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The macrodynamics of financialization: shareholder value, structural bubbles and inequalities in an agent-based model.

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Abstract: In this paper, we would like to contribute to the literature on the macroeconomic dynamics of financialized economies. After outlining the main aspects of the financialization of the economy and its aggregate consequences, we propose the thesis that the 2010's stock market bubble is a direct consequence of *shareholder value*. We then present a macroeconomic agent-based model containing a stock market, which will provide a basis to prove the latter thesis. We run small experiments and find that rising dividends-to-payouts ratio leads to a deterioration of the wage share, increased inequalities, and deeper economic crisis. Plus, the rise of inequalities is exacerbated by the presence of a stock market, which gives rise to the endogenous emergence of an extremely wealthy capitalist class.

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1. Introduction

The 2008 financial crisis and the severe economic recession that followed seemed to have revealed blatantly the flaws of both the neo-liberal view on the economy and the *general equilibrium* models used to predict its behavior. In the wake of the crisis, some institutional changes were implemented, such as prudential regulations and increased capital requirements for banks. However, if households and the financial sector have indeed been deleveraging in the US since then, the leverage of non-financial corporations have risen dramatically during the same time. While a massive bubble of *Collateralized Loans Obligations* is growing unsustainably on financial markets to sustain the debt of highly leveraged firms, the US stock markets have never been so shiny than during the 2010 decade, showing a long-sustained boom without signs of any euphoric overpricing. All in all, it seems that a ponzi scheme has set-up between corporation's leverage and prices on the stock market, and that the fundamental of financialized capitalism have not been wiped out by the crisis. More particularly, in this paper we would like to show that the 2010's stock market bubble is a consequence of structural effects induced by the financialization of non-financial corporations (NFC).

The literature on *financialization* emerged in the early 1990's, as scholars were trying to make sense of the profound transformations brought by the neo-liberal revolution and followed the seminal works of Marxian authors such as Hilferdings (1910) or Magdoff & Sweezy (1972). The concept has generated the interest of many scholars coming from different fields of study, and in economics it has become one of the main components of the heterodox agenda. Yet, it still lacks a precise definition and delimitation, and different authors tend to refer to different phenomenon. To be comprehensive, Epstein (2005) coined financialization as the "*increasing role of financial motives, financial markets, financial actors, and financial institutions in the operation of the domestic and international economies*". If this definition has the merit of encompassing the whole literature, it is rather elusive. In this paper, we prefer to follow Krippner (2010) and consider financialization as a multi-dimensional process, which is characterized by an array of interrelated phenomenon, comprising mainly : (1) the growing dominance of financial markets over bank-based financing, (2) the shift of corporate governance toward the maximization of shareholder value, (3) the explosion of financial innovations and trading volumes, (5) the increasing involvement of Households in financial schemes, and finally (6) patterns of accumulation in which profits are increasingly made through financial channels rather than productive ones.

The process of financialization as been associated to deep structural changes in the economy and to important changes in macroeconomic trends, namely the rise of inequalities, a decrease of the wage share, economic stagnation and a growing aggregate leverage. To make sense of this dynamics and outline the causality links at stake in the emergence and sustaining of finance-led capitalism, many scholars in the past two decades attempted to build macroeconomic models of financialization (Boyer 2000, Lavoie 2008, Riccetti et al. 2016). In this paper, we would like to contribute to this literature, and after a review, we will identify the lines of improvements and the aspects which are still ill-addressed by models. Then, we build an agent-based model inspired by the JAMEL model of Seppecher et al. (2018), and we implement small experimentations. Our first result is that rising dividends-to-payouts ratio induce increased inequalities, a deterioration of the wage share, and deeper economic crisis. In addition, we show that the interaction between the stock market and rising payouts results in exacerbated inequalities. Further, the model presented will provide the basis to prove the coherence of our thesis on the 2010 stock market bubble in future contributions.

The paper is organized as follows. Section 2 presents the basic features of financialized capitalism. In section 3 we develop our argumentation on the structural equity bubble induced by the financialization of NFC. Section 4 is a review of existing models of financialization. Section 5 presents the agent-based framework. Section 6 details the functioning of our model, and in Section 7 we discuss the results.

2. Financialization

Financialization refers to a wide array of phenomenon, which tend to be treated separately by scholars. Yet, there are strong, complex and intricate causal links between the different dynamics of financialization, and our opinion is that deciphering those links is crucial to understand the conditions of emergence and stability of financialized capitalism, and to explore policies to prevent or escape from it. In this section, we will first describe the main aspects of financialization and attempt to draw causal links. A special emphasis will be laid on the phenomenon of the *financialization of Non-Financial Corporations (NFC)*, as it is the focus of the model proposed in section 5. In a second part, we will describe the main macroeconomic dynamics of the finance-led regime.

2.1 A Multidimensional evolutionary process

As is often the case in Economics, the origin of Financialization is to be found in a complex interaction between economic theory, changes in the regulatory environment, and evolutionary processes within the private sector. For the most part, it happened in the United States during the 1980's and 1990's, before spreading across the developed world. Our analysis in this paper will therefore remain focused on the USA in order to make the key feature of financialization as salient as possible.

First, according to Vercelli (2013), financialization can be understood as an evolutionary process, in which new financial innovations are constantly invented to remove constraints on economic exchanges and agent's balance sheet. Thus, since the 1980's, financial engineers have developed ever more sophisticated and complex financial products. Further, each new financial innovation was almost systematically validated by a loose regulatory environment which essentially followed more than impulse the financial sector (Tymoigne 2009). Two main types of financial innovations have been at the center of academic discussions in recent years. First, *derivatives* products, aimed initially at protecting non-financial agents against market prices risks, can be used as a speculative tool and provide a possibility of increased leveraged and risk on trade positions. But most importantly, during the past three decades, the financial system has been making an ever more developed, ingenious and systematic use of *securitization*. Securitization is a process by which a creditor, often a commercial or investment bank, can turn illiquid financial claims into tradeable securities. Initially praised and validated by Economic theory as a good way to distribute risk within the financial sector, securitization proved to be a very noxious practices which increased systemic risks and was at the center of the 2008 crisis Tymoigne 2013). It is not the purpose of this paper to discuss the risks associated with securitization, but we want to stress that the possibility of refinancing by securitization enabled Banks to expand their credit capacity, and removed the incentives for creditors to monitor properly the financial sanity of their debt claimers, which led to the widespread emergence of poor-quality, high-yield credit

In parallel of this surge of financial innovations, the early 1980's saw the rise of institutional investors as key sources of funds for financial markets. It originally came out of the action of the regulator: the *ERISA act* in 1974 was meant to spur the use of pension funds as a retirement

schemes for US citizens. At the same time, it also authorized pension funds to invest large part of their portfolios in risky assets. This rise of institutional investors came in close interaction with the securitization process, as pension funds and mutual funds were often the final acquirer of a large part of produced securities.

In the early 1980's, the very special environment provided by new financial innovations and growing sources of non-bank funding enabled the small private equity firm *Kohlberg Kravis Roberts* to engineer the *Leveraged Buy-Out* (LBO) operation. Briefly, a LBO is a financial structure which allows a private equity firm to acquire a large company, with a very small amount of capital and a huge amount of debt. The equity part is provided by fund investors, typically institutional investors, while the debt part was structured into different risk levels, and mainly financed through the emission of *high-yield bonds* freshly invented by the investment Bank *Drexel Burnham Lambert*. Following an evolutionary process, KKR successful LBO strategy was rapidly imitated by numerous other investment firms, which launched the *corporate raiding* craze of the 1980's (Kaufman & Englander 1993). These events were in many ways the starting point of the financialization of the US economy. First, by combining the huge funding capacity of pension funds and the possibility offered by securitization, private equity firms could operate *hostile takeovers* on literally any corporations, including giant conglomerates such as *RJR Nabisco*, which was acquired for $24.72 billion, an reap huge benefits by reselling is pieces[1]. Thus, this marked the emergence of the so-called *market for corporate control* which put management teams under high capital market pressure (Aglietta & Breton 2001). In order to appear less attractive to *hostile takeovers*, large conglomerates had to apply themselves a*shareholder value*, increase their leverage and pay attention to their share price (Börsch 2004). Likewise Acquired corporations would inherit from the enormous debt of the LBO and would be imposed with shareholder value. Finally, giant volumes of high-yield bond emitted for the financing of LBO operations launched a financial market and set up practices that were to become the norm in later developments.

In this context of rising financial markets, and due to the competition with market-based financing by investment bank, Commercial Banks had to transform fundamentally their business model, and abandoned traditional banking to focus on market-oriented activities, and capital gains and commissions on operations became a major source of profits. For this reason,

[1] The study of the predative strategies of private equity firms is the subject of an entire field of the financialization literature, and the interested reader can refer to Froud & Williams (2007) for more details.

it is often said that the 1980's has been characterized by a process of *disintermediation* of credit operations. But, in fact, the exact opposite occurred: the number and size of financial intermediaries literally exploded, along with the size and volume of financial markets. To guide pension funds in their investment strategies, many actors developed counselling or *money management* activities. With the rise of financial markets and the emergence of derivatives, *hedge funds* emerged, and proposed investors high-yield returns based on complex and risky strategies. The endless possibilities of recursion of finance enabled the bundling of securities into synthetic securities, and the creation of long chains of holding, with mutual funds owning shares in other mutual funds. Far from being disintermediated, the financial sector, once centered around the banking industry, has flourished into a whole set of financial intermediaries, all generating profits out of their activities around the financial markets.

2.2 The financialization of Non-Financial Corporations

The financialization of NFC can be characterized by a drastic shift in corporate governance and corporate strategy toward the short-term maximization of *share-holder value*, which resulted in an array of practices including wealth-based management, downsizing, financial investment, increasing payouts-to-profits ratio and high leveraging.

The financialization of NFC stemmed out of five main causes. First, in the 1970's, American large corporations had been suffering from a harsh foreign competitive pressure and difficulties to manage their very wide portfolio, which seemingly showed the limits of the conglomerate "*retain and reinvest"* model (Boyer 2000, Lazonick & O'Sullivan 2000). Second, the *hostile takeover* frenzy and the rise of *capital markets pressure* spurred the concerns of management teams for shareholder value. Third, with the advent of MMC, many companies went from passive direct ownership by households and banks to the ownership by mutual funds which were actively implicated corporate governance and strategy to maximize shareholder value (Froud et al 2006). Fourth, based on the *agency theory*, a powerful economic literature provided theoretical justifications for the principles of shareholder value, market for corporate control, and stock-based remunerations (Jensen & Meckling 1979, Jensen 1986). Lastly, large corporations must now pay careful attention to their stock prices for two strategic reason: (1) as corporate financing happens mainly through bond emission, the perception of the firm by capital markets is relevant to their cost of financing, and (2) since the 1990's, most *Mergers*

and Acquisition take place through share-swaps, which basically means that a firm's own shares are a currency for acquiring competitors, and the maximization of its value extends the possibility of aggressive growth (Borsch 2004).

Concretely, the principle of maximizing shareholder value came with a battery of corporate governance changes. Stock-based compensations were implemented in most large corporations and gradually increased, as a way of guaranteeing the alignment of top executives' interests with those of shareholders (Froud et al. 2006, Lazonick & O'Sullivan 2000). In the US, the annual stock-based incentives went from $1.4Bn in 1980 to $14bn in 2000 (Froud et al 2006). Consequently, the focus of management eventually came to shift from long term growth to the mere maximization of indicators such as *Earnings Per Share (EPS)* or *Return on Equity (ROE)*. The 1980's and 1990's also witnessed the rise of the *Chief Financial Officer* (*CFO*), a position which was initially assigned to financing acquisitions, but progressively came to popularity as a position whose mission was to restore corporate earnings and manage shareholder value.

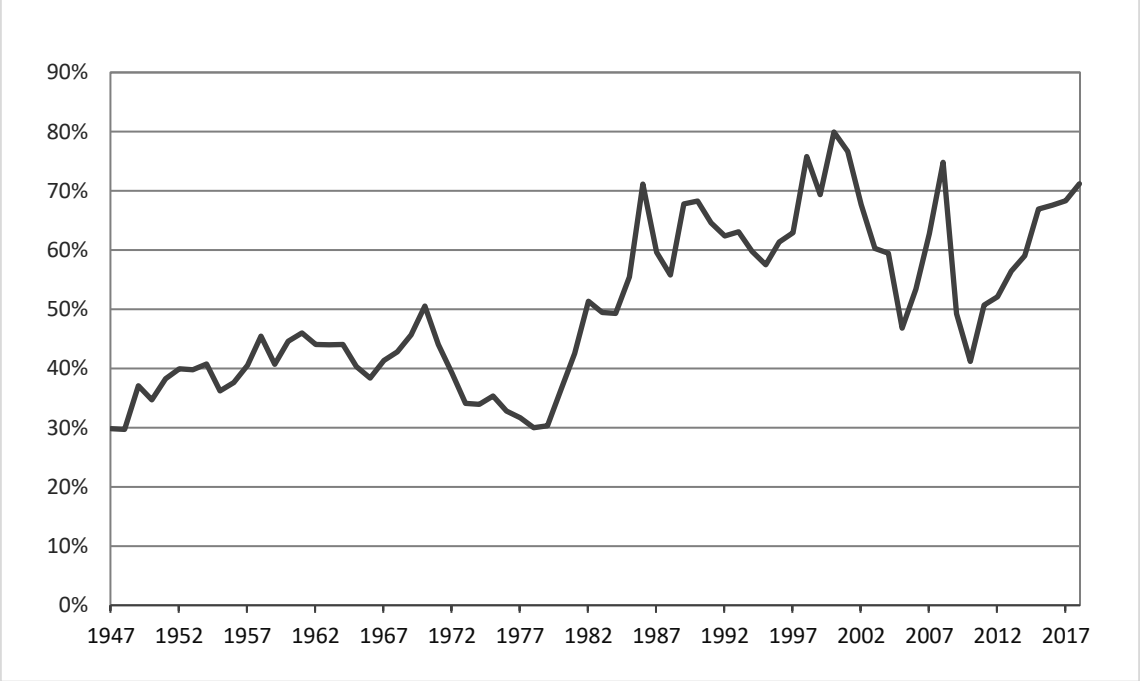


Figure 1: Corporate dividends-to-profits ratio in the US since 1947

Source: *Federal Reserve of St Louis (FRED)*

The first, undeniable consequence of the financialization of NFC is the dramatic rise of payouts-to-profits ratio (Floyd et al 2015, Davis 2016). On Figure 1, the reader can clearly that dividends in the US rose dramatically starting in the late 1970's, with a peak at 80% of profits in 2000. But more importantly, share repurchases have now become the dominant form of payouts, as

their total amount exceeds that of dividends (Skinner 2008). The key advantages of share repurchase is that they enable firms to boost their *EPS* ratio and meet sectorial norms, by reducing the total amount of shares and spurring prices up (Bens et al 2003, Farrell et al 2014). In addition, scholars have reported many usages of share buy-backs: management of the dilution resulting from stock-options or share emissions (Kahle 2002, Bond et al 2016) [2], signaling and fighting undervaluation (Bonaime 2014), or even funding corporate acquisitions. As documented by Lei et al. (2016), *leveraged buy-backs* – debt-financed buy-backs – are frequent, and they are often followed directly by a reduction of fixed investment.

In parallel of the share repurchase craze, the use of stock markets as a source of funding by well-established firms plunged dramatically, and net share emissions in the US became increasingly negative starting in 2000. In the following section, we will propose the hypothesis that the stock market bubble of the 2010's is mainly due to these developments.

Other features of the financialized firm are more debated. Some scholars have pointed a so-called "*crowding out*" of real investment by financial investment in large corporations (Krippner 2011). The justification of such a behavior is easy in a Keynesian framework: as financial profit rises above exploitation profits, and in times of uncertainty, firms would be driven to invest in financial assets rather than in real ones (see Stockhammer 2004). Even though there are blatant and extreme cases to confirm this theory, such as *General Motors* in the 1990's (see Froud et al 2006), and even if empirical evidence show a clear rise of financial assets in NFC balance sheets (Davis 2016), many researchers have raised skepticism, and the theory might at least be over-simplistic. First, as noted by Davis 2016 in an in-depth micro-empirical study, the rise of financial assets is exclusively concentrated in *Cash Holdings, Goodwill,* and *Intangibles.* Plus, even if financial assets account for a greater part of total portfolio than in the past, financial income is still marginal in financialized companies. For Davis (2016), *cash holdings* rise reveals a banking-like activity of large corporations, which benefit from lower than average interests on financial markets. Following Kliman & Williams (2015), our opinion is that the rise of financial assets in firm's portfolio is mainly a consequence of the strong *Merger & Acquisitions* activity in the US industry since the 1980's, which has overinflated *Goodwills,* and in a smaller extent of the offshoring process which led US firms to

[2] The reader might be puzzled at the idea that share repurchases are implemented to counteract the effects of share emissions, but in financialized capitalism it seems to be a rational operation.

more *intellectual property* assets. In the next section, we will come back at the role of *Goodwills* in firms balance sheet and in the financialization dynamic.

As found by many empirical studies on the investment function, dividends and share buy-backs have seemingly a negative effect on fixed capital accumulation (Oranghazi 2008, Auvray & Rabinovitch 2019). Yet if the correlation seems assured, there is some important ambiguity which makes final the causality very difficult to decipher. To simplify overly, we can describe the financing need of a corporation as such:

$$(Profits - \ Payouts) + \ financing = Investment$$

$$Financing = -(\ Profits - (Investment + Payouts))$$

Concretely, for most corporations, the sum of investment and payouts superior to profits, and thus there is a need for external financing. However, only by looking company accounting data, it is very difficult to determine if borrowing was realized to finance share repurchases, dividends, fixed investment, or financial investment. And even if borrowing is officially made to finance fixed investment but is due to the distribution of excessive payouts, which is the real cause? We see that there is a real puzzle for economists here.

For the moment, let us just state that if a corporation increases its payouts-to-profits, it must either reduce the level of investment, or increase progressively its leverage (equity financing is prohibited as destructive for shareholder value). Yet, at some point leverage must reach an intolerable level and investment will be constrained. This view is confirmed by Turco 2018 who found empirically that share buy-backs have a negative effect on investment especially among already highly leveraged firms.

Lastly, as regard corporate strategy, Froud et al 2006 put forward the rising practice of *Value Based Management*, which consists in applying *Economic Value Added (EVA)* and *ROE* ratios to business units in a conglomerate. If a unit do not match the targeted group-scale ROE, it is either *downsized*, or simply the sold to a competitor or private equity firm.

All in all, the changes brought by shareholder value can be summarized in Lazonick & O'Sullivan (2000) phrase: "*from retain and reinvest to downsize and distribute"*. As a main consequence of this model, firms tend to engage in increasing leverage to finance investment, or simply to reduce the level of investment.

2.3 The Macrodynamics of financialization

Starting in the early 2000's, increasing efforts have been made to characterize the macrodynamics of financialization, following the pioneering works of authors in the French Regulationist school on the so-called "finance-led" regime of growth (Boyer 2000). We will try here to outline the key features of the finance-dominated regime, as identified by empirical studies.

First and foremost, an essential feature of financialization is the disproportionate growth of the financial sector in terms of profits and total assets. On Figure 2, we see that the share of the financial sector in US GDP has been rising thoroughly since 1946.

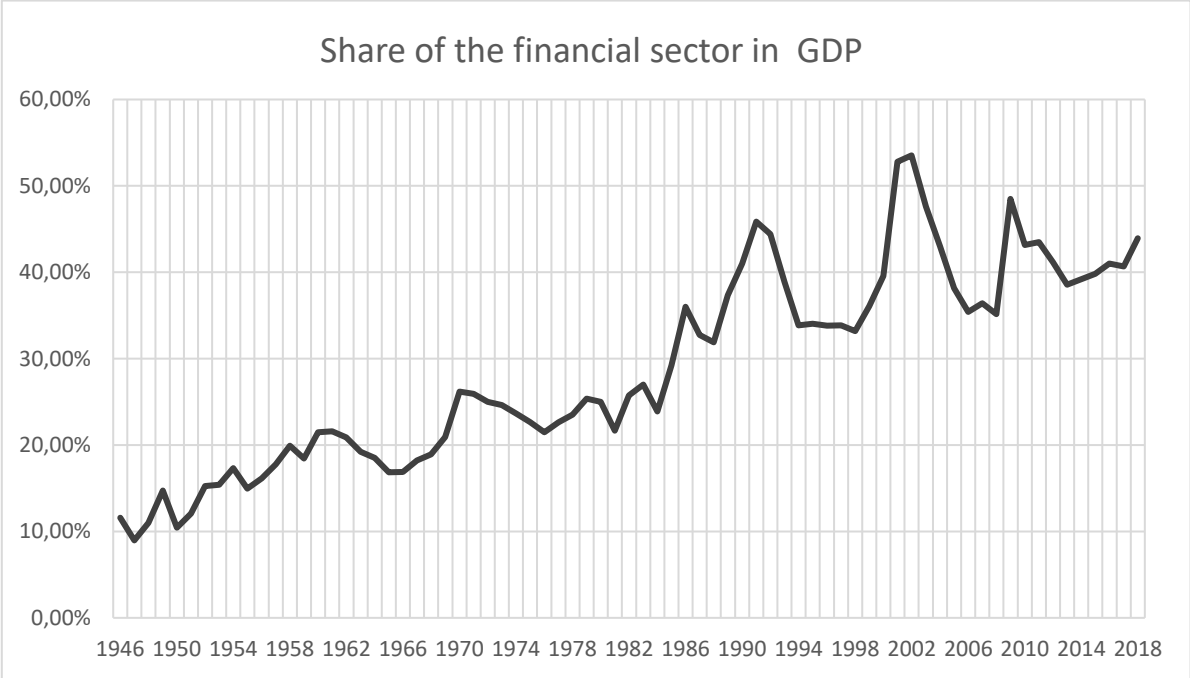


Figure 2: Share of the financial sector in US Gross Domestic Products from 1946 to 2018.

Source: *FRB Z1, Table F.2.*

As for other dynamics, we follow Stockhammer (2008) and Van Treeck (2009) who both conducted empirical investigation to assess the macroeconomic regularities of financialized developed economies, and identifies that financialization is associated with:

1. Rising income inequalities and rising households net-worth-to-income ratio.

2. A drastic decline of saving rates and a rapid expansion of household debt.
3. A downward trend of fixed investment, except for the 1990's new economy Boom. Meanwhile, profits recovered, which results in a puzzling divergence between profit rates and accumulation.
4. Rising corporate leverage and payouts, and negative net equity emissions
5. Higher fragility and instability due to the activity of domestic markets and of the extended debt accumulation, which leads to severe crisis.

We will not come back on the financialization of NFC side, which we extensively explored in the last section. However, the interactions between financialization and inequalities, as well as with the investment dynamics merits further details.

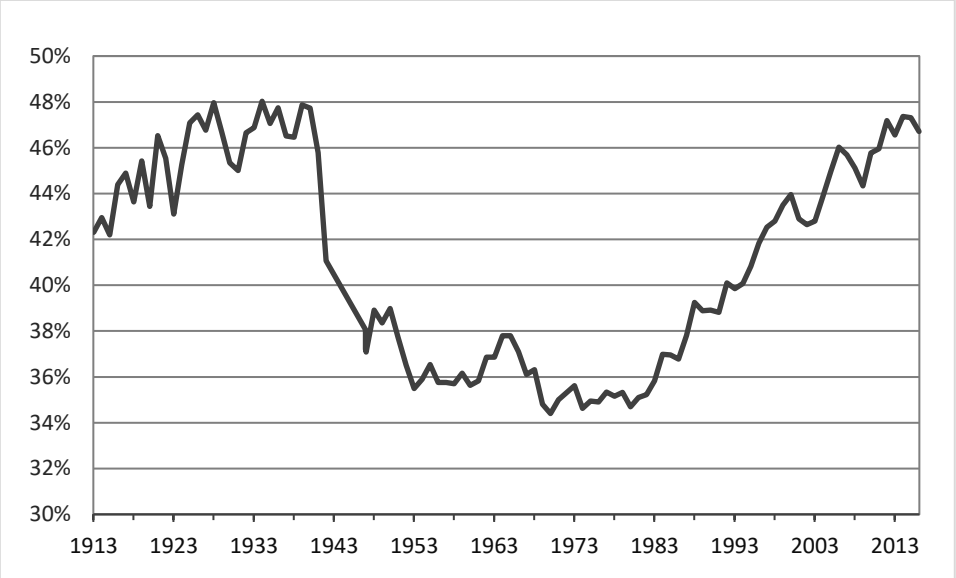


Figure 3: Share of the top 10% in US national income

Source: *World Inequality Database (Atkinson et al. 2011)*

The link between the process of financialization and the rise of inequalities has been extensively documented (Lazonick 2014, Godechot 2016). As we can see on Figure 3, the share of the top 10% in the US national income has reached a level close the 1930's in 2013. According to the same study by Atkinson et al (2011), capital inequalities are even more extreme: in 2016, 1% of US citizens possessed 36% of total US wealth. There are great evidences that this rise of inequalities is due at least partly to financialization (Epstein 2005, Crotty 2005 Godechot 2016).

If most authors agree on the correlation between financialization and inequalities, the question of the channels of causality is still debated and problematic. First, many scholars have pointed at a deterioration of the wage-profit compromise. Numerous empirical studies have provided robustness to this theory. Dünhaupt (2013) established a negative correlation between increasing dividends, interest payments and the wage-share. Lin & Tomaskovic-Devey (2013) proved that the fall in labour's income is related with the rise of top executives' compensations in a panel data of countries. Zalewski & Whalen (2010) and Van Arnum & Naples (2013) found similar results. Theoretical explanations point at downsizing, offshoring and investment sluggishness which are said to result in higher levels of unemployment and stagnant wages (Palley 2007), and to the switch of corporations to short-term 'survivalist" strategies which has pushed them to cut labour-costs (Crotty 2005).

However robust empirically, the wage-share explanation is rather unsatisfying. First, between 1970 and 2017, the wage share in the US only declined of about 6%, while inequalities measured by top 1% income were multiplied by 2. Furthermore, as argued by Atkinson, Piketty & Saez (2011), most of the rise of inequalities have been driven by the growth of top income percentiles, and less by stagnant low incomes. Plus, as many authors including Atkinson et al (2011) stresses, a large part of top income growth corresponds to the rise of high wages (Autor et al. 2008, Palley 2013, Bell & Van Reenen 2013). There are at least two channels through which financialization might have exacerbated wage inequality: the increasingly generous pay of top executives (Lin & Tomaskovic-Devey 2013), but most importantly the extraordinary growth of wages in the financial sector (Phillipon & Reshef 2007, Bell & Van Reenen 2013). This fact is perfectly coherent with Krippner's (2005) concept of a shift in patterns of accumulation and sources of profits: as profits are increasingly made through financial activities and within the financial sector, the corresponding productivity and wages of financial professionals have surged as well (Phillipon & Reshef 2007).

Another important aspect of finance-led capitalism is that the rise of inequalities is correlated to the rise of household debt (Kumhof 2015, Bazillier & Héricourt 2017). Consumer credit booms are seen as the condition of emergence of a finance-led regime of growth, as they enable low income household to "keep up with the Joneses" with debt-financed consumption, which counteracts the depressional effects financialization (Frank 2014, Palagi 2017). Yet the growth of household generates financial instability, and it has been cited as the fundamental cause of the 2008 crisis (Stockhammer 2015, Botta et al 2019).

Lastly, financialization has been associated with a slowdown of accumulation and a sluggishness of economic growth (Stockhammer 2004, Van Treeck 2009). As we saw earlier, the origin of this phenomenon has been attributed to a crowding out of real investment by financial investment, but this hypothesis does not convince most scholars. Instead, it is much plausible that the shift toward shareholder value pushed firms to maximize the short-term profit rate, at the expense of long-term growth targets (Stockhammer 2004, Crotty 2005). Thus, in their arbitrage between profits and growth, firms will more often choose to maximize profits, even if it means downsizing or renouncing to growth (Dallery 2009).

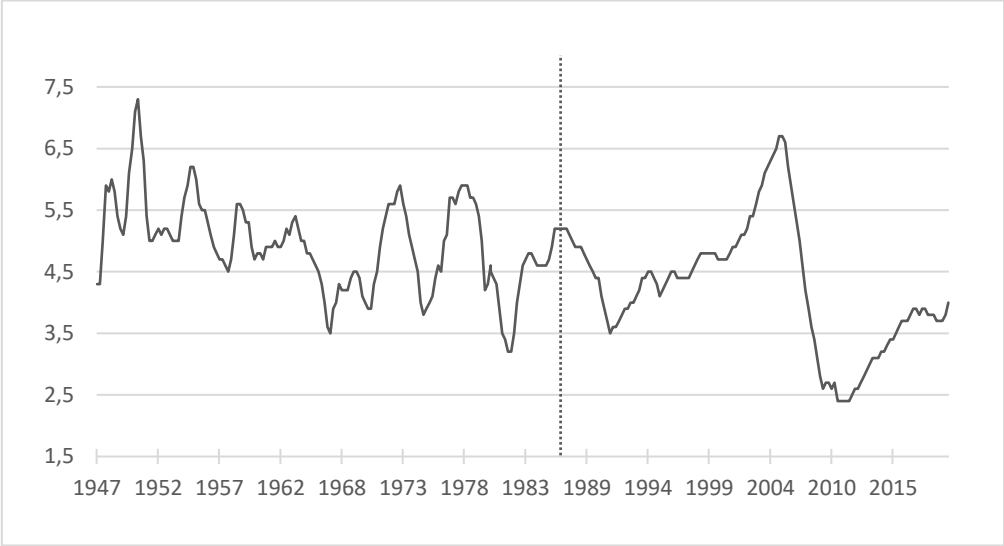


Figure 4: Fixed investment as a ratio of GDP in the US since 1947.

Source: *Federal Reserve Bank of St Louis*

To all these considerations, we would like to add a novel idea which is more rarely evoked in the literature, namely that financialization interferes with the business cycles dynamics, most notably by slowing down the frequency of cycles. On Figure 4, the reader can see that investment cycles have been shorter in the Post-war period, and went more sluggish after the mid-1980's. The dynamic of unemployment has been following a similar trend, and it is even more blatant on the stock market dynamics: booms since the 1980's have been longer and reached higher peaks.

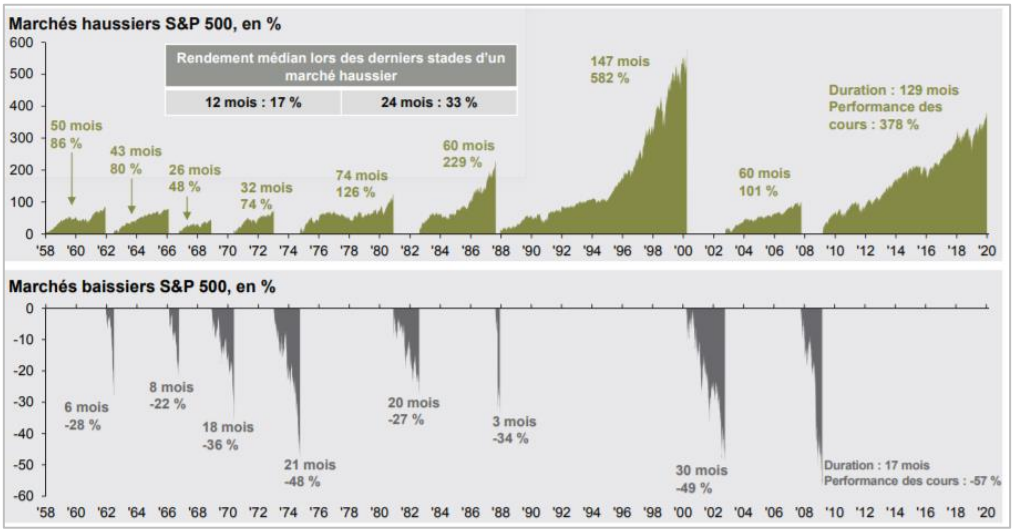


Figure 5: Rising and falling markets since 1958 in the US.

Source: *JP Morgan Chase*

Palley (2013) also identified this shift and attributed these "New Business Cycles" to the increased access to credit of agents thanks to securitization and rising collateral prices. In addition, our opinion is that sluggish investment and a tendency of firms tend to prefer the profit rate over absolute growth resulted in slower booms and a decreased tendency of the economy to enter in *overcapacity.*

3. Structural Bubbles on equity markets

In this section, we would like to lay the emphasis on the role of financial market bubbles in financialized capitalism. There are multiple reasons explaining our choice to stress that dynamic among other trends associated with financialization.

First Godechot (2016)'s empirical study found that the impact of financialization on inequalities can be explained almost entirely by the size of domestic financial markets, which made him state that "financialization is marketization". Hence our desire to propose a more in-depth explanation of why financial market mechanisms are fundamental in financialization.

Second, we think that the works on financialization can shed fresh light on the understanding of financial bubbles in general. For a long time, the literature on financial markets has been dominated by the debate between the supports of the *Efficient Market Hypothesis* (Fama 1969)

and the *Irrational Markets Hypothesis* (Shiller 2016). Yet Shabani & Toporowski (2015) argue that the theories of these scholars - though being of significant interest – fail to account properly for the behavior of financial markets, because they do not integrate them into a broader macroeconomic system.

Third, the literature on financial bubbles tends to focus on speculative euphorias, when the enthusiasm for a promising new technology provokes the explosion of innovative projects, an investment boom and the strong rise of asset prices fueled by self-fulfilling expectations. Such explanation apply well to the late 1990's economic boom, but it does not give a fair account of the 2010 stock market bubble. In that section, we would like to draw inspiration from the Minskian literature, and from the theory of Capital Market Inflation of Toporowski (2009) to demonstrate the possibility of bubbles without speculative euphoria, *ie* the possibility of *structural equity bubbles*.

3.1 Theoretical considerations

In his typology, Hyman Minsky differentiates agents in three categories, according to their financial situation: *hedge* agent's income covers both interests payments and principal reimbursement, *speculative* agents can only afford to pay interests and must refinance their debt, while *ponzi* agents cannot even pay their interests, and must roll both debt and interests (Minsky 1982). What enables ponzi agents not to go bankrupt is the rising value of their assets, that they can propose as collateral for refinancing. Conversely, the debt-financed acquisition of financial assets is what spurs the prices. In that, we think that Minsky pointed at an essential aspect of financialization, which is *ponzi schemes.* In this paper, we will define *ponzi schemes* as a situation in which a feedback loop sets up between the indebtedness of a class of agents and the market value of their total assets, so that their leverage never seems to increase, and they can engage in endless indebtedness. In the 2000's, such a mechanism occurred as household got ever more indebted to buy overpriced houses, which in turn spurred real estate prices. In the next part of this section, we will show that a *ponzi scheme* has now set-up between financialized corporations and the stock market. Another particularly important aspect of ponzi schemes is that to meet their debt and financial requirements, *ponzi* agents cannot use their cash-flows, and must generate liquidity with their assets, often by offering them as collaterals for a loan, Therefore *ponzi schemes* enable financial profits to be drawn directly out of debt, and not productive surplus. Our opinion is that the dramatic rise of the financial sector's profits as well as rising inequalities associated with financialization can be attributed to an array *ponzi*

schemes. In that, we could say that Minsky's FIH and financialization are the two sides of a same coin.

A second theoretical consideration which is important to our demonstration concerns the nature of secondary financial markets. Secondary markets are essentially exterior to the monetary circuit, as the goods traded have already been paid to their producers. Thus, exchanges on secondary markets only represents a transfer of money between two agents on a monetary circuit perspective. In financialized capitalism, secondary markets are often used as a saving engine, which enables agents with excess liquidity to transfer it to agents in need for liquidity in exchange for a reserve of value. In theoretical models of speculative bubbles, authors describe capital gains as a net surplus of income which spurs aggregate demand. Yet, if financial markets are only money transfer engine, it means that the capital gains of outgoing agents must be financed by the money of agents entering the bubble. In that, at the macroeconomic scale, the effect of capital gains on demand are necessarily null: all capital gains of agents must be financed by other agents renouncing to a part of their income to invest on financial markets.[3] Actually, there is only one way through which capital gains can be a net income in the economy: if agents gets indebted to buy securities. All in all, capital gains do not finance rising consumption, debt does (Baduri et al. 2006). Only, the agent getting indebted is not the agent who will spend the extra money.

Lastly, the theory of Capital Market Inflation of Toporowski (2009) is insightful as regards the stock market bubble. Toporowski (2009) notes that, if the amount of money that agents are willing to invest on financial markets exceeds the amount that emitters are willing to raise on primary markets, prices must increase. Yet, as prices increase, demand will not slowdown as on a classic market, but instead rise due to speculation, and thus financial markets can operate out of equilibrium for long-sustained periods. As we will see, due to enormous share buy-backs program, financed partly by debt, the net equity emission on the stock market has been negative throughout the 2000's, while demand from institutional investors was rising. This provides the basis for a structural rise of prices compatible with regular capital gains withdrawn from the market.

[3]Interrestingly, a common confusion in popular langage is that buying financial assets is called « investing » when, really, its exactly the opposite, *ie* a saving.

3.2 The financialization of NFC as an explanation of the 2010's bubble

On Figure 6, the reader can see the clear evidence of a stock market bubble which started in 2009, with a peak at $33 billion - more than 150% of US GDP – in January 2020. Yet, there are no evidence of a speculative euphoria or even a booming dynamic. First, the investment dynamic remained very sluggish throughout the decade (Figure 4). Second, no promising technology has showed up to stimulate euphoric expectations as was the case during the New Economy boom, even if some licorns such as Netflix, Uber or Tesla raised consequent amount of capital while not proving much profitable. Our opinion is that this bubble is a direct consequence of the financialization of NFC, through several channels, and of money manager capitalism in general.

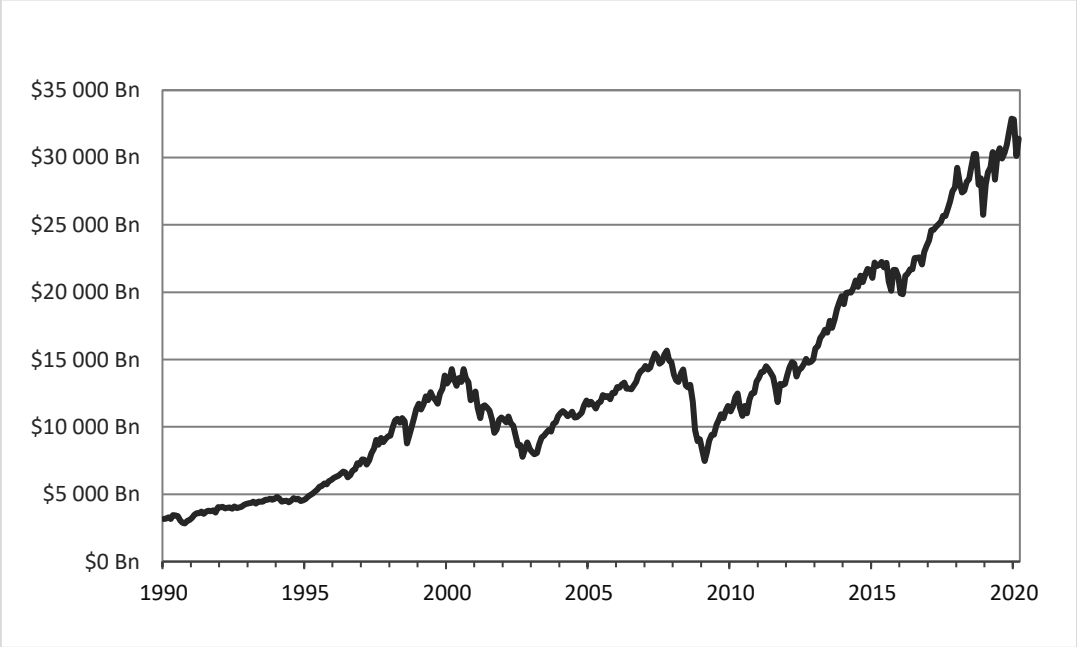


Figure 6: Total US stock market capitalization since 1990 in $ billions.

Source: *Wilshire 5000 Index.*

First, the practice of share repurchases could be the major cause of the rise of equity prices. As we can see on Figure 7, net share emissions have been negative during the past four decades in the US, but went extremely low since the mid 2000's. Throughout the last decade, they fluctuated around -$400 billion a year, which represents one quarter of the annual growth of the stock market. Already, we see that the massive demand of shares by firms due to buy-back programs seems a good causal explanation for the rise of prices.

But most important is that share repurchase distorts the Price-Earnings ratio, which is the main indicator used by investors to assess whether stocks are under- or overestimated. The price-to-earnings ratio is calculated by dividing the price of shares by the *Earning Per Share* indicator (Shiller 2016). Although there are differences depending on sectors and context, it is generally considered that a normal price-to-earnings ratio is of 12 to 15. Any share under this level will be considered undervalue and interesting to buy, and conversely if above. Thus, the price-to-earnings ratio constitutes a strong stock-flow norm for the financial sector.

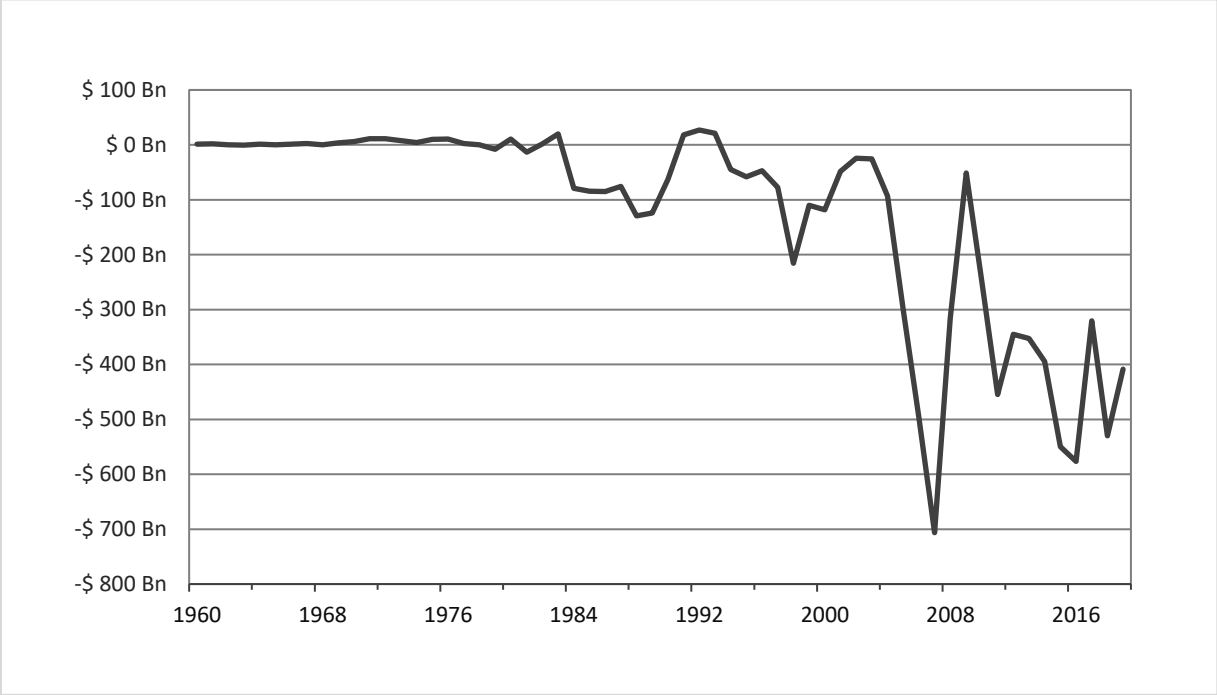


Figure 7: Net equity emissions of Non-Financial Businesses in the US since 1960.

Source: *FRB Z1*.

As we saw, share buy-backs programs boost artificially the *EPS* ratio of corporations, by reducing the number of outstanding shares. Thus, the price-to-earnings ratio is decreased artificially, and the company seems underpriced, which will spur demand for its shares. This means that widespread share buy-backs provide a structural basis for asset prices inflation. On figure 8, we see that both the classic P/E ratio (short-term) and the Shiller P/E ratio (longer term) increased only slightly throughout the decade, compared to what occurred during the dot.com bubble. Meanwhile, the stock market capitalization to GDP has in the US has surpassed its 1999 peak. All tend to confirm our hypothesis.

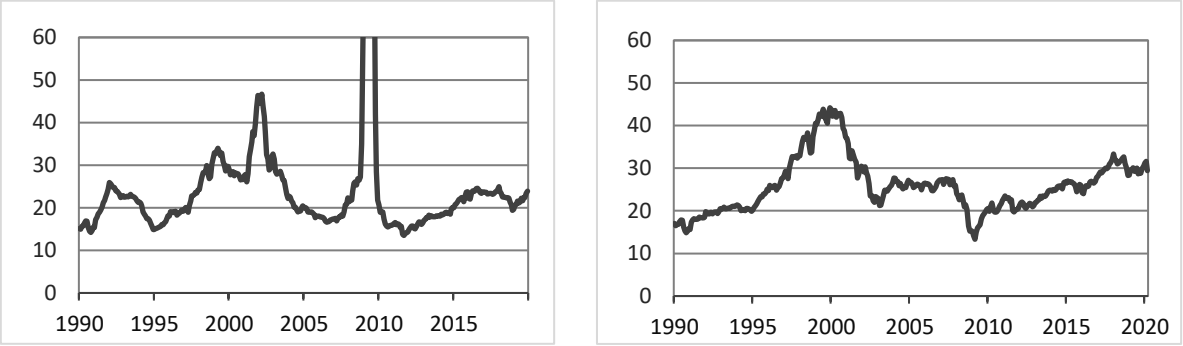


Figure 8: Classic (left) and Shiller's (Right) Price-Earnings ratio for S&P 500 companies.

Sources: *Standard & Poors, Shiller 2016*

Also, as we saw earlier, financial bubbles can develop and reach high levels only if some actors finance asset acquisition with debt. While the 2000's New Economy bubble was driven by Household and Banks debt, there is much evidence that the 2010's bubble is driven by Corporations leverage, in clear link with financialization. There are at least three channels through which debt feeds into the stock market. First, many large corporation finance their share repurchases programs and dividends with debt. According to Roslender (2018), in 2017, 44% of the S&P500 firms distributed payouts superior to their profits. Second, the operations on the market for corporate control, mainly *Leveraged-Buy-Outs* and *Mergers & Acquisition*, are often financed with a huge amount of debt (Kaufman & Englander 1993). Plus, these operations tend to have a direct positive effect on market prices, because the acquisition price must be attractive and is set above current market price. Plus, there are often multiple candidate to the takeover, which results in *bidding wars* and even more overvalued acquisition price (Kaufman & Englander 1993). Third, the increasing leverage and deficit of small *ponzi* firms finances the extraordinary profits of large, well-established oligopolies, and thus their generous buy-backs and dividends programs.

The first element of a ponzi scheme is thus set up: debt finances rising asset prices. But conversely, rising stock markets extend the indebting capacity of large corporations, as some assets in their balance sheets are sensitive to market evolutions. First, equities and mutual fund shares, which represent currently about 6% of corporations balance sheet, are accounted at market value in compliance with *International Financial Reporting Standards (IFRS)*. Second, *Goodwills* are also directly linked to stock markets dynamics, as they stem out of *Merger & Acquisition* operations. When a company buys out another, the difference between the purchasing price and the book value of identifiable assets – which can be important, considering

the bidding wars evoked above – is accounted as a *Goodwill* in the acquirer balance sheet. Theoretically, *Goodwills* are supposed to represent intangible assets such as *brand recognition* or *team cohesion*, but in reality they are more the product of the overpricing of *M&A* operations and more generally of the high level of Tobin's Q in US corporations, which was of 3:1 in 2017. Thus, *M&A* operations captures and validate the overpricing of stock market, finances the capital gains of shareholders and commissions of financiers, and includes fictitious capital in the balance sheet of American groups, so that it can serve as collateral for further indebting. Plus, as Goodwills are not amortized, they tend to accumulate indefinitely, and end up forming a consequent share of NFC's assets (8% in 2017 according to Roslender (2018)).

As a part of their balance sheet is correlated to stock market rises, corporations can increase their level of debt while seemingly maintaining a constant and relatively sane leverage. But as Figure 9 shows, the leverage of US corporations calculated on the basis of historical costs has actually soared dramatically since 2009, reaching an historical peak of 117% in 2017.

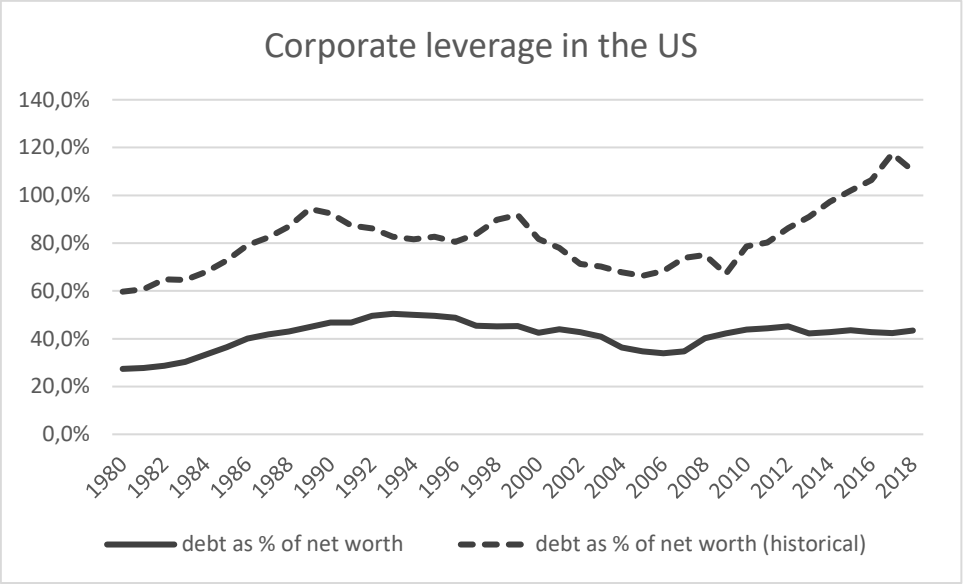


Figure 9: Corporate debt as % of net worth in the US, at fair-value and historical accounting.

Source: *FRB Z1.*

Let us summarize at this point: thanks to rising stock markets and cheap credit, large financialized corporation can finance their dividends and share buy-backs operation with debt, while hiding the dramatic rise of their leverage. Meanwhile, those very operations tend to distort

financial indicators, and drives demand for shares, so that stock market keeps on soaring. Thus, all elements of *Ponzi Finance* are present. There are two main consequences of such a financial set-up : (1) as the disequilibrium between the level of debt and the cash flows of some agents grow, financial fragility increases dangerously, and (2) a privileged elite has access to an exuberant income which is almost directly financed by debt, and inequalities develop. Figure 10 shows that as firm increase their leverage, the debt-to-profits ratio rise dangerously and reaches unsustainable levels. This means that some firms are progressively turning to *speculative* and *ponzi* state. Much like in 2008, a whole financial market mechanism has set up to securitize the risky *leveraged loans* of firms, and pack them into complex *Collateralized Loans Obligations*. It is not the purpose of this paper to discuss the implications on financial fragility of the securities industry, but we will simply note that securitization tend to sustain and finance the disequilibrium brought by the financialization of NFC. Another mechanism which supports the rise of corporate leverage is the monetary policy of the *Fed* who, according to Palley (2013), is now more focused on "putting a floor under asset prices" than under unemployment. For example, in the wake of the Covid-19 pandemic the Fed bought for $750 billion of downgraded junk bonds. With its Quantitative Easing program and by rescuing financial markets in the advent of crashes, the Fed validates ex-post the whole structure of financialization.

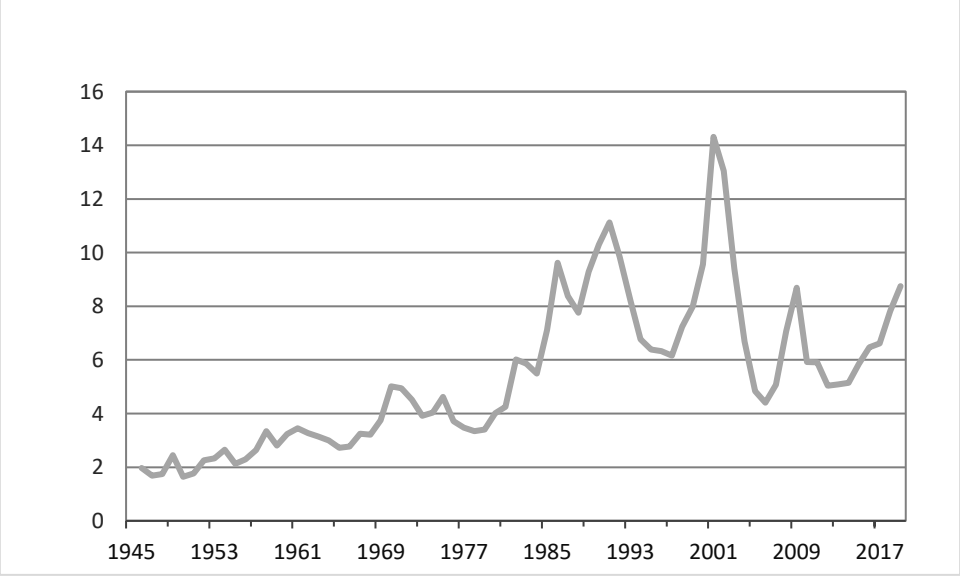


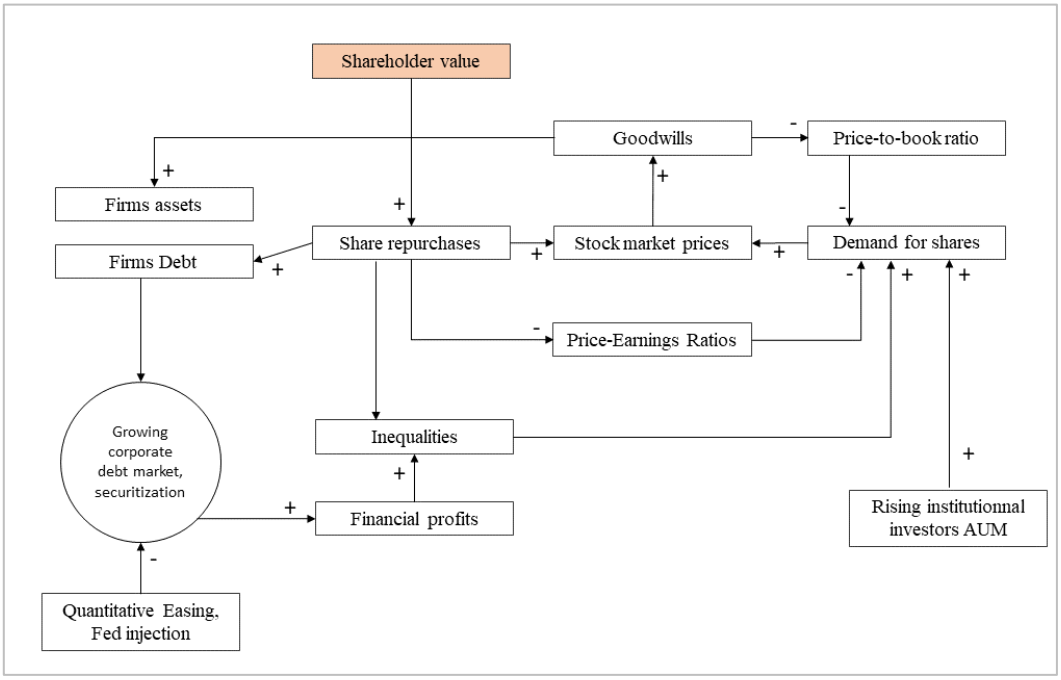
Figure 10: Debt-to-Profits ratio

Source: *FRB Z1*.

The last question we would like to answer in this part is: Who draws benefits from the stock market bubble? Why does Godechot (2016) find a strong correlation between financial market volumes and inequalities? In which extent does the stock market explain the inequalities associated with financialization? Three groups get a privileged access to the financial income associated with the stock market. First, top executives and managers, whose remuneration is based on stock-performance and partly paid in stock-options, see their income directly correlated with market prices. The wealthiest individuals are also the prime beneficiary of the rise in the stock market, as they possess more shares. But most importantly the financial sector corporations and professionals are the direct beneficiary of stock market bubbles through commissions. Commissions on financial services, very conveniently, evolve with both asset prices and financial volumes, and thus financial actors can benefit from bubbles without the need to endorse risks. At some point, stock market bubbles collapse, causing the losses of long-time holders and costs for the government and the real economy. But all along the line, financial professionals, top executives, and wealthy individuals withdrew a secure income from the bubble.

In addition to this, there is potentially an important feedback effect of inequalities on asset prices. The idea that higher income and wealthier individuals have a higher saving propensity is very old in economic theory (Fisher 1930, Keynes 1936, Pigou 1951), and is a fundamental assumption of Post-Keynesian Kaleckians models (Lavoie 2014). Recently, Dynan et al. (2004) and Cynamon & Fazzari (2013) have provided a fresh empirical validation to this theory. . Further, Vissing-Jorgensen (2002) found that the level of non-financial income of households is correlated to their stock market participation, and with the proportion of portfolio placed in the stock market. Thus, not only do the rich save more, but they also invest more in the stock market. Consequently, rising inequalities result in rising demand on stock markets, and potentially spur prices. This also means that wealthy households tend to hold a larger share of their portfolio as financial assets and benefit more from the stock market bubble. This theory can explain why wealth inequalities tend to be exacerbated compared to income inequalities, and in the modelling part, we will try to prove the coherence of this reasoning.

In conclusion of this section, we can characterize financialization as a regime in which the over-indebtedness finances the income of others. One of the key mechanisms that enables this is the emergence of *ponzi schemes*. Preceding the 2008 crisis, the *ponzi* mechanism have been operating on household's debt, but since 2009 it has seemingly shifted to firms, in close interaction with the *shareholder value ideology*, the practice of share-repurchases, mergers and acquisitions, and goodwill's accounting. A feedback loop has set up between corporations debt and stock market prices, which enables the sustained rise of a bubble. The first consequence is that the financial fragility of corporations is growing and that the stability of the system is increasingly dependent on the markets for *high yield bonds* and collateralized products. But at the same time, the *ponzi scheme* also provides the basis for tremendous incomes of financial professionals and top executives, and feed inequalities. In that, we can say that Minsky's *ponzi finance* and the inequalities associated to financialization are the two sides of a same coin.



Scheme 1: The structural bubble on equity markets.

4. Modelling Financialization

Starting with the pioneering works of Boyer (2000), numerous attempts have been made to analyze financialization in formal models. In addition to proving the coherence of causal explanations, the purpose of these models is also to analyses the condition of stability of the financialized regime. Lastly, some scholars have cautiously experimented policies that could

reduce the perverse effects of financialization. In this section, we review this literature and then identify the mechanisms which are still ill-addressed, in order to propose a research agenda for the modelling of financialization.

4.1 Early attempts: Regulationist and PKK Models

Although most authors in the Regulationist school prefer literary demonstration, at the beginning of the 2000's, some have felt the need for a more rigorous formal definition (Boyer 2000, Aglietta & Breton 2001). Boyer (2000) introduced the notion of finance-led capitalism and proposed a model in which financial markets sets a *hurdle rate* for profits to firms. The regime was then qualified as *finance-led* if an increase in the hurdle rate leads to an increase of growth.

These early attempts were completed by the very interesting works of authors in the Post-Keynesian literature. Stockhammer (2005) proposed an innovative model based on Lavoie (1992) theory of the firm and a Kaleckian model of growth, to which he added considerations on shareholder value and an account of political conflict interal to corporations. Bhaduri et al (2006) also provided a foundational work by showing how the wealth effect due to stock market booms enables that in the medium run, stock market growth and economic growth can go in opposite direction.

In general, those models provided fruitful insights on financialization, and especially proved that the overall effect on macroeconomic trend depended on behavioral parameters such as the propensity to spend out of wealth. However, most of them are rather simple and makes restrictive assumptions: equity return is exogenous in Boyer (2000), and Bhaduri et al (2006) assume that all capital gains are spent. Plus, as argued by Dos Santos & Macedo e Silva (2009), the time frame of these models is constrained to the short-run because they are based on formal analysis and the concepts of equilibrium and steady state. Thus, they can only explain the effect of a shock "*on the next accounting period"*, and they are unable to account for long-run growth regime in historical time.

4.2 Stock-Flow consistent models of financialization

The *Stock-Flux Coherent* (SFC) methodology, pioneered by Tobin & Brainard (1968) and later Godley & Lavoie (2010) enables to overcome these difficulties and construct dynamic models that make an explicit account of historical time. The literature on SFC models has provided the largest part of the modelling of financialization effort during the past decade. In the wake of the sub-prime crisis, the interest on financialization and its modelling exploded and Lavoie (2008) proposed the first SFC model explicitly dealing with financialization. Yet this first model appears to us as lacking some fundamental characteristics of financialization: firms finance their investment with equities, and the household sector is reduced to one class.

Zezza (2008) addresses the puzzle of falling saving rates in the US in the face of rising inequalities in a two-classes SFC. His conclusion is that the wealth-effect and the development of household debt can explain the dramatic decrease of Household saving rate.

Van Treeck (2009) presented a more complete analysis of financialization in a SFC model which accounted for both rising household debt and *shareholder value* through exogenous shocks on payouts ratio and equity financing propensity. The main feedback loop at stake in his model is that household's collateral prices rise enable the expansion of credit. In all his simulations, the net-worth-to-income ratio rises for both corporations and household, and the investment-to-profit ratio declines. The model of Van Treeck (2009) captures very well the fundamental nature of financialization as an interplay between debt and asset prices dynamics which leads to a disconnection between financial wealth and productive income. Yet it lacks an endogenous force to bring down firm's leverage which tend to reach a steady-state and never fall.

Reyes & Mazier (2014) build an SFC model which is original in two regards. First, they address microeconomic issues concerning the financing function of firms, by comparing the behavior of the model under two different closures: an indebtedness norm and an equity norm. Second, in both cases the model features financial cycles, which is rare among SFCs. Yet this behavior is obtained at the price of behavioral assumptions that are not in line with the financialization of NFC literature, for example that excess debt leads firms to increase their equity financing.

Caversazi & Godin (2015) present an SFC explanation of the 2008 crisis which is very close to the approach of this paper, by uniting Minsky's FIH, Toporowski's Capital Market Inflation, and the Post-Keynesian literature on financialization. The intra-sectorial dynamics of the Firms

sector is accounted as firms are at the same time issuer and acquirer of equities. Their conclusion is that the depressive effects of financialization can be balanced if a channel for capital gains exists. However, if this channel implies the growth of household debt without an equivalent growth of their income, which leads to a self-reinforcing unsustainable dynamic.

Following the empirical multi-country study of Dodig et al. (2015), which identified two different growth regimes under financialization in Europe - the *private demand debt-led* and the *export-led mercantilist* models -, Detzer (2016) build an SFC model to analyze the effects of financialization on countries depending on their institutional setting. His model is original in that it introduces open-economy considerations. Interestingly, he proves that the depressive effects of inequalities can also be balanced by an increasing reliance on exports, and thus the debt of agents in other countries.

4.3 ABM Models of financialization

SFC models have enabled to shed light on the macroeconomic patterns of financialization. However, they suffer to some limitations due to their aggregate nature, which must be relaxed to go further into the analysis of financialization. First, it seems at this point very clear that a key aspect of financialized economies is a trade-off between aggregate demand sluggishness and financial instability due to rising debt. SFC perform badly at modelling instability and can only suggest financial fragility. Second, the aggregated nature of SFC does not allow them to capture typically structural aspects of financialization: credit networks, industrial relationships, complex value chains. Third, the arbitrary separation of households in two classes is unsatisfying for a fine-tuned study of inequality dynamics, and a disaggregation of the household sector is required. Lastly, as argued in Pedrosa & Lang (2018), the aggregate analysis of corporate leverage can be misleading, as it does not take into account the interdependence of balance sheets inside the private sector and the effects of the distribution of profits between firms. To alleviate those issues, an increasing number of *Agent-Based Models* (ABMs) have been developed throughout the 2010's. By relying on endogenous fluctuations more than exogenous shocks, ABM are also more suited to explore policy sets, and much works has been made in this field.

The major contributions of ABMs to the study of financialization is provided by an important literature on the interactions between inequalities, household debt and financial instability.

These works tend to confirm the idea that inequalities are not a mere consequence of financialization, but more a causal, driving force at the core of a self-reinforcing dynamic. Meanwhile, only one attempt has been made to explicitly deal with the financialization of NFC, in Ricetti et al (2016); which leaves a large research avenue for future models.

Erlingsson et al. (2014), Russo et al. (2016) and Cardaci (2014) all constructed independently an ABM model to account for the interplay between inequalities, rising housing prices, consumer credit and instability. Their conclusions converge on the fact that inequalities have a depressive effect on the economy, which can be counterbalanced by a higher access of households to credit. Yet, the rising indebtedness of households is fundamentally unsustainable and increases the risk of financial crisis, which leads to debt-driven boom-busts cycles.

Cardaci & Saraceno (2016) goes a step further and assess the effectiveness of different policies in reducing inequalities and avoid financial crisis in an AB-SFC model. In their model, monetary and fiscal stimulus cannot be efficient beyond the mere short-term, and a progressive taxation to address structural inequalities is needed to improve long-run stability. Palagi et al. (2017) in a similar AB-SFC model showed that direct social transfers to lower-income households are more efficient than the simple deficit-spending of government to counteract the depressive effects of inequalities

However, in most of these models, either inequalities or the expansion of credit are simulated through exogenous parameters. In this extent, Botta et al. (2018) provide an important contribution to the literature by presenting an AB-SFC model in which "*changes in income and wealth distribution are endogenous and co-evolving together with the development of shadow banking"*. They introduce the process of *securitization* in their model: Banks gather household's loans into *Collateralized Debt Obligations (CDOs)* and sell them to institutional investors. Therefore, in their model, a strong feedback loop sets up: rising inequalities stimulates the demand for high-yield risky assets by rentiers, which in turn increase the refinancing capacity of the bank and foster the access to credit for low income households. The financial return stemming from CDOs exacerbate inequalities and a self-reinforcing dynamic emerges, which stops suddenly as default rates rise and the market collapses.

D'Orazio (2019) builds an ABM models which reproduces the same results on the inequalities-instability nexus, but with an interesting focus on prudential banking regulations. First, she shows that the effectiveness of banking regulation depends on the phase of the Minskyan cycle.

But most importantly, her model demonstrates that prudential regulations should take into account the distribution of income to be effective. In doing so she provides robustness to the idea that Minsky's FIH and the process of financialization are two sides of a same coin.

To our knowledge, Ricetti et al. (2016) represent the only attempt to explore the effects of the financialization of NFC in an agent-based model. They implement a simple model which generates endogenous business cycles based on the interplay between profits, investment , unemployment, and a financial accelerator. Starting from this baseline scenario, they test the effect of rising dividends-to-profits ratio on the macroeconomic dynamic and find highly non-linear results. Up to a certain threshold, the reduction of retained earnings and investment is counterbalanced by rising consumption out of dividends: the effect on unemployment and instability is slight. Beyond the threshold ratio, the economy endures a drastic slowdown, banks and firms net worth fall, and the instability of the system increases.

4.5 A research agenda on modelling financialization

Although the literature on the modelling of financialization has been blossoming throughout the past decades, many aspects remain uncovered. First, most ABMs have been focused on the housing market and household debt, and the dynamic between stock market prices, firm's leverage and inequalities remains largely unexplored. In the section X, we build an agent-based model which will provide a basis to address the issues of shareholder value and stock market prices.

Apart from these considerations, we would like to propose an exhaustive list of phenomenon treated by the financialization literature but which still lacks formal analysis:

1. Monopolisation and industrial relationships seems to play an important role in financialization (Durand & Gueuder 2018). A proper analysis in a disaggregated private sector would be interesting. The pioneering ABM model of Ciarli et al (2012, 2016), which is specifically designed to study industrial concentration, could be a good basis.
2. In the same spirit, we think that financialization should be analyzed in the light of more structural aspects of the industrial sector, and especially of the network of subsidiaries and value chains. By introducing several different industries we could verify the hypothesis that financialization happened in close interaction with deconglomeration and the restructuration of American capitalism (Kaufman & Englander 1993). This would also allow to assess more finely

the coherence of the hypothesis that goodwill's accounting and the *mergers & acquisitions* operations tend to spur stock market booms and leverage.

3. In the same vein, a better account could be made of the role of private equity firms and *LBO* operations on investment, debt and inequalities. Introducing new financial agents (investment banks and private equity firms) could thus yield very interesting insights, especially in explaining the 1980's financialization craze.
4. Analyzing the role of institutional investors and the funneling of household debt in the stock market appears crucial to us, even though it implies a careful modelisation of life-cycle savings and an account of population growth.
5. To extend the attempt of Detzer (2016), it would also be interesting to financialization in an open-economy perspective, to assess the imbrications with international financial transfers and exchange rate dynamics. Further, as noted by empirical works (Milberg 2008), global value chains are potentially a key in understanding the profit-investment puzzle.
6. Lastly, as we evoked it in the first section, financialization is an evolutionary process. Thus, we think that there is an urging need for a generalization of the concept of debt-financed booms, independently of which actors or financial innovations are at stake. Instead of following the previous crisis, researchers and public authorities could be preventing the next one and anticipating where the unstable dynamic will set up. In that purpose, we propose to implement in the future an evolutionary ABM model in which financial innovations and ponzi schemes emerge naturally and self-reinforce from the exploring and imitation behavior in the financial sector.

5. The Agent-Based framework

Alongside with the explosion of computers processing power which brought the possibility of large scale simulations, *Macro Agent-Based Models* (MABMs) have been put forward as an alternative to *Dynamic Stochastic General Equilibriums* (DSGE) models, especially to assess the effects of different policies. In this section, we will briefly recall the fundamental characteristics of the *agent-based* methodology, and its resulting advantages and drawbacks, with the purpose of justifying its use to study financialization.

5.1 Main characteristics and advantages

The *agent-based* methodology is based on three foundational concepts: *complexity*, *emergence,* and *chaos.* The underlying assumption is that the Economy is a *complex and adaptative system,* with fundamentally *emergent* and *chaotic* characteristics.

The definition of *complexity* is rather misty, but it broadly refers to any phenomenon or system which behaves in a non-linear, non-mechanical way. Typically, while long-lasting debates have been raging between economists on the direction of causality between - say – the interest rates and inflation; it becomes today ever more consensual that causality in economics is not mechanical and single-directional, but multidimensional, and that all variables tend to be linked to each other in a causality network. The first implication of this is that the causality analysis between to variables loses its relevance, and that the focus should be shifted on the analysis of the behavior of the whole economic system. Econometric studies tend to show interesting correlations between macroeconomic variables, but we must bear in mind that this correlation is only the reflect of a much wider and more complex causality network. To our opinion, the roles of models is not to predict the future path of the economy, but to provide complex causal explanations of results found by econometric studies. In dealing with complexity, the main approach throughout the history of economic thought has been to rely on the concept of equilibrium. The feedback loops running through the economy are assumed to be of a self-attenuating nature, and the economy converges at the very short-run. This enables analytical solving of models, but neglects the fundamentally unstable nature of the economy, the possibility of divergent dynamics, and cyclical dynamics. Meanwhile, frameworks such as Keen-Goodwin, SFC or ABM explicitly consider *complexity,* and so do ABM models.

The concept of *emergence* refers to the idea that the whole system displays properties that its isolated elements do not have. Conversely, the trivial interactions of the isolated parts of a complex system gives rise to an emergent pattern at macroeconomic scale. Many economic phenomena fall into this category, which created endless puzzling issues for economists on the links between micro- and macro-behaviors. In agent-based models, macrodynamics emerge endogenously from the microeconomic behavior and decentralized interactions of a multiplicity of heterogenous agents, which enables to precisely study micro-macro interactions.

In consequence of these two foundational concepts, it also comes that both the economic system and ABM models are characterized by *chaos* and *bounded rationality*. In a chaotic system, the complexity of causality links makes that a very slight change of initial parameters will result in a completely different outcome, which makes them unpredictable. Thus, in order to predict the future, economic agents must know exactly the parameters of the whole economic system, an information they clearly do not possess. This lack of information is referred to by Simon (1976) as *substantial uncertainty.* Plus, even if individuals could access a precise information on the whole economic system, their memory and computational capacities are simply too limited to handle such a huge load of information and suffer from *procedural uncertainty.* In that, we see that the Post-Keynesian concept of *fundamental uncertainty* ensues directly from the complex and chaotic properties of the economic system. In consequence, most ABM models follows the assumption of *bounded rationality* proposed by Simon (1959): agents follow simple rules-of-thumb that they adjust to reach their objectives, and not an omniscient rational maximizing rule.

Starting from there, the advantages of ABM are numerous. First, they place the focus of analysis at the lowest point of abstraction possible, which enables to use rather realistic assumptions. ABM also permits to simulate endogenously emergent macroeconomic patterns and avoid relying too much on external shocks. In that, they enable to assess the robustness of other models' assumptions (Seppecher 2010). Furthermore, the *agent-based methodology* provides the possibility of micro-empirical foundations in modelling without the use of the controverted concept of the representative agent. Lastly, agent-based models are particularly suited to study evolutionary processes in economics, as it is possible to endow agents with an innovate-and-imitate behavior which will leads to a selection and collective adoption of best suited strategies, and result in an interaction between the evolution of the economic system and agents strategies.

All in all, we think that the ABM methodology is best suited to further study financialization owing to three reasons. First, the emergent and chaotic behavior makes them prone to "of persistently out-of-equilibrium systems, where behaviors that are nearly stable for long time may change dramatically, stochastically, and irreversibly in response to small endogenous shocks" (Balint et al 2017). Second, as we expressed above, the analysis of financialization should be enriched by an evolutionary perspective, which can be best achieved by means of an ABM. Third, as we saw, much interesting work has already been made in modelling the aggregate properties of financialization, and there is an urging need for a disaggregated, structural comprehension.

5.2 The agent-based literature

The foundations of the agent-based agenda can be found in the seminal work of Simon (1959), who called for the building of macroeconomic models based on heterogenous agents. Then, as early as 1974, the first computer-simulated agent-based macroeconomic model was proposed by Nelson & Winter (1974). Starting in the 1970's, interesting micro-founded ABMs were built to study the national economies of the US (Bergman 1974, Benett & Bergman 1986), and Sweden (Eliasson 1977, 1984). Yet at this very moment, models based on the *general equilibrium* emerged and imposed as the standard tool for macroeconomic research, which eclipsed those early works. The agent-based methodology remained limited to small-scale microeconomic research until in the mid-2000's, when the financial crisis revealed brutally the flaws of DSGE models. The early works of Dosi (2006) or Battiston (2007) proved that it was possible to generate endogenous business cycles and contagion dynamics with ABM, and a literature emerged to elaborate a new paradigm. A decade later, Dawid (2018) identifies at least six main MABM frameworks, which provide the basis for dozens of models (Eurace, JAMEL, K+S, CATS and LAGOM). In addition to these main frameworks, a constellation of agent-based models has emerged, with each attempts serving specific logics : for example, the *WorkSim* model (Goudet et al. 2016) aims at studying labour market dynamics, and Lang & Bassi (2015) developed an ABM model based on the neo-Kaleckian framework. In fact, as it is often the case with emerging paradigm, the ABM framework "has progressed in several weakly coordinated streams" (Dawid 2018), and despite some efforts to provide benchmark models (Caiani et al 2016), the literature is still in ebullition.

6. The Model

6.1 Overview

The model we present in this paper is inspired by JAMEL developed by Seppecher and coauthors (2010, 2012, 2015, 2018), and it is particularly close to the version of Seppecher et al (2018). The model is populated with four classes of agents - *Households, Firms, Bank* and *State* – which interacts on two principal markets (*Labour* and *Goods*) and an experimental *Stock market*. As in Seppecher (2018), there is only one type of produced good, that firms can

purchase to transform them into machines. The balance sheets of agents contain three types of financial assets: *Cash* (held by all actors), *Shares* (emitted by the Firms and held only by households), and *Loans* (held by the bank).

The *Stock-Flow coherence* of the model is provided by its design but also guaranteed by consistency verifications on aggregated flows and stocks. Following the principle of endogenous money (Moore 1989), the monetary mass entirely stems out of demand-led bank credit.

One important aspect of this model is that firms are provided with an innovation-and-imitation behavior to determine their target leverage. This gives rise to an evolutionary process and generates endogenous business cycles based on the investment dynamic.

In the following section, we will present the basic functioning of the model, while laying the emphasis on some important behavioral rules and discussing our assumptions. For a complete discussion of the assumptions, we refer the reader to Seppecher et al. (2015) and (2018), and the full specification of the model can be found in the appendix.

6.2 Markets

In line with a large part of the Agent-based literature, the labour and goods markets in our model follow a *decentralized matching protocol* (see Ricetti et al 2016). Concretely, this means that buyers only consult a limited number of offers on the market. This protocol first ensures that agents operate under *limited information*, and reinforces realism.

On contrary, the *Stock Market* that we added in the model follows a centralized protocol, in accordance with the empirical works on the microstructure of financial markets (see Madhavan 2000). The protocol is the following:

1. Both buyers and sellers post their orders on the market, associated with a price and a quantity.
2. Orders are sorted: buy orders from the highest price to the lowest and sell orders from lowest price to highest.
3. If the price proposed by the best buy order is superior to the price proposed by the best sell order, the transaction takes place at a mean price.
4. The last operation is repeated until the highest ask price is inferior to the lowest bid price.

6.3 Firms

While behavioral assumptions concerning price determination, employment, and inventories tend to be consensual among the agent-based literature (and more broadly among macroeconomic models); other aspects such as the investment and financing behavior are far more debated. The reasons of such controversies are that : (1) the causal links between investment decision, financing conditions, and payouts policies are very complex, (2) investment throughout the economy obeys to very different logics (extensive or intensive, addressing a new market or an existent one), and (3) the financing behavior of firms tend to depend on their size and sector. To simplify things, in this model we voluntarily neglect technological progress and investment in productivity. Thus, the only rationale behind investment in the model is the extension of the production capacity to address rising demand.

According to the neo-classical theory of the firm, investment is explained by the wealth maximizing behavior of firms and Tobin's Q (Bernardo 2016). When the Q is above one; *ie* if the market price of equity is superior to its book value, investment is implemented and financed by equity emission. This theory is still used in many *general equilibrium* models (Bernardo 2016), despite disappointing empirical validation (Chirinko 1993) and a blatant lack of realism pointed by several critiques (see Crotty 1990, Palley 2001). The theory seems particularly irrelevant in the context of financialization: while Tobin's Q is hanging well above one since the 1990's, most firm still refuse to finance investment with equity, and even operate massive share buy-backs.

In this paper, we prefer to refer to the *pecking order theory*, which states that firms finance investment with internal funds in priority, with debt if needed, and with equity as last resort[4]. In fact, equity financing is totally excluded in our model, for purposes of simplification and because we intend to study a financialized economy in which net equity emissions are negative. [5] In addition to this, our model also relies on the *growth-safety trade-off* theory (Crotty 1990, Dallery 2009). Investment is constrained by the target ratio of leverage fixed by firms in this model. As is expressed by the basic Minskyan theory, the tolerable level of leverage tends to fluctuate with business cycles and depends on the perception of the market conditions (Minsky

[5] Yet if the pecking order theory holds for some large corporations, the situation is different for smaller firms (Frank 2003). Particularly, equity emission are the main source of financing for young companies with still ill-established business model. Further versions of the model should take this into account.

1982). To account for this behavior, firms are provided with an imitation rule which makes them copy the target leverage of successful counterparts.

Production, Quantity decisions, price setting and wage setting

As regards the production process, quantity decisions as well as wage and price setting, our model is like Seppecher (2010). Briefly, each unit of capital must be operated by one employee, and the level of production of each firm is given by the minimum between its number of employees and machine, time productivity. Recruitment and price setting decisions are made depending on the level of inventories: if inventories are low, the firm considers that demand is high and will increase its price and its labour force. If during several periods a firm has difficulties to recruit, it will increase the offered wage, and conversely decrease it after several periods of full employment.

Financial decisions and investment

Production Financing: If retained earnings are insufficient to cover the wage bill, a short-term loan is asked automatically granted by the bank.

Investment decision: As for the investment decision, we departed from Seppecher et al. (2018) which proposed an interesting investment function based on the principle of *Net Current Value*. Yet we think that this function brings unnecessary complexity in the model and the same results can be achieved with simpler assumptions based on capacity utilization and the growth-safety trade-off.

Each d^{Prod} period, after having set its new employment target, the firm considers investing. If the capacity utilization ratio $U_{j,t}$ is above a target ratio, the firm will try to expand its productive capacity and invest. The estimated cost of the investment is computed as well as the estimated loan necessary to finance it. If the resulting loan pushes the debt ratio of the firm above its targeted ratio, the investment is abandoned, else it is pursued.

Dividends payments: At the end of the period, the firm computes its net profits $\Pi_{j,t}$, and constructs its current balance sheet. If net profits are positive, the firm pays a tax to the state at

the rate $\boldsymbol{t_F}$.[6] If net profits are positive and leverage is below the target, the firm will distribute a proportion div^r of its after-tax profits as dividends. The level of the dividends is also limited by the available amount of cash held by the firm. [7]

6.Adaptative behaviour

In this model, we use a *"blanketing shotgun process"* like Seppecher (2018). Yet, due to the lack of computing power we cannot simulate enough agents to make it work properly. To strengthen the evolutionary process and enable it to work with only 60 firms, we added a mating-pool protocol, which is a common tool in evolutionary modelling.

Every 10 periods; each firm is attributed a fitness grade depending on a chosen variable. In the baseline scenario, we set this variable to be the annual profits, so that firms will try to "maximize" the absolute growth of profits. Then, a "mating-pool" is filled with firms according to a representation number. For example, if a firm's fitness is 0.2, its representation number will be 20 and the firm will be added 20 times in the mating pool. [8]

Contrary to the protocol used by Seppecher (2018), imitating firms in our model do not copy a firm picked in the set of other firms, but instead in the mating pool. Thus, a more successful firm has multiplicated chances of being imitated, and the evolutionary mechanism is improved. Plus, with this protocol, we can control the criterion of success, which will be important for future experimentations.

Whenever a corporation goes bankrupt and is bailed-out by the bank, it is considered that the management team is changed, and the firm imitates the target debt ratio of a firm randomly picked in the mating pool. In addition, an "imitation-and-exploration" process occurs each year. For each firm, a random number $a_{j,t}$ is drawn between 0 and 1 and depending on the result, the firm will either: (1) innovate by changing slightly its target debt ratio, (2) imitate by copying

[6] In most countries, the previous losses can be deduced on the tax on profits. We did not introduce this feature in the model yet, which might result in a slight overtaxing of firms. This will be adressed in future versions of the model.
[7] This assumption could, and may be should be relaxed on future versions. We plan to introduce the possibility of debt-based dividends in the future.
[8] The reader can refer to the appendix for the precise calculation of fitness

the target debt ratio of another firm picked in the mating pool, (3) innovate radically by taking a totally random new target debt ratio.

6.4 Households

Job searching, budget

The behavior of households as regard job searching and budget calculation is very close to Seppecher (2018) and is described precisely in the Appendix. Basically, households adjust the minimum wage accepted depending on their difficulties to find a job, and they try to maintain a stock of deposits equal to a proportion of their annual income $s_{i,t}^{p}$, which results in saving or dissaving.

Endogenous saving propensity and financial assets target

In Seppecher (2018), household saving propensity $s_{i,t}^{p}$ is homogenous among household and fixed in time. In this model, we would like to relax this hypothesis. to be more in line with the empirical findings of Dynan et al (2004) and with the Post-Keynesian assumptions on saving propensity. Thus, we consider that a household's saving propensity depends on its real income. Based on Vissing-Jorgensen (2002), we will also consider that the proportion of financial assets that the household desire to hold in its portfolio ($rs_{i,t}^{T}$) is dependent on the real income.

Our mechanism is the following:

(1) If the real income is inferior to 50 goods, the household is considered in extreme poverty and both saving propensity and target financial ratios are set on minimum.

(2) If the real income is comprised between 50 and 1000, a linear mapping is applied to obtain the saving propensity and financial assets target ratios.

(3) If the real income is equal or superior to 1000, both ratios are set on their maximum values $s_{i,t}^{pmax}$ and $rs_{i,t}^{Tmax}$.

As this formal presentation might not be very clear to the reader, we plotted on Figure 11 a graph drawn from a simulation which shows the saving propensity of households depending on their level of real income.

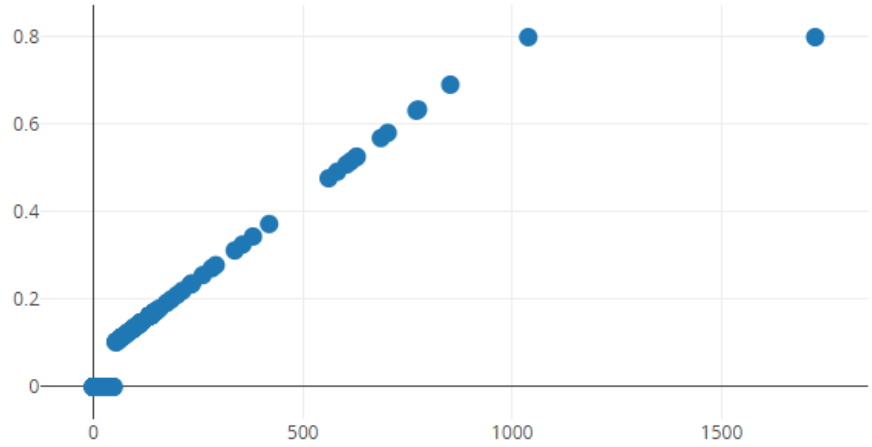


Figure 11: Households saving propensity (y axis) depending on their real annual income (x axis), at the 600th period.

Portfolio Behaviour

In this model, we start to experiment with the portfolio behavior of households and their interaction with the stock market that we introduced. Households manage only two classes of assets, money and shares. The ratio of their portfolio that they are willing to hold in shares depends only of their real income, and there is no tobinesque portfolio behavior, *ie* households do not take into account the respective return on assets. This assumption removes totally the possibility of a speculative-led boom and is quite unrealistic. Yet we have two main reasons for it. First, as ABM tend to be very complex and unstable, it is a good practice to follow a step-by-step process and not rush into several aspects at the same time, so we decided not to include the wealth effect, nor the speculative aspect of portfolio choice. Second, as we exposed in section 3, we think that financialized capitalism is characterized by the growth of structural bubbles, independently of euphoric speculation. Proving that financial bubbles can emerge even without the assumption of speculative investment is good first step in our demonstration.

At each period, households will compute the level of their financial wealth, and compare it to the level of cash holding, to obtain their current ratio of financial assets $rs_{i,t}$. If this ratio is

under their target ratio, they will try to buy shares on the stock market, and conversely. As the stock market is centralized, households have access to the price of the last transaction, that they multiply to an adjustment ratio $\delta_{i,t}^{SP}$. Much like the adjustment process of wages by firms, household will increase or decrease this adjustment if they do not meet their portfolio objectives during several periods. This mechanism will drive prices up when demand exceeds supply and vice versus.

6.5 The Bank

In this model, the financial sector is abstracted to a single bank which plays at the same time the role of Central Bank and Commercial Bank as in Seppecher (2018). Credit is totally unconstrained, and the bank systematically grant a loan to a firm or the state on demand. Loans to finance wages are short-run while loans to finance investment or the state are long-run. All loans are "amortized", which means that the principal is reimbursed progressively throughout the contract. If a firm is unable to meet its debt payments, the bank refinances it with an overdraft loan graded "doubtful" and at a majored interest rate. Thus, loans are always repaid and there is no possibility of liquidity bankruptcy.

Bankruptcy procedure

However, firms can go bankrupt if: (1) their level of equity becomes negative (total assets are inferior to total debt), (2) its number of units of capital falls to zero. In that case, the bank will try to recover all the loans of the bankrupted firm on its cash holdings. If the level of cash-on-hand of the firm is insufficient to reimburse all loans, the bank registers the loss on its own account. Then, the values of the firm are set to initialization, except for the target leverage wich is copied in the mating pool.

In Seppecher (2018), if the reserves of the bank fall under zero, the simulation is stopped. In this paper, we prefer to let the simulation continue, and note that a severe financial and monetary crisis might have happened at that point.

Interest Rate

The bank set the base interest rate by following a simple taylor rule formalized in this equation:

$$i_t = max\,(\varphi_\pi \times (\pi_t - \pi^T), 0)$$

Where i_t is the base interest rate, φ_π the inflation reaction, π_t the current rate of inflation and π^T the targeted rate of inflation (monthly).

6.6 The State

The state has a very simple behavior in the model. It collects taxes on Households and Firms, and buys a share of the production at each period. Following Dos Santos & Zezza (2008) and Pedrosa & Lang (2018), we consider that the share of production that is purchased by the public sector each year depends on a fixed structural size $\emptyset_S$ and a contracyclical component $\boldsymbol{c_r}$. The contracyclical component evolves with the deviation of the economy from a target employment U^t

If the tax revenues plus the cash reserves are insufficient to cover the expected cost of spending, the state borrows a long-term loan to the bank. Conversely, if the state runs a surplus for several periods and its cash reserves exceed a target ratio M^{max} of GDP, the state will increase its consumption slightly so that cash reserves joins back the target. The rationale behind this mechanism is that: (1) it seems realistic to assume that most government facing a rising tax surplus will increase their spending, and (2) without this assumption, an excessive surplus of the state creates deficits among firms which has a depressive effects on the economy, often leading to a crash.

6.7 Timeline of the Model

The smallest unit of time in this model is the month, that we also call a period. Almost all operations, from production to sale and dividends payments, happen at each period. Some events also happen on a yearly basis, with the length of a year being set on 10 periods for practical purposes.

Within each month, the following operations are implemented:

1. The Bank adjusts the interest rate according to the Taylor rule.

2. Firms and the Bank pay dividends to households, and taxes on profits to the State (based on the previous period profits)
3. Firms compute the expected labour cost and borrow if necessary. Then they post the job offers on the Labour Market.
4. Households answer offers on the Labour Market.
5. Firms produce goods and pay households. Then they post offers on the Goods Market.
6. The State determines its spending level. If there is a budget deficit, it borrows the needed amount to the Bank.
7. Firms determine their investment and buy the corresponding amount of goods on the market. The goods are immediately transformed into machines.
8. Workers spend their budget on the Goods Market.
9. The State spends its budget on the Goods Market.[9]
10. The Bank tries to recover credits. Debtors who cannot reimburse are credited with refund loans.
11. The Bank handles bankruptcies of firms whose equity is under zero, or whose number of machines is of zero.
12. Banks and Firms calculate their income statement and decide the amount of dividends to be distributed.

This loop is then iterated *N* times (in the baseline model, 1000 times).

6.8 Calibration

The most common practice for empirical validation in the ABM field is *indirect inference*, which consists in setting the parameters so that the model reproduces the largest amount of empirical regularities (Windrum et al. 2007). In this paper, we rely on this method and our model is able to reproduce a large part of the basic stylized cited by Dawid (2018) :

- Endogenous business cycles
- Positive correlation between output and consumption
- Higher volatility of investment over output
- Procyclicality of employment, inventory change, inflation, velocity of money

[9] Due to the order in which agents access the Goods Market, the State and Households will more often be frustrated as regard their spending target than firms, and they will pay a higher price on average. This assumption has been made for strictly technical reason, and its realism is rather questionable. A random queuing of agents would be more adapted and prevent unwanted bias. It is planned in future versions.

- Phillips curve
- Right-skewed firm size distribution

In the next pages, Table 1 and 2 show the fixed parameters and initialization values that we set for the baseline scenario.

Table 1. Baseline parameters

Symbol	Parameter	Baseline Value
Model		
N	Number of periods	1000
N_{year}	Number of periods in a year	10
H	Number of Households	640
F	Number of Firms	60
Firms		
u_f^T	Capacity utilization target	0.8
d^k	Lifetime of a machine	60-100
v^k	Machine value in real terms (goods)	250
pr^k	Machine productivity	40
max^k	Maximum number of machines per Firm	60
δ^{Prod}	Production flexibility	0.1
d^{Prod}	Production adjustment delay	U(2,5)
c^{cap}	Commercial capacity (in months of production)	6
in^T	Targeted inventories (in months of production)	2
D^T	Target debt ratio (as percentage of total assets)	U(0,1)
div^{rate}	Dividends ratio	0.3
d_f^W	Wage adjustment delay	U(0,6)
δ^W	Wage flexibility	0.01
δ^P	Price flexibility	0.04
δ^{mP}	Majored price flexibility	0.08
Households		
d_w^h	Work contract duration	U(12,36)
G	Number of consulted offers	3
w_H^f	Accepted wage flexibility	0.01

w_H^d	Accepted wage adjustment delay	U(2,5)
d^s	Saving propensity adjustment delay	U(4,7)
s^{pmin}	Minimum saving propensity	0
s^{max}	Maximum saving propensity	0.8
rs^{min}	Minimum target financial assets ratio	0.1
rs^{max}	Maximum target financial assets ratio	0.5
Bank		
d_{ST}^c	Short-term credit duration	12
d_{LT}^c	Long-term credit duration	80
k_B^T	Capital adequacy ratio	0.1
π^T	Inflation target (Monthly)	0.02 / 12
φ_π	Inflation reaction (Taylor Rule)	2
rp	Risk premium	0.04
k_S	Recapitalization rate for insolvent firms	1/10
State		
$\boldsymbol{t_H}$	Flat tax rate (Households)	0.2
$\boldsymbol{t_F}$	Profit tax rate (Firms)	0.2
$\boldsymbol{\emptyset_S}$	Structural size of public sector	0.3
$\boldsymbol{c_r}$	Contracyclical component	0.04
U^T	Unemployment target	0.93
M^{max}	Max cash reserve (in % of GDP)	0.5

Table 2. Initialization values

Symbol	State variable	Baseline initialization
Firm j		
$M_{j,t}$	Cash	0
$k_{j,t}$	Number of Machines	10
$K_{j,t}$	Fixed Capital (in nominal value)	2500
$E_{j,t}$	Shareholder Equity	2500
$A_{j,t}$	Total Assets	0
$L_{j,t}$	Total Liabilities (loans)	0
$\Delta D_{j,t}$	New loans	0
$in_{j,t}$	Inventories	0
$d_{j,t}^n$	Duration of full employment / underemployment	0
$n_{j,t}^T$	Target Employment / demand for labor	10

$I_{j,t}$	Investment (in number of machines)	0
$n_{j,t}$	Number of employees	0
$P_{j,t}$	Production (in real terms)	0
$w_{j,t}$	Offered Wage	300
$p_{j,t}$	Unit Price offered	10
$S_{j,t}$	Sales	0
$\Pi_{j,t}$	Net Profits	0
$D_{j,t}$	Dividends paid	0
$l_{j,t}$	Debt ratio (leverage computed as $D_{j,t}$ / $A_{j,t}$)	0
$l_{j,t}^{T}$	Target Debt Ratio (leverage)	U(0,1)
$U_{j,t}$	Capacity utilization ratio ($n_{j,t}$ / $k_{j,t}$)	0
$f_{j,t}$	Fitness	0

Household *i*

$M_{i,t}$	Cash-on-hand	0
$W_{i,t}$	Wage	0
$D_{i,t}$	Dividends	0
$Y_{i,t}$	Income	0
$wr_{i,t}$	Accepted Wage	1
$d_{i,t}^{u}$	Unemployment duration	0
$s_{i,t}$	Savings (of the period, in nominal term)	0
$s_{i,t}^{p}$	Saving propensity	0.1
$S_{i,t}^{T}$	Targeted nominal Savings	0
$rs_{i,t}^{T}$	Portfolio target risky ratio	0.1
$rs_{i,t}$	Current risky ratio	0
$\delta_{i,t}^{SP}$	Stock Market price adjustment	0

Bank *b*

$M_{b,t}$	Cash	
$E_{b,t}$	Equity	0
$A_{b,t}$	Total Assets (Loans to Firms)	0
$D_{b,t}$	Dividends paid to shareholders	0
i_t	Base interest rate	0
i_t^{m}	Majored interest rate	0
π_t	Inflation Rate (monthly average)	0

State *s*

$M_{s,t}$	Cash	0
$R_{s,t}$	Tax Revenues	0
$SP_{s,t}$	Contracyclical rate of spending (in % of production)	0

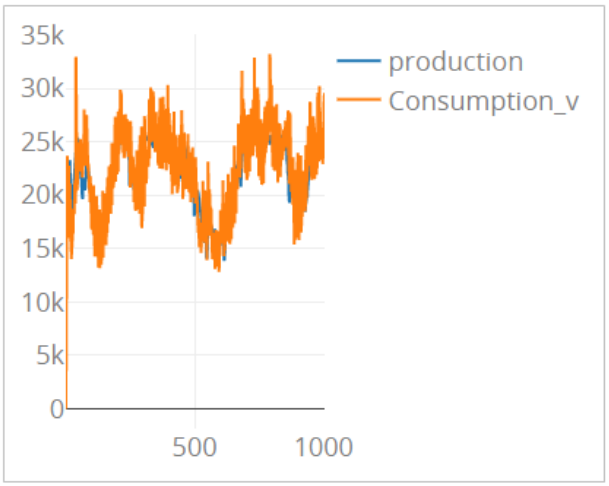
$sp_{s,t}$	Consumption rate (in % of production)	0
$SP_{s,t}$	Government spending (in number of goods)	0
$\Delta D_{s,t}$	New loans	0
$D_{s,t}$	Total Debt	0
$Dc_{s,t}$	Debt Charge	0
$Ic_{s,t}$	Interest Rate Charge	0

7. Results

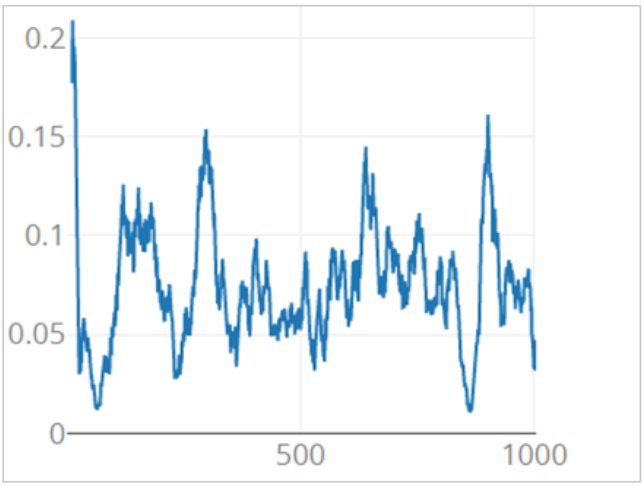
7.1 Baseline Scenario

In the baseline scenario, the distribution of shares among workers is uniform, so that there is no capitalist class. Also, the stock market is disabled, and the distribution of shares remain the same throughout the simulation. The behavior of the model is very close to that of Seppecher 2018, featuring endogenous business cycles driven by an evolutionary process. Figure 12 shows the main aggregate indicators for the baseline scenario.

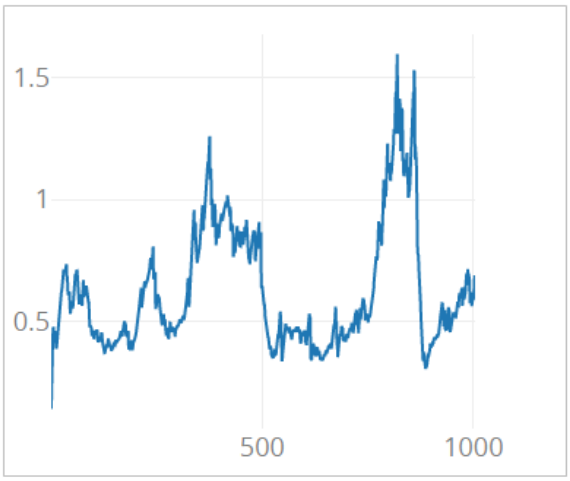
First let us describe briefly the order of events along the path of business cycles A new cycle begins when corporate leverage is low and unemployment high. Progressively, some firms will increase their target leverage to invest and hire new employees. Their success drives other firms to increase their leverage by imitation, and because profits and sales are rising. A period of economic boom occurs, with rising investment, employment, profits and leverage. Yet as the boom progress, the financial fragility of firms builds up, and the economy slowly enters in overcapacity, since the total number of units of capital overshoots above the labour supply. Then, some firms start to reduce investment because they do not find enough workers to operate their machines, and this reduction of demand pushes other firms into bankruptcy. This reverse the dynamic and the economy enters in a period of economic slump, with decreasing investment, leverage and employment. As wages are set to be less flexible than prices, demand can recover, and the economy does not crash (see Seppecher 2012). The countercyclical spending of the state also helps the recovery. At some point, rising the target leverage becomes a successful strategy again for firms and a new economic boom begins.



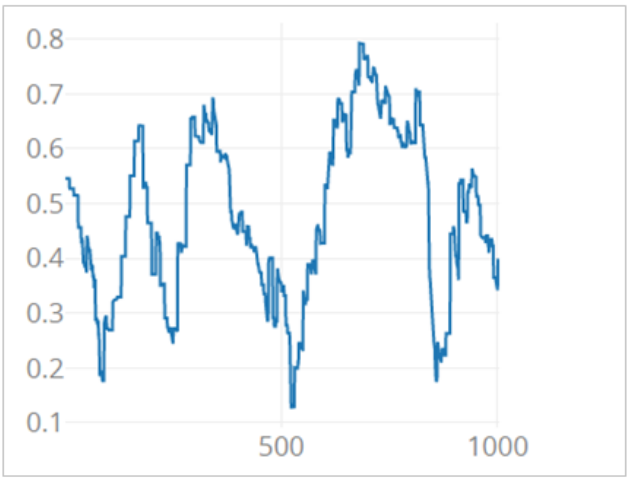
a. Production and Consumption



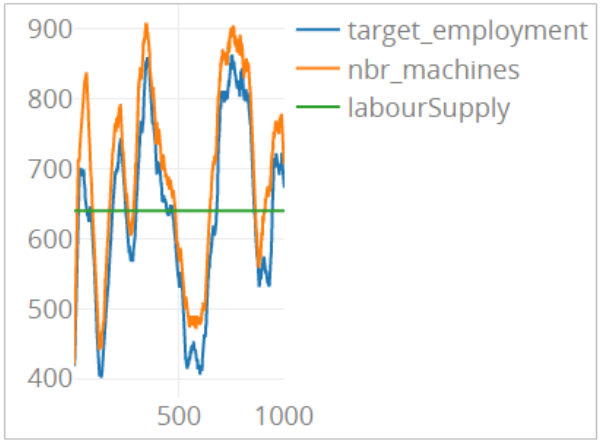
b. Investment-to-GDP ratio



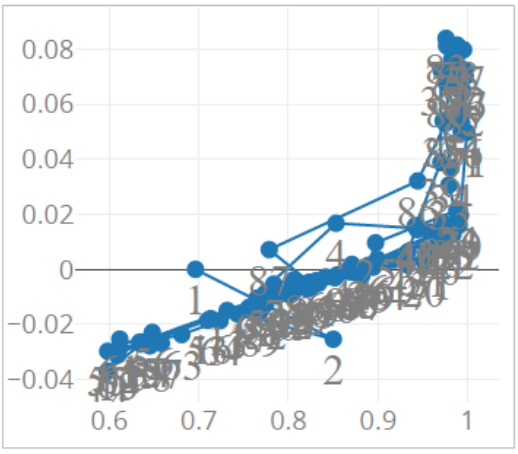
c. Firms aggregate leverage



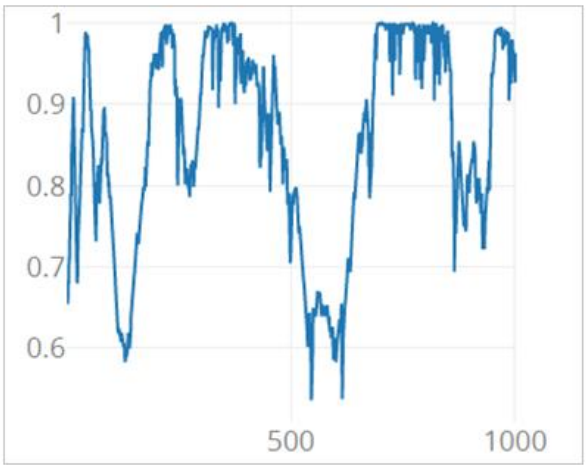
d. Average target debt ratio



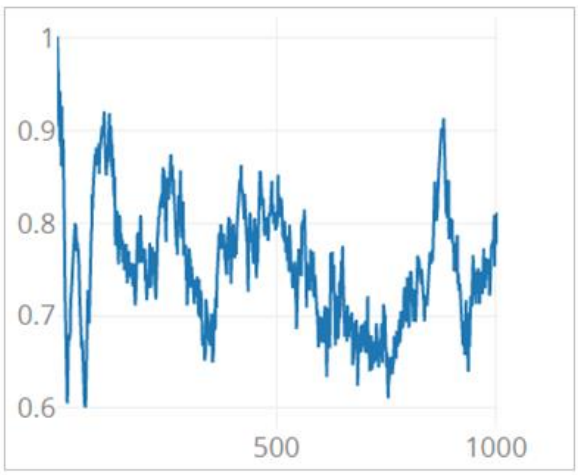
e. Capital and target employment



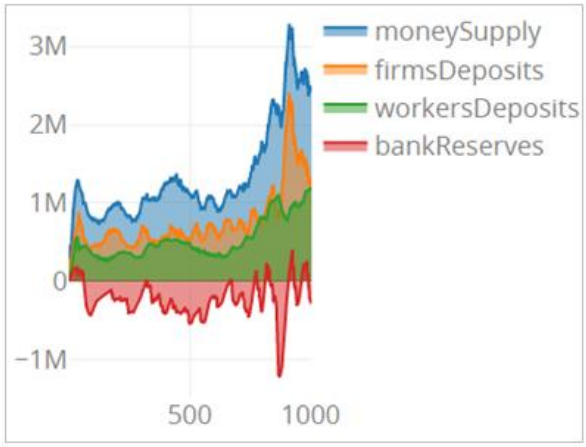
f. Phillips curve



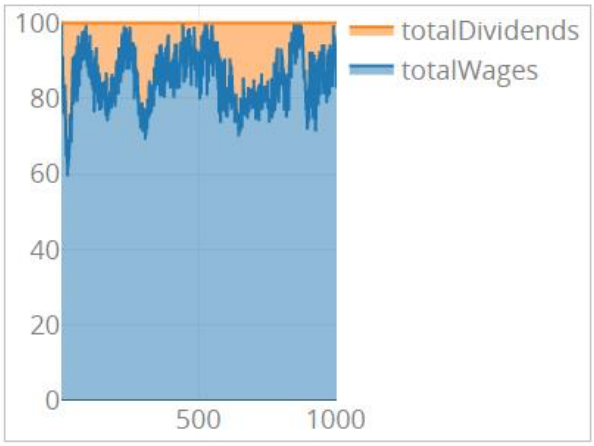
g. Employment Rate



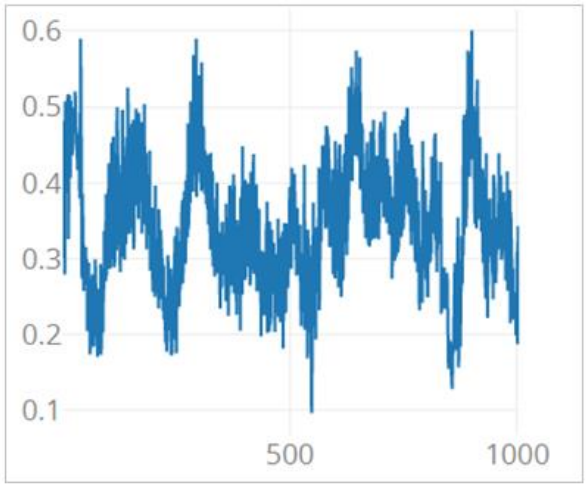
h. Capacity utilization



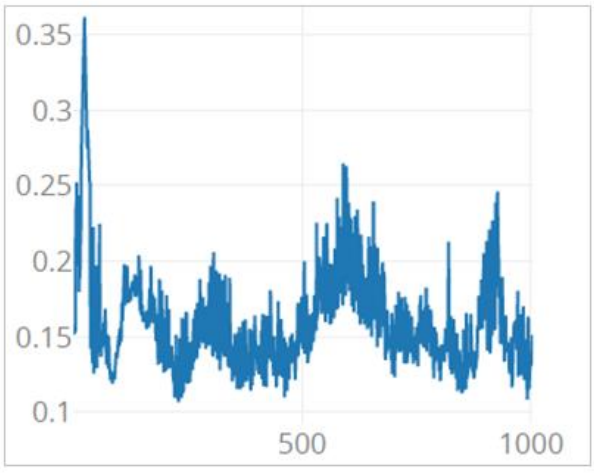
i. Cash holding



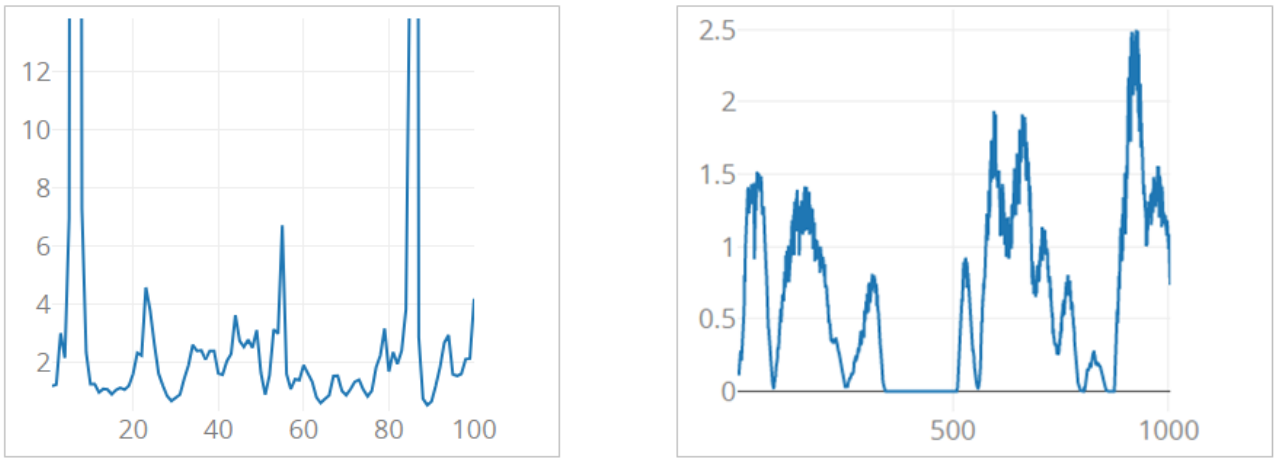
j. Income distribution



k. Profit share



l. First decile income share



m. Financial fragility

n. Public debt-to-GDP ratio

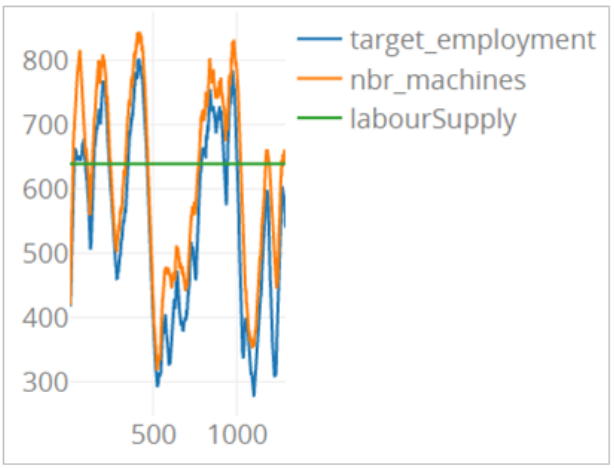
Figure 12: Results of the baseline scenario run for 1000 periods. Financial fragility is computed as the ratio of corporate debt over annual profits.

Source: *Authors simulation.*

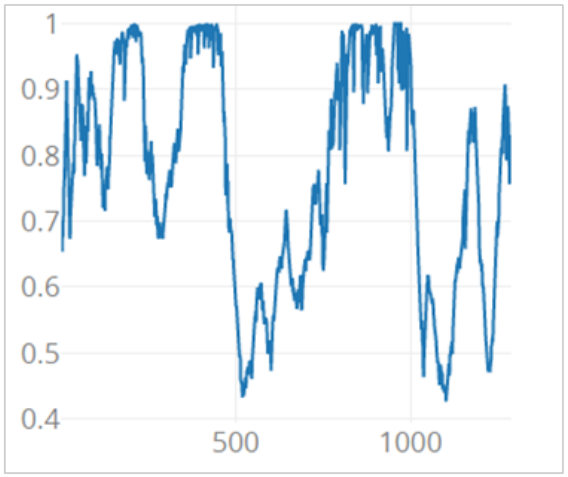
7.2 Rising payouts scenario

As a first experiment, we sought to assess the effects of rising payouts on the macroeconomic dynamic of the model. We ran a simulation with the same parameters as in the baseline scenario, but with a linear increase of the dividends-to-profits ratio of firms from period 500 to period 800. The starting value is 0.3 and the maximum reached is 0.8. These values are rather in line with the empirical results of Van Treeck (2009), who found that retained earnings in the US went from 0.7 in the early 1980's to 0.2 on average a decade later.

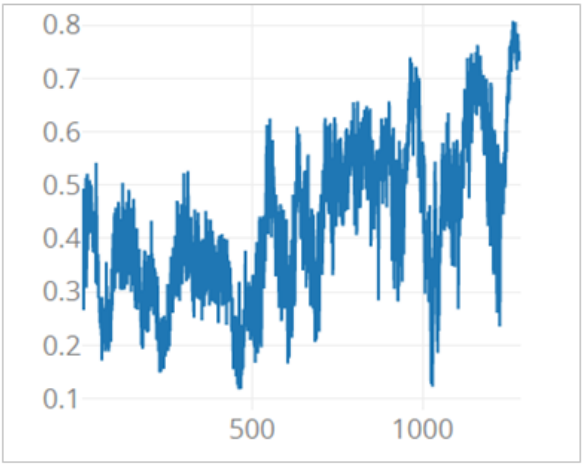
We were expecting results very close to Ricetti et al. (2016), *ie* increasing inequalities and rising instability through more recurrent and deeper economic crisis. We also expected the leverage of firms to naturally rise as a compensation for the reduced possibility of internal financing. In this extent, the results we found are mitigated as the reader can see on Figure 13.



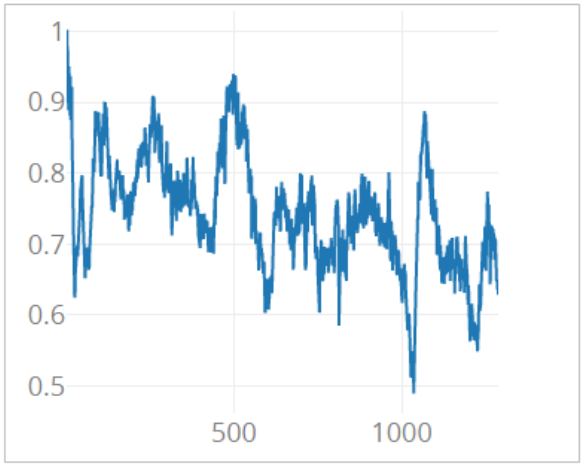
a. Target employment and capital



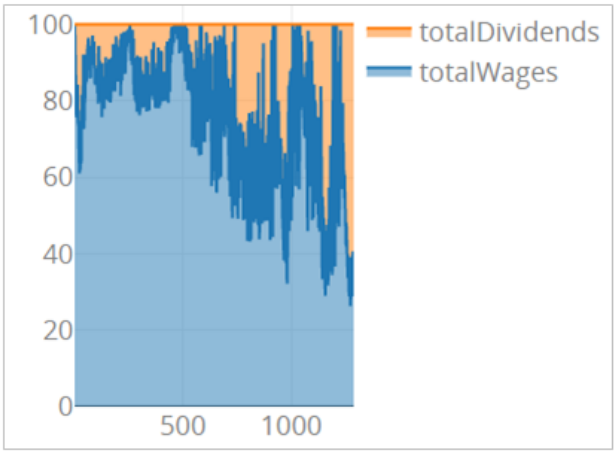
b. Employment rate



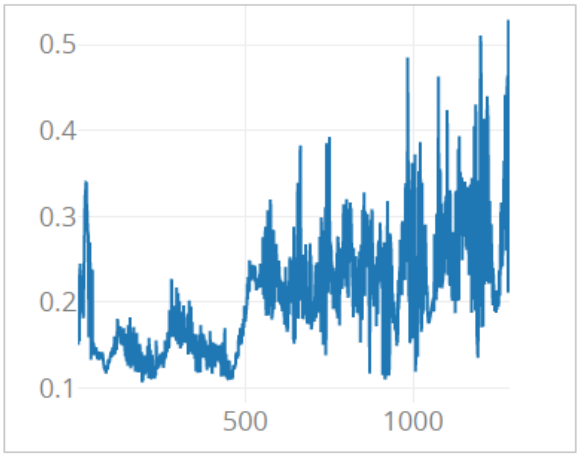
c. Profit Share



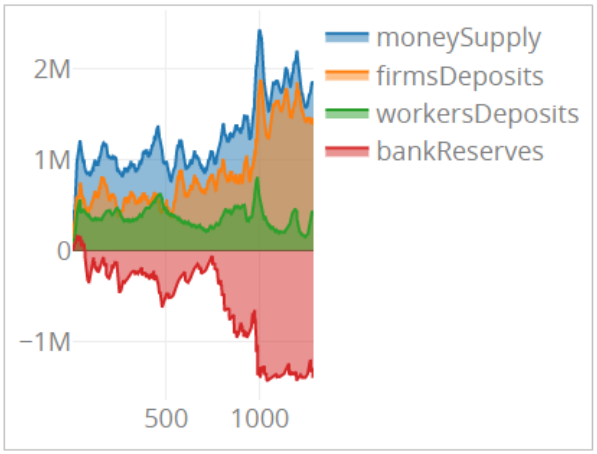
d. Capacity utilization



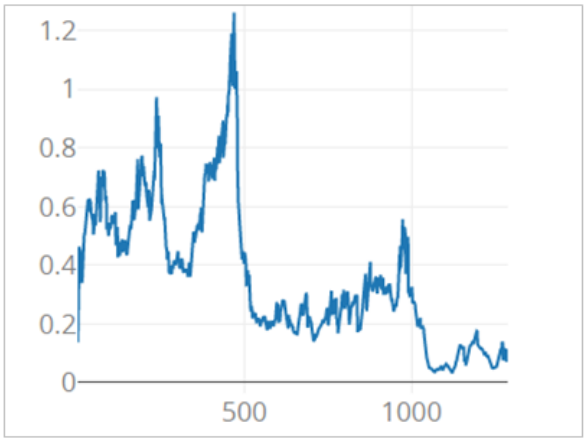
e. Income Share



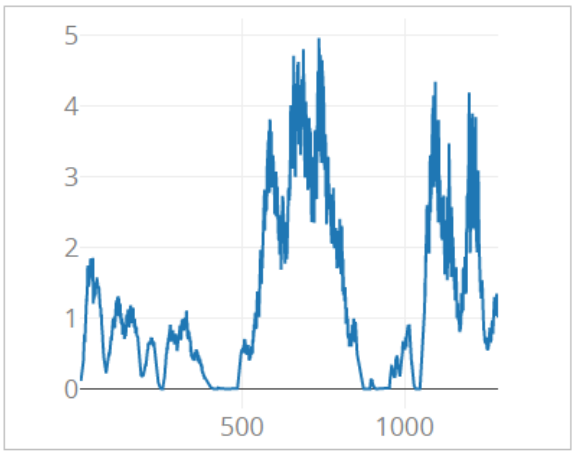
f. First decile income



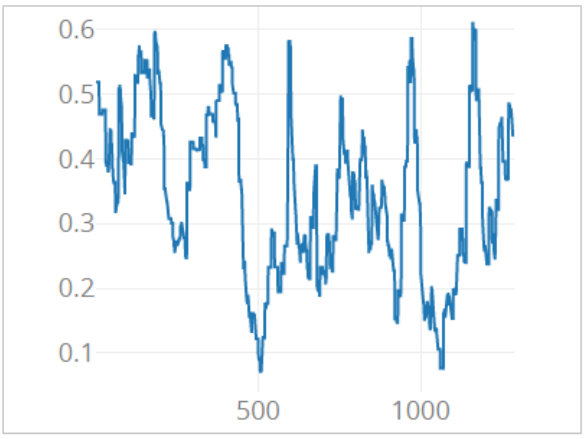
g. Cash holding



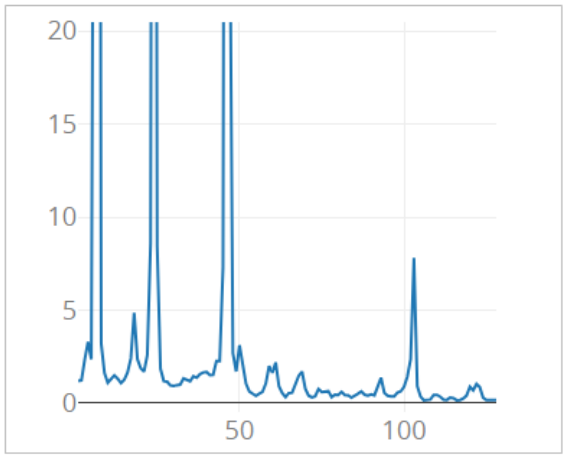
h. Firm's Leverage



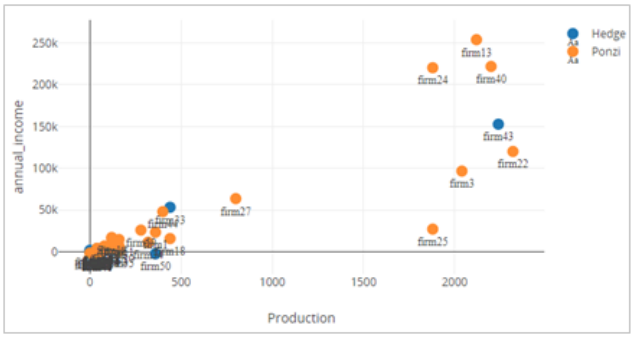
i. Public debt



j. Firms average target debt ratio



k. Financial fragility



l. Distribution of firms by Production and profits

Figure 13: Results of the financialization simulation. Payouts are increased progressively from period 500 to period 800.

First, consistently with Ricetti et al. (2016), we can see on graph (a) and (b) that the model under *sharheholder value* is characterized by deeper crisis followed by sluggish recoveries.

Second, we find that the rise of the dividends is accompanied by a slight increase of inequalities measured as the first decile share in income (graph f). Even if shares are distributed evenly among households, inequalities rise because production and profits tend to concentrate in a handful of oligopolistic firms (graph l).

But one of the most interesting results of this simulation is that the profit share rises naturally alongside the dividends share in income. This seems to confirm the hypothesis that *shareholder value* is a direct cause of the decrease of the labour share in developed countries. Yet, contrary to Crotty (2005) or Palley (2007) who put forward a microeconomic causal channel (the imperative to increase payouts is transferred to labour costs), this model puts forward a macroeconomic explanation. A very interesting feature of JAMEL is that the price fixing mechanism of firms is not based on a *mark-up* on unit costs, and profit rates emerge naturally out of the dynamics on labour and goods market. In the baseline "retain and reinvest" scenario, firm's profits are bounded macroeconomically because rising prices without rising wages will depress demand, ultimately leading to the decrease of prices. However, if, due to financialization, firms begin to distribute more dividends to shareholders, this creates a rising demand which is compatible and even correlated with decreasing real wages and rising prices and profits. On a Post-Keynesian Kaleckian perspective, we could say that *shareholder value* turns an economy into a "profit-led" regime. [10]

Aside from these expected results, we can also observe more puzzling dynamics. First, while we thought that leverage would rise dramatically, it felt to less than 0.2 in the wake of financialization (graph h). Similarly, even if crisis are more dramatic and long-lasting, financial fragility measured as the corporate financial fragility has also decreased and became less volatile (graph k). These findings are problematic, since the rise of leverage is pointed as an essential aspect of the financialization of NFC. Yet, there is a coherent explanation which pertains to the interdependence of balance sheets and to the incompleteness of the model. First, the rise of dividends distribution tends to spur demand and support more vigorous profits, while in the last simulation retained earnings sometimes remained idle, creating a depressive effect on demand. Further, as long periods of unemployment occur, the contracyclical spending of the

[10] The possibility of studying growth regimes with the JAMEL model seems very promising and would be a very interesting subject for a future paper.

government drives a consequent public debt (5 times the GDP at peak, graph (i)). This rise must have its counterpart in the deleveraging of other agents – here, corporations. In the meantime, we see on graph (g) that the Bank's reserve goes well under zero following a divergent path. Concretely, this means that, as over-indebted firms go bankrupt, their debt is deleted of the asset side of the balance sheet of the bank, but the money associated remains in the economic system and feeds profits. This already gives coherence to our statement that an important aspect of financialization is that some agents benefit from the debt of other financially doomed ones. Starting from there, we can say that our model is incomplete as regard the study of financialization. First, even if growing profits enable firms to finance investment with internal funds, the *shareholder value* principle requires that they make use of their surplus financing capacity, through share repurchases, debt-financed dividends, or financial investment. Second, it seems obvious that in the face of recurring deficits, the financial sector would eventually tighten credit conditions, either by bank credit constraint or by a collapse of debt markets; which will in both case lead to an exacerbated crisis. For now, the entire financial sector is abstracted as a single bank, and we can understand the perpetual deficit as the growth of a securitization bubble, or a massive injection of liquidity by the central bank. In future developments of the model, it seems of prime importance to disaggregate the financial sector into multiple heterogenous actors and introduce credit constraint aspects.

7.3 Endogenous inequalities and the stock market

Lastly, we led a small experiment with the basic stock market introduced in JAMEL. We let aside the interactions between the stock market and the real economy, because the model is not complete enough to give it a fair account. Yet we can already make an interesting proof on the endogenous rise of inequalities, for which an agent-based model is particularly adapted. As we saw in section 3, inequalities and financial markets seems to evolve in tight interaction: financial markets act as an exacerbator of income inequalities and in return inequalities tend to spur demand on financial markets.

To verify this hypothesis, we activate the stock market and portfolio behavior of households, and we run two simulations: the first is identical to the baseline scenario, and the second features a rise of dividends-to-payouts ratio from period 300 to 600. The results of those simulations are plotted on Figure 14.A and 14.B.

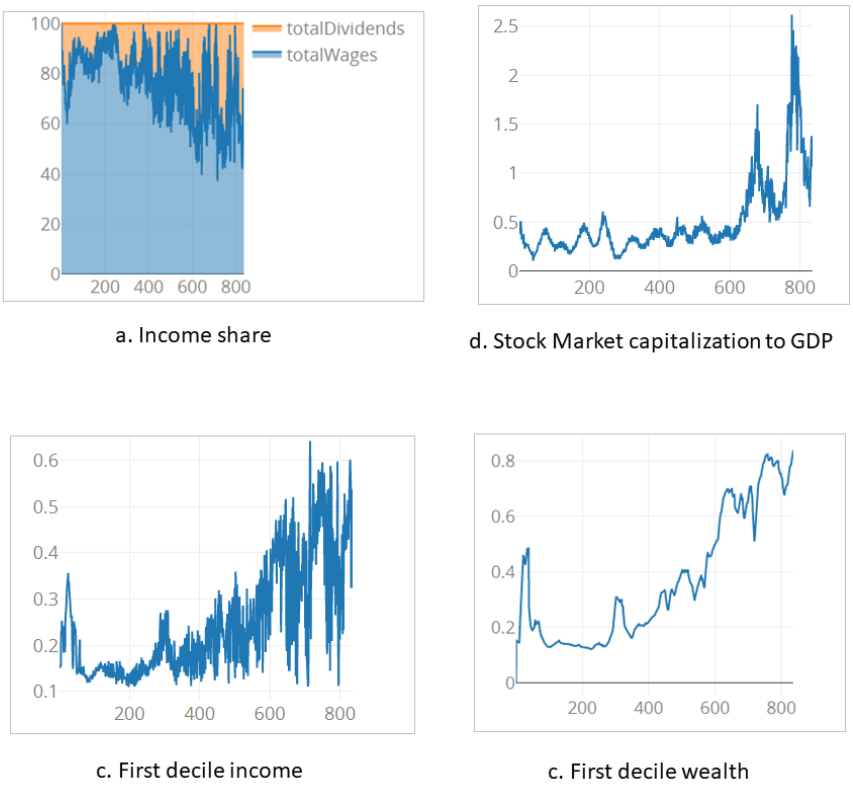


Figure 14.A : Simulation with rising dividends-to-payouts ratio from period 300 to 600, and with a stock market.

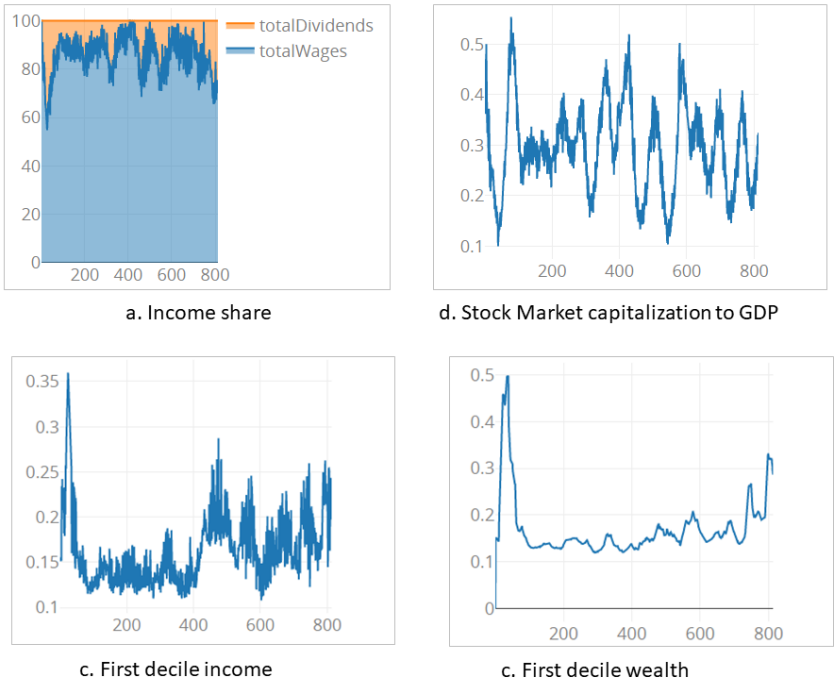


Figure 14.B : Simulation with rising dividends-to-payouts ratio from period 300 to 600, and with a stock market.

As we can see on Figure 14.A, the stock market has indeed worked as an exacerbator of inequalities brought by financialization. While in the last simulation, the first decile in income represented around 30% of total income at its peak, here it jumps to 60% (graph c). Also, consistently with empirical findings, wealth inequalities are more extreme than income inequalities, and the first decile share in wealth peaks at 80%. The explanation for this is that, as wealthier household desire to hold more shares, a temporary rise of income of an household will push it to acquire more shares. These new shares will result in a further increase of its income and a self-reinforcing loop will set up. Thus, starting from the simple hypothesis that wealthy household have a higher propensity to hold financial assets, we see that the presence of the stock market will take the economy from a situation where wealth and income are evenly distributed to a capitalist economy where most of the wealth is concentrated in the hands of a few individuals. Instead of acting as a buffer or equilibrating mechanism, the stock market acts as a super-sensitive memorizer which renders inequalities very hysteretic: the random small perturbations in income will be decisive on the path of each household toward rags or riches.

As we can see in Figure 14.B, in the absence of the rising payouts process, the positive feedback loop does not emerge, and inequalities remain limited. We can thus state that even if, as Godechot (2016) expressed, “financialization is marketization”; the effect of the financial markets on inequalities finds all its power due the rise of shareholder value.

In addition to that, we can note that the rise of inequalities has indeed a positive effect on stock market prices. Yet, as the portfolio behavior of households is very limited, and as many important financial agents are absent from the model, we prefer not to draw conclusions on the dynamic of stock prices. Let us just note that in financialized capitalism, the progressive rise of income inequalities can be a driver of prices on secondary markets.

Lastly, we would like to make a remark concerning the saving propensity of households. First, as the reader can see on Figure 15, the level of Household savings as a multiple of income rise dramatically and becomes more unstable in the wake of the financialization process. Yet we do not treat the effect of this rise of inequalities on demand because : (1) the design of the precautionary saving mechanism makes that dissaving’s also rise sharply and the overall effect seems to be only a more volatile demand, (2) this rising savings is not consistent with empirical findings and counterbalancing mechanisms are lacking in the model. Nonetheless, we would

like to make a remark concerning the Post-Keynesian hypothesis that redistribution toward capitalists increases savings at macroeconomic scale. In this model, as capitalists emerge and become richer, the wage share deteriorates, and low-income household are pushed into more extreme poverty. Thus, the saving propensity of most household tends to decrease also in the process. This means that depending on the way inequalities develop (with a link to productivity increase or not), on the forms the income distribution curve take, and on sensitivity parameters, the overall effect of inequalities on aggregate savings is not necessarily negative.

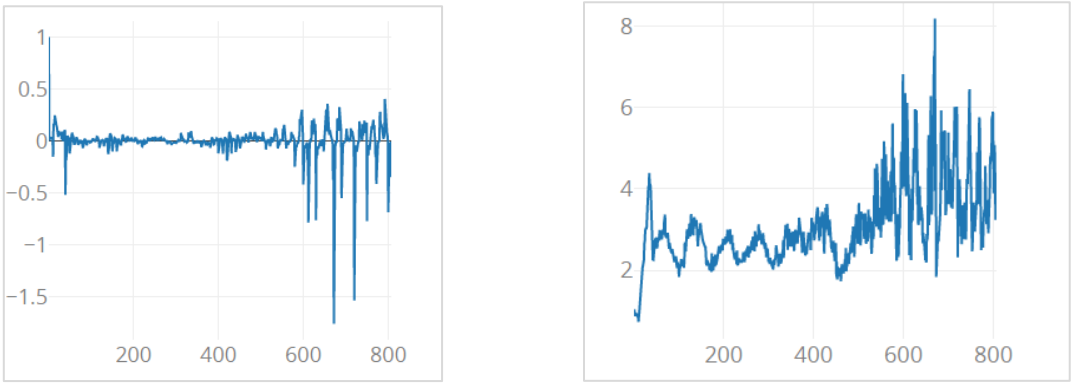


Figure 15: Savings flows (left) and stocks (right) as a ratio of Household income in a financialization simulation (Stock Market + Rising payouts)

Source: *Authors simulations.*

7.4 Discussion of the results

Our purpose with this model was more to establish a basis for future studying of financialization than to make demonstrations. In the current state, it is still incomplete and unable to give a fair account of the micro- and macroeconomic interactions which characterize financialized capitalism. In order to prove the thesis that we presented on section 3 on structural equity bubbles, the model must be completed with an array of features.

In future versions of the model, we plan to introduce in priority the share repurchases programs and a Price-to-Earnings norm in the portfolio behavior of agents. As the stock market still lacks liquidity, it also seems relevant to introduce some speculative traders, or a market maker. Improvements on firm's behavior, such as the introduction of a *ROE* instead of absolute size of profits as a maximization rule, is also necessary. Lastly in order to link the balance sheets of

firms stock market prices and close the ponzi scheme, we will introduce *mergers and acquisition* and an account of *goodwills*, as well as simple financial assets holding. The introduction of growth drivers, either by expanding labour force or by productivity gains, will also yield very interesting results.

In parallel, it also seems important to disaggregate the financial sector. The confusion of the central bank and commercial banks into one unique agent posits accounting issues and limits the possibility of studying the impact of monetary policies.

As regard the robustness of results, we have to acknowledge that for now the behavior of the model tends to vary drastically throughout the parameter space, thus reducing the conclusive power of results. Yet this tends to be a common flaw in ABM, as most paper tend to neglect sensitivity analysis. Not that the high sensitivity on parameters is a problem as such, in the real Economy macroeconomic behaviors vary drastically throughout historical time and institutional set-ups. But we think that it is crucial to explore properly the parameter space of agent-based models, analyze the different effects yielded by different adjustment mechanism and different types of random distribution, to gain control and confidence over results (see Windrum 2007). To do so, it seems important to aim a greater part of the research on ABMs toward purely methodological issues, and a later work should be dedicated to a thorough analysis of the parameter space of the model.

Further, as noted by Fagiolo et al. (2019), it is possible to combine *indirect inference* calibration with a micro-empirically founded calibration and obtain a model which is consistent with reality at both micro- and macroeconomic scales. In the model presented in this paper, we have not sought to calibrate microeconomic parameters nor initialization values on empirical findings and introducing those concerns would provide more robustness to results.

Lastly, we want to remark that due to the introduction of randomness in behavioural equations, and due to hysteresis effects, the model tends to display quite different dynamics from one simulation to the other. This is problematic as regard to the experimental methodology and should be alleviated by a *monte-carlo* analysis, as is done by Ricetti et al. (2016). The principle is that many simulations are run on the same calibration parameters, and then statistical analysis is implemented on the series, which enables to reduce the potentially misleading heterogeneity between simulations, and it also allow for the observation of rare extreme events. In future works, we believe that our methodology should rely more on *monte-Carlo* analysis

Conclusion

In this paper, we have sought to outline the macrodynamics of a financialized economy, based on empirical evidences and theoretical works of the financialization literature. The key features of such a regime are: (1) a disproportionate growth of the financial, (2) the dramatic rise of income and wealth inequalities, (3) economic stagnation and sluggish investment, (3) longer business cycles and deeper crisis, (4) a growing leverage and increased financial fragility, and (5) rising asset prices and net-worth-to-income. In order to explain the emergence and stability of the finance-led regime, we have discussed the complex causal links between those different dynamics, and in addition we showed that the deep roots of financialization are to be found in a co-evolution between neo-liberalism, the development of new financial innovations, the rise of financial markets, and the dominance of the *shareholder value* ideology.

More particularly, we laid a special emphasis on the phenomenon of the *financialization of NFC*, as we think it has come to a somewhat extreme state and threatens the financial stability of the economy. Our thesis is that with massive share repurchases program, US corporations fed a structural bubble on the equity market along the 2010 decade. With dividends remaining very high, the rise of share repurchases forces firms to engage in increased leverage. But as financial assets in corporate balance sheets - most importantly *goodwills* - are linked to stock market prices, the growth of the bubble enables the pursuit of share repurchases programs. In that, we argued that a Minskyan ponzi process is operating, and while on one side corporate leverage is increasing to an unsustainable level, on the other side, a privileged elite benefit from extraordinary income drawn almost directly on debt.

In order to prove the coherence of this hypothesis, we built an agent-based model based on Seppecher (2018), to which we added a stock market. Even if our model is still incomplete and cannot prove our point, we were able to make interesting experimentations. First, consistently with the literature, we found that a rise of payouts-to-profits ratio results in increased inequalities, deeper financial crisis and slower recoveries. But more interestingly, we showed that the rise of payouts turns the economy into a profit-led regime, in which real wages can decrease without a depressing effect on the aggregate demand, which leads to the natural rise of the profit share. This provide a macroeconomic explanation for the decrease of the wage-share observed in financialized economies.

Finally, we showed that the existence of a stock market, combined with high payouts-to-profits ratios, generates endogenous inequalities, and makes the economic system go from a state where income and wealth are relatively well distributed among households to a situation where a handful of individuals concentrate most wealth and revenues. In return, in our model, inequalities feed back into stock market prices. Thus, the model presented in this paper is already able to account for the complex links between inequality, shareholder value and the stock market capitalization.

Yet the model is still incomplete, and in future versions we plan to add several new features, among which the possibility of wealth-effects, a speculative behavior, debt-financed dividends, share repurchases programs and a price-earnings norm for portfolio decisions.

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Appendix

Specifications of the model

6.2 Markets

In line with a large part of the Agent-based literature, the labour and goods markets in our model follow a *decentralized matching protocol* (see Ricetti et al 2016). Concretely, this means that at each period:

1. The supply side posts offers on the market, associated with a price and a quantity.
2. Each buyer consults only a random sample of offers and chooses the best one in terms of price.

This protocol first ensures that agents operate under *limited information*, which reinforces realism.

On contrary, the *Stock Market* that we added in the model follows a centralized protocol, in accordance with the empirical works on the microstructure of financial markets (see Madhavan 2000). The protocol is the following:

5. Both buyers and sellers post their orders on the market, associated with a price and a quantity.
6. Orders are sorted: buy orders from the highest price to the lowest and sell orders from lowest price to highest.
7. If the price proposed by the best buy order is superior to the price proposed by the best sell order, the transaction takes place at a mean price.
8. The last operation is repeated until the highest ask price is inferior to the lowest bid price.

6.3 Firms

While behavioral assumptions concerning price determination, employment, and inventories tend to be consensual among the agent-based literature (and more broadly among macroeconomic models); other aspects such as the investment and financing behavior are far more debated. The reasons of such controversies are that : (1) the causal links between investment decision, financing conditions, and payouts policies are very complex, and (2) investment throughout the economy obeys to very different logics (extensive or intensive, addressing a new market or an existent one), and (3) the financing behavior of firms tend to depend on their size and sector. Thus, introducing a single homogenous investment function, or an aggregate investment function is generally doomed to failure or incompleteness. To simplify things, in this model we voluntarily neglect technological progress and investment in productivity. The market is homogenous and new firms are only introduced when existing firms go into bankruptcy. Thus, the only rationale behind investment in the model is the extension of the production capacity to address rising demand.

According to the neo-classical theory of the firm, investment is explained by the wealth maximizing behavior of firms and Tobin's Q (Bernardo 2016). When the Q is above one; *ie* if the market price of equity is superior to its book value, investment is implemented and financed by equity emission. This theory is still used in many *general equilibrium* models (Bernardo 2016), despite disappointing empirical validation (Chirinko 1993) and a blatant lack of realism pointed by several critiques (see Crotty 1990, Palley 2001). The theory seems particularly irrelevant in the context of financialization: while Tobin's Q is hanging well above one since

the 1990's, most firm still refuse to finance investment with equity, and even operate massive share buy-backs.

In this paper, we prefer to refer to the *pecking order theory*, which states that firms finance investment with internal funds in priority, with debt if needed, and with equity as last resort[11]. In fact, equity financing is totally excluded in our model, for purposes of simplification and because we intend to study a financialized economy in which net equity emissions are negative. [12] In addition to this, our model also relies on the *growth-safety trade-off* theory (Crotty 1990, Dallery 2009). Investment is constrained by the target ratio of leverage fixed by firms in this model. As is expressed by the basic Minskyan theory, the tolerable level of leverage tends to fluctuate with business cycles and depends on the perception of the market conditions (Minsky 1982). To account for this behavior, firms are provided with an imitation rule which makes them copy the target leverage of successful counterparts.

All in all, in this model, firms invest whenever their capacity of production is insufficient to meet demand, if the new debt required does not make its leverage exceeds the norm.

1. Production

Each unit of capital needs to be operated by one worker to be productive and workers can only operate one machine per period. Consequently, the periodic production of a firm is given by the minimum between the number of employees $n_{j,t}$ and the number of units of capital $k_{j,t}$, times the machine productivity pr^k. Each time a machine is used, it is deteriorated, so that after d^k periods of activities, a unit of capital becomes irremediably unproductive and must be replaced.

$$P_{j,t} = Min\left(n_{j,t}, k_{j,t}\right) \times pr^k$$

2. Quantity decisions

Firms control the size of their production by setting a targeted number of employees $n_{j,t}^T$. They adjust this target each δ_d^{Prod} periods, depending on their perception of the market conditions.

[12] Yet if the pecking order theory holds for some large corporations, the situation is different for smaller firms (Frank 2003). Particularly, equity emission are the main source of financing for young companies with still ill-established business model. Further versions of the model should take this into account.

As they operate under limited information, their only way of assessing the state of demand is by looking at the level of their inventories $in_{j,t}$. If inventories are inferior to one period of production, demand is interpreted to be high and the firm raises its target employment. If inventories go above 4 times the monthly production, the firm decreases its target employment. Each period, the firm will immediately lay off excess employees if employment is under the target, or conversely will try to recruit the missing employees.

$$n_{j,t}^{T} = \begin{cases} n_{j,t-1}^{T} \times (1 + \delta^{Prod}) \quad \boldsymbol{if} \ \dfrac{in_{j,t-1}}{P_{j,t-1}} < 1 \\ n_{j,t-1}^{T} \times (1 - \delta^{Prod}) \quad \boldsymbol{if}\ 4 < \dfrac{in_{j,t-1}}{P_{j,t-1}} \\ n_{j,t-1}^{T} \quad \boldsymbol{else} \end{cases}$$

With δ^{Prod} being the parameter of production flexibility. This operations happens only each δ_d^{Prod} periods.

3. Wage setting

The level of the offered wage depends on the firm's perception of the pressure on the labour market. Once again, there is no centralized information available, and the firm can only look at its past difficulties to recruit. If during d_f^W consecutive periods the firm encounters difficulties to recruit ($n_{j,t} < n_{j,t}^T$), it will increase the offered wage. Conversely, if during d_f^W the firm has known no difficulties to recruit ($n_{j,t} = n_{j,t}^T$), it will decrease the wage. The size of the adjustment is fixed in time and homogenous among firms and given by the parameter δ^W.

$$w_{j,t} = \begin{cases} w_{j,t-1} \times (1 + \delta^{W}) \quad \boldsymbol{if} \ d_{j,t}^{n} < -d_T^n \\ w_{j,t-1} \times (1 - \delta^{W}) \quad \boldsymbol{if}\ d_{j,t}^{n} > d_T^n \\ w_{j,t-1} \quad \boldsymbol{else} \end{cases}$$

With $d_{j,t}^n$ being the number of consecutive periods of full employment - if positive - or underemployment – if negative . [13]

[13] Note that what we mean here by « full employment » is not a macroeconomic concept, but only a microeconomic equality between a single firm's target employment (and often its number of machines) and its number of employees.

4. Price setting

The firm adjusts the offered price $p_{j,t}$ according to the level of inventories $in_{j,t}$, which is considered to represent the state of demand on the market. If this level of inventories goes under - respectively above – a certain multiple of the periodic production $P_{j,t}$, the firm will increase – respectively decrease – the offered price.

$$p_{j,t} = \begin{cases} p_{j,t-1} \times (1 + \delta^p) \quad \textbf{\textit{if}} \quad \dfrac{in_{j,t-1}}{P_{j,t-1}} < in^T \\ p_{j,t-1} \times (1 - \delta^p) \quad \textbf{\textit{if}} \; in^T < \dfrac{in_{j,t-1}}{P_{j,t-1}} \\ p_{j,t-1} \quad \textbf{\textit{else}} \end{cases}$$

Where in^T is the targeted level of inventories expressed as a ratio of the periodic production, and δ^p is an homogenous and fixed parameter of the size of price adjustments.

5. Financial decisions and investment

Production Financing: Each period, the firm computes its expected wage bill, and if retained earnings are insufficient to cover it, a short-term loan is asked automatically granted by the bank.

Investment decision: As for the investment decision, we departed from Seppecher (2018) which proposed a very interesting function based on the principle of *Net Current Value*. Yet we think that this function brings unnecessary complexity in the model and the same results can be achieved with simpler assumptions based on capacity utilization and the growth-safety trade-off.

Each d^{Prod} period, after having set its new employment target, the firm considers investing. If the capacity utilization ratio $U_{j,t}$ is above a target ratio, the firm will try to expand its productive capacity and invest. The estimated cost of the investment is computed as well as the estimated loan necessary to finance it. If the resulting loan pushes the debt ratio of the firm above its targeted ratio, the investment is abandoned, else it is pursued.

$$I^{e}_{j,t} = \begin{cases} Min(n_{j,t} \times (1 + \delta^{Prod}), 1) \quad \textbf{\textit{if}} \quad U^T_{j,t} < U_{j,t} \\ 0 \quad \textbf{\textit{if}} \quad U^T_{j,t} < U_{j,t} \end{cases}$$

Where $I^{e}_{j,t}$ is the potential level of investment (expressed in units of capital). Its scale is determined by the production flexibility parameter δ^{Prod}, but it will be at least of one.

$$\Delta D^{e}_{j,t} = I^{e}_{j,t} \times v^{k} \times p^{m} - M_{j,t}$$

Where $\Delta D^{e}_{j,t}$ is the estimated debt increase due to investment, v^{k} is the value of a unit of capital in number of goods, p^{m} is the medium price on the goods market, and $M_{j,t}$ is the amount of cash held by the firm at this period. [14] Then, the firm can compute its estimated future debt ratio $l^{e}_{j,t}$:

$$l^{e}_{j,t} = \frac{(D_{j,t-1} + \Delta D^{e}_{j,t})}{A_{j,t} + I^{e}_{j,t} \times p^{m}}$$

If this estimated debt ratio is below the target (what the firm finds tolerable), the investment is implemented: the firm buys $I^{e}_{j,t} \times v^{k}$ goods to other firms on the market and immediately transforms them into $I^{e}_{j,t}$ new units of capital.

Dividends payments: At the end of the period, the firm computes its net profits $\Pi_{j,t}$, and constructs its current balance sheet. If net profits are positive, the firm pays a tax to the state at the rate $\boldsymbol{t_F}$.[15] If net profits are positive and leverage is below the target, the firm will distribute a proportion $div^{r}$of its after-tax profits as dividends. The level of the dividends is also limited by the available amount of cash held by the firm. [16]

$$D_{j,t} = \begin{cases} Min(\Pi_{j,t} \times (1 - \boldsymbol{t_F}) \times div^{r} - (1 + \delta^{Prod}), M_{j,t}) \ \boldsymbol{if}\ \Pi_{j,t} > 0 \ and \ l_{j,t} < l^{T}_{j,t} \\ 0 \quad \boldsymbol{else} \end{cases}$$

6.Adaptative behaviour

In this model, we use a *"blanketing shotgun process"* like Seppecher (2018). Yet, due to the lack of computing power we cannot simulate enough agents to make it work properly. To

[14] To be perfectly rigorous, we should substract to the cash holding the wage bill that is also paid on retained earnings. It is done in the model but for simplicity we removed it from the equations.
[15] In most countries, the previous losses can be deduced on the tax on profits. We did not introduce this feature in the model yet, which might result in a slight overtaxing of firms. This will be adressed in future versions of the model.
[16] This assumption could, and may be should be relaxed on future versions. We plan to introduce the possibility of debt-based dividends in the future.

strengthen the evolutionary process and enable it to work with only 60 firms, we improved the *BSP* of Seppecher (2018) with a mating-pool protocol, which is a common tool in evolutionary modelling. Every 10 periods; each firm is attributed a fitness grade depending on a chosen variable. In the baseline scenario, we set this variable to be the annual profits, so that firms will try to "maximize" the absolute growth of profits.

The fitness calculation is performed in three steps:

1. Fitness is set equal to the maximizing variable.
2. The maximum fitness is calculated.
3. Fitnesses are normalized by being divided by the maximum fitness. Thus all fitnesses lay between 0 and 1.
4. The fitness of each firm is multiplied by 100 to obtain its representation in the mating pool.

Then, a "mating-pool" is filled with firms according to their representation number. For example, if a firm's fitness is 0.2, its representation number will be 20 and the firm will be added 20 times in the mating pool.

Contrary to the protocol used by Seppecher (2018), imitating firms in our model do copy a firm picked in the set of surviving firms, but in the mating pool. Thus, a more successful firm has multiplicated chances of being imitated.

Whenever a corporation goes bankrupt and is bailed-out by the bank, it is considered that the management team is changed, and the firm imitates the target debt ratio of another one randomly picked in the mating pool. In addition, an "imitation-and-exploration" process occurs each year. For each firm, a random number $a_{j,t}$ is drawn between 0 and 1 and depending on the result, the firm will either: (1) innovate by changing slightly its target debt ratio, (2) imitate by copying the target debt ratio of another firm picked in the mating pool, (3) innovate radically by taking a totally random new target debt ratio.

$$l_{j,t}^{T} = \begin{cases} l_{j,t}^{T} = l_{m,t-1}^{T} \; if \; a_{j,t} < 0.6 \\ l_{j,t}^{T} = l_{j,t-1}^{T} \times (1 - U(-0.5\,,0.5)) \; if \; 0.6 < a_{j,t} < 0.95 \\ l_{j,t}^{T} = U(0\,,1) \end{cases}$$

Where $l_{m,t-1}^{T}$ is the target ratio of the imitated firm, and U(x,y) refers to a randomly number between x and y. This process happens only each 10 periods.

6.4 Households

1. Job research and reservation wage

When a household gets unemployed, either because he has been dismissed or because the work contract went to the end, it will try to find a job each period. He consults g offers on the market, plus the offer of its last employer if there is one. He then compares the wages offered to its reservation wage $wr_{i,t}$, and chooses the best offer which exceeds this reservation wage. If no offers meet the reservation wage, the household remain unemployed.

If the household remains unemployed for a duration of w_H^d periods, it will start to decrease its reservation wage and accept lower-paid jobs. As soon as a new position is found, the reservation rate is set equal to the current wage.

2. Budget and spending

The income of households is computed as the sum of wages and dividends, to which the tax on income is substracted as a rate $\boldsymbol{t_H}$. Then, following Seppecher (2018) and based on the empirical work of Allen & Carrol (2001), we consider that households build a precautionary saving reserve, which is adjusted periodically. Regularly, the household computes its annual income (the sum of the last 10 periods) and set its target nominal savings to be a share $s_{i,t}^p$ of this annual income. Each period, this target is compared the current level of deposits, and the household will accordingly either save or dissave a share $s_{i,t}^p$ of its income.

$$Inc_{i,t} = W_{i,t} + D_{i,t}$$

$$S_{i,t}^T = s_{i,t}^p \times Inc_{i,t}^y$$

$$s_{i,t} = \begin{cases} s_{i,t}^p \times Inc_{i,t} \ \boldsymbol{if} \ M_{i,t} < S_{i,t}^T \\ -s_{i,t}^p \times Inc_{i,t} \ \boldsymbol{if} \ S_{i,t}^T < M_{i,t} \end{cases}$$

Where $Inc_{i,t}$ is the monthly income, $Inc_{i,t}^y$ the average yearly income, $s_{i,t}$ the level of this month savings in nominal term, $S_{i,t}^T$ the target stock of Saving in nominal term, and $M_{i,t}$ the current amount of money held by the household.

Endogenous saving propensity. In Seppecher (2018), household saving propensity $s_{i,t}^p$ is homogenous and fixed in time. In this model, we would like to relax this hypothesis to be more

in line with the empirical findings of Dynan et al (2004) and with the Post-Keynesian theory of saving propensity. Thus, we consider in this model that a household's saving propensity depends on its real income. Based on Vissing-Jorgensen (2002), we will also consider that the proportion of financial assets that the household desire to hold in its portfolio ($rs_{i,t}^{T}$) is dependent on the real income.

Our mechanism is the following:

(1) Household computes their real annual income ($Inc_{i,t}^{y} \,/\, p^{m}$)

(2) If the real annual income is inferior to 50 goods, the household is considered in extreme poverty and cannot save. Saving propensity and risky ratio are set on minimum.

(3) If the real income is comprised between 50 and 1000, a linear mapping is applied to obtain the saving propensity and risky ratios.

(4) If the real income is equal or superior to 1000, both saving propensity and risky ratio are set on their maximum values $s_{i,t}^{pmax}$ and $rs_{i,t}^{Tmax}$.

As this formal presentation might not be very clear to the reader, we plotted on Figure 11 a graph drawn from a simulation which shows the saving propensity of households depending on their level of real income.

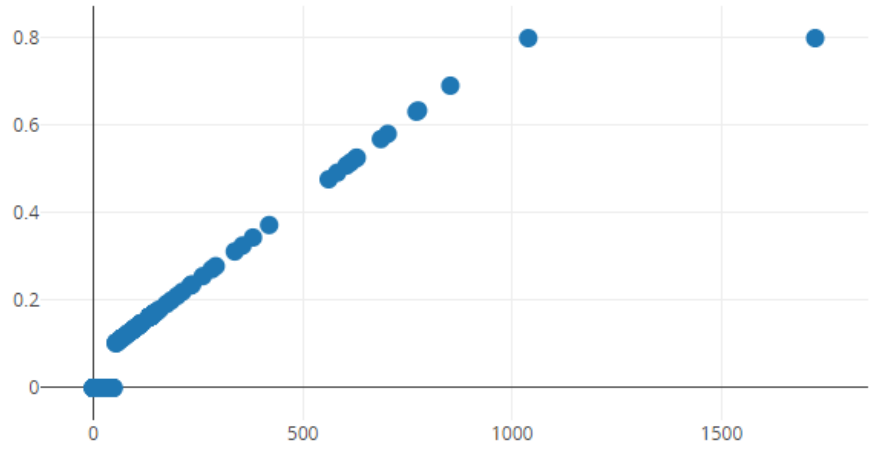

Figure 11: Households saving propensity (y axis) depending on their real annual income (x axis), at the 600th period.

Portfolio Behaviour: In this model, we start to experiment with the portfolio behavior of households and their interaction with the stock market that we introduced. For now, the financial investment behavior of households is very simple, and results are only experimental. Households manage only two classes of assets, money and shares. The ratio of their portfolio that they are willing to hold in shares depends only of their real income, as we presented above, and there is no tobinesque portfolio behavior, *ie* households do not take into account the respective return on assets. This assumption removes totally the possibility of a speculative-led euphoric boom on the stock market and is quite unrealistic. Yet we have two main reasons for it. First, as ABM tend to be very complex and unstable, it is a good practice to follow a step-by-step process and not rush into several aspects at the same time, so we decided not to include the wealth effect, nor the speculative aspect of portfolio choice. Second, as we exposed in section 3, we think that financialized capitalism is characterized by the growth of structural bubbles, independently of euphoric speculation. Obviously, the structural pressure upward on financial markets will interact with the speculative tendencies of agents in the real economy. Yet proving that financial bubbles can emerge even without the assumption of speculative investment is good first step in our demonstration.

Concretely, at each period, households will compute the level of their financial wealth, and compare it to the level of cash holding, to obtain their current ratio of financial assets $rs_{i,t}$. If this ratio is under - respectively above – their target ratio, they will try to buy – respectively sell – shares on the stock market. As the stock market is centralized, households have access to the price of the last transaction, that they multiply to an adjustment ratio $\delta_{i,t}^{SP}$. Much like the adjustment process of wages by firms, household will increase or decrease this adjustment if they do not meet their portfolio objectives during several periods. This mechanism will drive prices up when demand exceeds supply and vice versus.

6.5 The Bank

In this model, the financial sector is abstracted to a single bank which plays at the same time the role of Central Bank and Commercial Bank.

Loans issue: The bank systematically grants credit to firms for financing their production and investment. Production is financed by short-term loan, while investment is financed by long-term loans.

Reimbursement and recovery: All loans are reimbursed throughout the duration of the contract, which means that at each period, firms pay to the bank the interests plus a portion of the principal, so that at the end of the contract, the loan is entirely reimbursed. The following equation shows the calculation of debt payments associated with a single loan.

$$\text{Monthly debt payment} = \text{principal} \times \text{interest\_rate} + \frac{\text{principal}}{credit\ duration}$$

Each period, the bank will compute the total amount of debt payments owed by each firm. If a firm cannot meet the debt payments, *ie* is in liquidity bankruptcy, the bank will provide an *overdraft* loan to refinance it. This new loan is considered riskier and is graded "doubtful", and a majored interest rate i_t^m is applied. Thus, all loans are repaid at the end of their duration, and the bank makes losses only when enterprises go bankrupt.

Bankruptcy: There are two cases of bankruptcy in the model: either the firm's level of equity $E_{j,t}$ becomes negative (balance sheet bankruptcy), or the number of units of capital falls to zero.

In both cases the bank will:

1. Compute the total amount debt owed by the firm and compare it to the cash holding of the firm.

2.If cash holding are insufficient to reimburse all loans, the Bank registers the difference as a loss on its own equity.

3. All employees of the firm are dismissed, and remaining units of capital and inventories destroyed[17].

4. The firm behavioral values are reinitialized, except for the target debt ratio which is copied from a firm randomly picked in the mating pool.

[17] Liquidation process for inventories and units of capital are planned to be added in the future.

In Seppecher (2018), when the Bank's equity fall under zero, the simulation stops and the economy crashes. In this model, we prefer to enable the simulation to continue, and note that a severe financial and monetary crisis might have occurred at this point. [18]

Interest rate policy: The bank follows a simple taylor rule formalized in this equation:

$$i_t = max\,(\,\varphi_\pi \times (\pi_t - \pi^T), 0)$$

Where i_t is the base interest rate, φ_π the inflation reaction, π_t the current rate of inflation and π^T the targeted rate of inflation (monthly).

6.6 The State

The state has a very simple behavior in the model. It collects taxes on Households and Firms, and buys a share of the production at each period. Following Dos Santos & Zezza (2008) and Pedrosa & Lang (2018), we consider that the share of production that is purchased by the public sector each year depends on a fixed structural size $\boldsymbol{\emptyset_S}$ and a contracyclical component $\boldsymbol{c_r}$. The contracyclical component evolves with the deviation of the economy from a target employment U^t. [19]

$$c_{s,t} = \boldsymbol{c_r} * (U_t - U^T)$$

$$sp_{s,t} = \boldsymbol{\emptyset_s} + c_{s,t}$$

$$SP_{s,t} = sp_{s,t} \times P_{t-1}$$

Where $c_{s,t}$ is the rate of contracyclical, $sp_{s,t}$ the total rate of government spending, $SP_{s,t}$ the final consumption of the state in real terms, and P_{t-1} the production in real terms in the last period.

[18] This assumption breaches temporarily the stock-flow coherence of the model, because there is more money in circulation than loans in the assets of the bank. Yet such situations are theoretically possible and empirically observed in some countries (Ize 2005). In future versions of the model, a more complete financial sector, with a central bank and several commercial bank, will alleviate this issue.

[19] In Pedrosa & Lang (2018), the capacity utilization is used instead of the employment rate. Yet in our model, this leads to a terrible bias: if the economy enters in overcapacity, capacity utilization drops while employment remains very high. In such situation, it is very unlikely that a government will engage in a contracyclical policy, and the inverse is more probable. We thus finds more relevant to use the employment rate.

If the tax revenues plus the cash reserves are insufficient to cover the expected cost of spending, the state borrows a long-term loan to the bank.

$$\Delta D_{s,t} = R_{s,t} - SP_{s,t} \times p^m$$

Where $R_{s,t}$ are tax revenues, $SP_{s,t}$ spendings in real terms and p^m the medium price index.

Conversely, if the state runs a surplus for several periods and its cash reserves exceed a target ratio M^{max} of GDP, the state will increase its consumption slightly so that cash reserves joins back the target. The rationale behind this mechanism is that: (1) it seems realistic to assume that most government facing a rising tax surplus will increase their spending, and (2) without this assumption, an excessive surplus of the state creates deficits among firms which has a depressive effects on the economy, often leading to a crash.