_1 \tilde{\pi}_{t-1} + (A)\, \tilde{i}_{t-1} + B\,(X)\, \tilde{i}_{t-1} + B\,(Y)\, \tilde{\pi}_{t-1}$$

i.e.

$$\tilde{\pi}_t = (\varphi_1 + BY)\, \tilde{\pi}_{t-1} + (A + BX)\, \tilde{i}_{t-1}$$

Indicating with

$$Y_1 = \varphi_1 + BY$$

and with

$$X_1 = A + BX$$

we obtain

$$\tilde{\pi}_t = (Y_1)\, \tilde{\pi}_{t-1} + (X_1)\, \tilde{i}_{t-1} \tag{30}$$

Finally, with Eq. (30) and Eq. (29) one period lag, we rewrite Eq. (26) in the following way

$$\tilde{i}_t = \frac{\gamma\,(1-\rho)}{v^*}\,(X)\, \tilde{i}_{t-1} + \frac{\gamma\,(1-\rho)}{v^*}\,(Y)\, \tilde{\pi}_{t-1} + \gamma\,(1-\psi)\,(Y_1)\, \tilde{\pi}_{t-1} + \gamma\,(1-\psi)\,(X_1)\, \tilde{i}_{t-1}$$

from which

$$\tilde{i}_t = \left[\frac{\gamma\,(1-\rho)}{v^*}\,(X) + \gamma\,(1-\psi)\,(X_1) \right] \tilde{i}_{t-1} + \left[\frac{\gamma\,(1-\rho)}{v^*}\,(Y) + \gamma\,(1-\psi)\,(Y_1) \right] \tilde{\pi}_{t-1}$$

Indicating with

$$X_2 = \frac{\gamma\,(1-\rho)}{v^*}\,(X) + \gamma\,(1-\psi)\,(X_1)$$

and with

$$Y_2 = \frac{\gamma(1-\rho)}{v^*}(Y) + \gamma(1-\psi)(Y_1)$$

we obtain

$$\tilde{i}_t = (X_2)\,\tilde{i}_{t-1} + (Y_2)\,\tilde{\pi}_{t-1} \tag{31}$$

Eqs. (30) and (31) represent our two-dimensional system of difference equations

$$\tilde{\pi}_t = (Y_1)(\tilde{\pi}_{t-1}) + (X_1)\left(\tilde{i}_{t-1}\right)$$

$$\tilde{i}_t = (Y_2)(\tilde{\pi}_{t-1}) + (X_2)\left(\tilde{i}_{t-1}\right)$$

i.e.

$$\begin{pmatrix} \tilde{\pi}_t \\ \tilde{i}_t \end{pmatrix} = \begin{pmatrix} Y_1 & X_1 \\ Y_2 & X_2 \end{pmatrix} \begin{pmatrix} \tilde{\pi}_{t-1} \\ \tilde{i}_{t-1} \end{pmatrix}$$

The Jacobian matrix J is

$$J = \begin{pmatrix} Y_1 & X_1 \\ Y_2 & X_2 \end{pmatrix}$$

The characteristic roots are

$$\lambda_1, \lambda_2 = \left[(\mathrm{tr}J) \pm \sqrt{(\mathrm{trJ})^2 - 4(\det \mathrm{J})}\right]/2$$

where

$$trJ = Y_1 + X_2$$

and

$$\det J = Y_1X_2 - X_1Y_2$$

With the benchmark parameters presented in section (3) we obtain

$$\Delta = (Y_1 + X_2)^2 - 4(Y_1X_2 - Y_2X_1) < 0$$

with a pair of complex roots

$$\bar{\lambda}_{1,2} = \frac{trJ}{2} \pm i\frac{\sqrt{-(\Delta)}}{2} = a + ib$$

where i is the imaginary part and a and b are real number.

The complex number in the cartesian form $a \pm ib$ can be written in the equivalent trigonometric form $\bar{\rho}(\cos\omega \pm i\sin\omega)$. The positive number $\bar{\rho} = \left(a^2 + b^2\right)^{\frac{1}{2}}$ is called the modulus or absolute value of the complex number (Gandolfo, 2009). With the benchmark parameters presented in section (3) we obtain

$$\bar{\rho} = \sqrt{\left(\frac{Y_1 + X_2}{2}\right)^2 + \frac{-\left[(Y_1 + X_2)^2 - 4(Y_1X_2 - Y_2X_1)\right]}{4}} = 1$$

i.e.

$$\bar{\rho} = \sqrt{(Y_1X_2 - Y_2X_1)} = 1$$

For those specific parameters we provide evidence for the existence of a discrete time limit cycle. Choosing γ as a bifurcation parameter, the conditions set by the Neimark-Sacker theorem are respected, then a limit cycle is generated. In particular, the eigenvalues' modulus become unity at γ and the derivative of the roots with respect to this parameter are not null (for a similar analysis see for example Ferri et al. 2015 and Ferri et al. 2016).

These conditions give support to our thesis of cycles persistence; furthermore, they highlight the relevance of the underlying endogenous economic forces associated with each of the parameters (i.e. the value of the coefficient γ in the investment equation, and the value of ψ in the Taylor equation).

It turns out that with a higher value of γ, the amplitude of the fluctuations increases monotonically, eventually exploding in the very long-run: indeed, as the parameter increases from its benchmark value, we obtain complex eigenvalues with modulus higher than 1, resulting in a significant reduction of system stability. The opposite happens when γ is lower with respect to the benchmark value. This result again stresses the importance of the reactivity of investment to the difference between expected rate of profit and real interest rate. At the same time, an increase in ψ tends to generate complex eigenvalues with modulus lower than 1. In other words, the Central Bank could stabilize the system with a more aggressive response to inflation.

Finally, we consider a wide range of robustness tests on other parameters values. We just report that from the linearized model we observe it is robust to both increases or decreases in the retention rate (the modulus of complex eigenvalue becomes equal to 1). In contrast, an increase in ξ is destabilizing for the positive (negative) effect of capital gains (losses) on the wealth/income ratio.

7 Conclusion

In the opening of the paper, we observed that in recent years the names of Minsky and Piketty gained increasing notoriety to researchers because the two authors investigated issues of financial instability and income inequality, which represent both two unsolved macroeconomic problems of the new millennium, and evidence contradicting the long-run implications of mainstream macroeconomics.

By combining these two names we set ourselves the ambitious goal to contribute directly to the debate meant at clarifying the controversial relationship between financial instability and income inequality; and to address the broader issue of explaining why a theoretical revolution in macroeconomics has not yet occurred, especially emphasizing why financial aspects still play a subordinate role to real factors in the causation of growth and cycles. In this broader perspective Minsky and Piketty were assumed as polarized "symbols" of heterodoxy and orthodoxy.

The theoretical framework proposed was grounded on Ferri (2016), who presents a class of demand-led models in a medium-run time horizon. This class of models is not conventional too, though it belongs to "Pedagogical models", we consider especially relevant tool for macroeconomics.

Moving from particular to general we draw the following conclusive remarks.

About the technical aspects of the model and its implications. We have presented a macrodynamic model which, considering the financial components of capital, analyses the increasing wealth inequality in the context of the Financial Instability Hypothesis (FIH). When a shock disturbs the steady-state value, the simulated variables trace a cyclical pattern which remains bounded through the endogenous economic forces. It is important to stress that the results do not depend only upon the hypotheses underlying the model, but also upon the values of the parameters.

The model generates bounded endogenous dynamics of expansions and contractions, where the co-movements between main variables are different from those obtained in Piketty's model; we revisited and compared the main results. Moreover, this approach allowed us the possibility to reconsider the increasing economic inequality in the light of Minsky's FIH.

In this respect, we obtained two main results: firstly, during the boom phase of Minsky cycles, we observe a contemporaneous increase of capital share in the functional distribution of income. This result is in line with the idea that those who hold financial assets become wealthier during the growth process with respect to those who have no financial wealth (Stiglitz 2015a; Stiglitz 2015b; Madsen 2019).

Second, and this is the fundamental novelty highlighted by our model, it appears that a sufficient fall in the retention rate reinforces Minsky's theory, thus at the same time emphasizing the destabilizing role of shareholders in the functional distribution of income (Charles 2015; Lavoie and Seccareccia 2001). Conversely, with an increase in the retention rate, we find a counter-cyclical debt ratio. This is the case in which we refer to the "Steindl regime", where the debt cycles move in the opposite direction of that of Minsky cycles (Lavoie 2014). In this sense, the model emphasizes the non-neutrality of finance on the level of economic inequality and the fundamental role of retention rate in the generation of Minsky cycles. Overall, our results suggest inequality can increase as growth accelerates, as it happened since the mid-1990s where strong growth was accompanied by both financial instability and remarkably increasing wealth inequality. In other words, the process of Minsky's instability characterizes the process of growth, simultaneously fueling the process of inequality in the functional distribution of income.

About the role of "Pedagogical models". Through the analysis we presented, we showed that one of the most relevant merits of this class of models is that they are powerful instruments of synthesis and comparison of alternative theses. Obviously, they are not "realistic" (as underlined, both Piketty's and our model are somehow over-simplistic), but they allow to compare on the same grounds alternative visions of macroeconomics both affecting the overall conception of dynamics, or specific aspects of the sub-processes involved in it. In doing so they become together the technical counterpart of (at least implicit) narratives in macroeconomics (which can be faced with emerging facts in actual behavior of economic systems), and the basis justifying the rationale for policy choices.

Furthermore, the inconclusiveness of tests on alternative linear causation descriptions (indirectly present in the paper through the reference to other contributions) underlines the need of a change of economic vision such that complexity comes as a substantial part of representation. How to end-up with such complex Pedagogical models is, in our view, one interesting challenge for future research.

About the evolution of competing paradigms in Macroeconomics.

Saying Minsky was not a mainstream exponent, whereas Piketty is, should not raise any kind of

objection wherever the statement is laid off. Taking the two authors as epitomes of heterodoxy as opposed to orthodoxy is quite a different and more controversial issue because this implies the acceptance the two authors are "especially representative" of the two categories. We are confident that other scholars should find different "champions" to contrast. But this was not the rationale behind our selection. Somehow our choice was guided by the attempt to answer a different question. Why the two authors have different degrees of popularity even though the themes they focus on are unanimously considered relevant, especially while considering present days dynamics? Two considerations emerge. The answer implied by the second section of the paper is: not so much because the authors are differently convincing, but because they are exponents of two different fronts; thus, the success of Piketty to us mainly depends upon the fact he does not pose any real challenge to mainstream views (or to their methodological roots).

The second consideration is linked to another question: why Minsky selection among the heterodox? The answer in this case in only indirect, as the paper does not explore it explicitly. We think that despite the possible weaknesses, Minsky's contribution, if considered as a whole research body, is interesting because it cannot be categorized into a definite school of thought or into a single language of approach. If this can be considered by many to be a limitation, from our point of view it is a strength. The transversality with respect to schools and languages is indeed an important identification factor: a transversal author joins instead of dividing.

An alternative paradigm to the mainstream can only be constructed through a synthesis of what is today a variegated and belligerent heterodoxy often fighting with blows of models refined in detail; perhaps for this very reason it fails to generate the intellectual revolution awaiting to show up for at least fifteen years. There is no lack of detail in the literature of recent years, as reported in our article; rather a lack of synthesis and visions, enabling to turn the stream of rivulets into a river of change. The reference to Minsky then becomes an essential suggestion, because it could constitute a sufficiently large basin of attraction around unavoidable themes of macroeconomics. It should clear, in the end, that we did not refer to Minsky for technical aspects, but because his work is centered around two essential traits (which underlie our contribution in the method): dynamic interdependence between the real and financial dimension of the economy (the core of the FIH) and the dynamic interdependence between the financial dimension and income distribution (the theme of tight full employment which is at odds with inequality). Such interdependencies are in stark contrast with mainstream perspectives and method. Making them evident could change the relevance of the keywords of research and in turn change the fate of economic paradigms.

Observations in terms of future perspectives. Even though the task is beyond the scope of our paper, policy conclusions can be grasped from the model we presented. The process we described, as the source of an increase in inequality, can be controlled by the state through a process of taxation on capital gains and regulation finance processes. It is necessary to understand how to stabilize or control financial fluctuations to avoid significant and negative repercussions on the rest of the economy. This is especially important in economies marked by large divisions, like our economies today. Second, since the global financial crisis, a wide consensus has emerged as to the importance of an integration of theory of the financial system with that of the real economy. We believe time has come to understand the increasing economic inequality in the light of an unstable financial capitalism, extending inequality studies into the sphere of the Financial Instability Hypothesis. It is a pragmatical need: overlooking this link, implies the risk to expose systems to institutionally (so endogenous) induced negative shocks, eventually endangering opportunities for growth and wellbeing. But there exists also a need to make new phase of economic research to happen.

We emphasized on the necessity for macroeconomic epistemology to resume constructive dialectics: a mixture of plural narratives and foundations for new visions of economic policy. Those proposed in the paper differ from orthodox ones as they call for financial regulation, they underline qualitative aspects and heterogeneity. Such embryonal policy suggestions stem from the overall perspective described in the article, a perspective rooted into Ferri's notion of medium-run and qualified by Minsky through an eclectic approach implying networks of balance-sheets relationships: two ways highly overlapping though not totally equivalent to represent the reality of a complex and endogenously unstable capitalism lying at the edge of chaos.

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