The stagnation-financialization paradox

Understanding a modern puzzle through complex systems

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Publication date
2021

Document Version
Final published version

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ACADEMISCH PROEFSCHRIFT

ter verkrijging van de graad van doctor
aan de Universiteit van Amsterdam
op gezag van de Rector Magnificus
prof. dr. ir. K.I.J. Maex
ten overstaan van een door het College voor Promoties ingestelde commissie,
in het openbaar te verdedigen in de Agnietenkapel
op donderdag 29 april 2021, te 16.00 uur

door Enrico Maria Turco
geboren te Verona

Promotiecommissie

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	dr. A. Russo	Universitat Jaume I

Faculteit Economie en Bedrijfskunde

Dit proefschrift is tot stand gekomen in het kader van het Marie Skłodowska-Curie Actions Innovative Training Network 'Expectations and Social Influence Dynamics in Economics' (ExSIDE), met als doel het behalen van een gezamenlijk doctoraat. Het proefschrift is voorbereid in de Faculteit Economie en Bedrijfskunde van de Universiteit van Amsterdam en in de Facoltà di Economia van de Università Cattolica del Sacro Cuore.

This thesis has been written within the framework of the Marie Skłodowska-Curie Actions Innovative Training Network 'Expectations and Social Influence Dynamics in Economics' (ExSIDE), with the purpose of obtaining a joint doctorate degree. The thesis was prepared in the Faculty of Economics and Business at the University of Amsterdam and in the Facoltà di Economia at the Università Cattolica del Sacro Cuore.

Acknowledgements

"It is astonishing what foolish things one can temporarily believe if one thinks too long alone, particularly in economics (along with the other moral sciences), where it is often impossible to bring one's ideas to a conclusive test either formal or experimental." At various times of my PhD journey I happened to recall and truly understand the meaning of the above phrase that John Maynard Keynes writes in the Preface to the first English edition of his *General Theory*.

This thought has generally been accompanied by, first and foremost, a profound sense of gratitude towards my supervisors Cees Diks and Domenico Delli Gatti. Not only did they give me the liberty to pursue my interests and ideas, encouraging me to be creative and to explore "unfamiliar paths", but they also provided me with technical and moral support to not get lost in foolish things – if that incidently occurred, it was only due to my never-satiated curiosity. Through their words and their own works they taught me the importance of combining innovative thinking with a rigorous analytical approach, and I feel confident in saying that this is the most important lesson that I take with me from the PhD experience. In particular, I am truly indebted to Cees for his careful supervision, support and great patience over the past three years. Thanks to him (and Tiziana) I was selected for this particular project and my daily effort was a way to recompensate the trust that he placed upon me. After being my Master thesis advisor, Domenico adopted me quite unexpectedly half-way through my PhD and guided me through the wilderness of agent-based modelling. Under his guidance, I began to organize, formalize and simplify my vague and speculative thoughts, though I know he thinks there is still a long way to go (and I agree). After the almost six years that we know each other, I think of him as a true mentor, something more and different than a supervisor.

Furthermore I am very grateful to Herbert Dawid for his patience and willingness to discuss and read my works, always providing valuable and enlightening insights. Our talks during the ExSIDE events have been a source of inspiration and motivation to the extent that immediately after I just wanted to get back to work and implement the new, typically clearer and more organized ideas. For all this, he has been a sort of shadow advisor for me. A special thanks goes to Alberto Russo for the genuine interest he has shown in my research work since our first meeting at the coffee bar near the Università Cattolica a couple of years ago. His great knowledge of economic theory and modelling, his openness to dialogue and careful attitude towards listening make him the kind of Professor every student would like to encounter at least once in their life. Maybe for this reason in August 2019 I did not think twice before flying to Poland to attend his workshop on Agent-Based Modelling at Poznań University – certainly, an original concept of summer holidays.

Moreover I would like to express a big thank to all the CeNDEF people at the UvA for welcoming me with great joy and warmth and providing me with a lively and highly stimulating environment to do research. Given the number of hours that I used to spend at the university, CeNDEF was like a second home that made me feel less lonely in a foreign country. In particular, I want to thank Cars, Jan, Marco and Steffi, who are not only sensational economists but also very pleasant people to talk and eat lunch with; Moutaz, the first guy I met at UvA and introduced me to PhD life with his smart advices ("Doing a PhD is like taking a long breath"); my wonderful officemates, that is Eva, Johan and Myrna (the CeNDEF Cinema has been a short but intense experience, before Covid screwed everything up); Hao, for her contagious happiness, which was so necessary out of the office; Alex, Gavin and Tolga, we might have different views on economics but the same passion for this job; last but not least, Alessandro, a sort of older brother with whom I shared joys and sorrows during the first year in Amsterdam, starting from the Juventus games.

It has been a privilege for me to come back to Università Cattolica of Milan in the guise of a PhD fellow, after being Bachelor and Master student in this University. A sincere thanks is due to the amazing people of CLE, that is, Alberto, Alessandro, Chiara, Domenico, Eleni, Federico and Jakob, with whom I spent most of my time during the secondment in Milan. I am particularly grateful to Alberto and Jakob who offered precious support in my first steps towards the making of an agent-based model. Looking back, this positive feeling is partially replaced by a sense of bitter nostalgia for those good old days. I consider myself lucky to have met these great minds all together before the mass exodus hit the group. My true hope is that the CLE will soon return to its glorious days, not only for the people working there, but for the scientific community as a whole. To put it differently: Make CLE great again! Also, I have to admit that the experience in Milan would not have been as pleasant without the company of Alessandro and Bulgan. Our funny and rather heterogeneous trio was the living proof that cultural diversity can only enrich oneself. Anyhow, I hope you don't mind, Bulgan, if I say that I prefer Italian wine to Mongolian horse milk. Jacopo was a friend, an inspiring scholar and a loyal companion of dinners in the secret places around Milan. Irene and Melike two pleasant discoveries who made my days at the GSE in Barcelona joyful and memorable.

It was a honour and a pleasure to be part of the ExSIDE community for the excellent organization, the numerous highly stimulating workshops and, most importantly, the wonderful people that I have had the chance to meet over the past three years. I acknowledge financial support from European Union Horizon 2020 research and innovation program under the Marie Sklodowska Curie grant agreement, for which I am thankful. The ExSIDE doctoral program provided us with ideal conditions to carry out innovative and cutting-edge research. I wish all PhD fellows, particularly my Italian colleagues, could have the same treatment that we have had the good fortune to receive. If only the Government invested more in public research, this would not remain just a pipe dream.

I am also grateful to all the workshop and conference participants whom I have interacted with during the first and second years of PhD and whose constructive criticisms have encouraged me to constantly review and improve my thinking. The group of die hard Sraffians in Siena and Roma deserves a special mention, above all Riccardo Pariboni and Antonella Palumbo, who, through their tough criticisms, helped me to work on and, to some extent, get rid of the neoclassical flaws affecting my early ideas.

Outside academia, my first thought goes to my parents, Paolo and Stefania, and my dear brother Alberto, who have always supported me along this challenging experience. To my superstar family as a whole, for reminding me the importance of one's own origins no matter the length of the journey. And to Alice: I wish you were here, little lioness.

Surprising as it may seem, PhD life is not only made of reading, coding and writing, but also, although to a lesser extent, spare time. A sincere thanks goes to all those people, old and new friends, who have been source of entertainment and distraction. In particular, I Butei, the family I have chosen back in high school, and Frdn, the Maestro; the sirs Alessio and Coco, great friends and companions of adventures (and misfortunes); Beatrice and Elisa, the 2020 would have been darker without their shining presence; Michelangelo, faraway so close; Gabriele, the twinning between Verona and Firenze/Pontassieve must go on (but not forget to *vaìa*); last but not least, Jlenia, our friendship has proved to be resilient to ageing, distance and Covid, which provides hope for the future as well.

To conclude, there are two people who, for the role they have played in my personal development, deserve a special mention in these lines. Roberta, who has always been

by my side in good and bad times. And Riccardo Bellofiore, who, more than anyone else, has contributed to shape my way of thinking about economics (and more).

Although it might not appear so obvious at first sight, the basic attitude toward the research work behind this dissertation takes a great deal of inspiration from Bellofiore's lesson, inherited from the Italian tradition in political economy, on the importance of combining history of economic thought and economic theory in order to identify and develop the analytical tools to critically address the fundamental economic issues of our times. Perhaps the reason why the analogy with his economic reasoning is not so evident, besides the underlying attitude, is because I must have taken seriously another lesson that he constantly repeats, which is to spot and dig into the flaws in your master's thinking in order to end up with a different and possibly original point of view. But I am quite sure that without the continuous dialogue with Roberta this road to science would have led to lower and less luminous summits. The present thesis is dedicated to both of them.

Milan, December 7, 2020

Coauthors

Chapter 4, entitled *"Concentration, Stagnation and Inequality"*, is joint work with Roberta Terranova, PhD student from Bielefeld University. We worked together on the definition of the research question and the implementation of the model as well as the programming. The writing part was approximately split into half, while I am mostly responsible for the simulation results of this chapter version.

Contents

Chapter 1

Introduction

> *'I am quite convinced that the inverted relation between the financial and the real is the key to understanding the new trends in the world.'* (Sweezy, 1997)
>
> *'The Truth is in the Whole.'* (Hegel, 1807)

A couple of weeks after I began the PhD at the University of Amsterdam, I was attending Prof. Cars Hommes' course on *Nonlinear Economic Dynamics* and I soon became convinced that the economy is a complex system. At the time I am writing these lines, I am almost at the end of this highly fascinating but no less arduous journey. In the meantime, the world has been shaken by one of the greatest global pandemics in history, the economic consequences of which have not fully manifested yet and can hardly be reasonably predicted by economists. If needed, I could not get a better demonstration that my initial belief, inspired by Cars' lectures, was correct.

The outbreak of the COVID-19 pandemic seemingly opened a new era, that could potentially lead us to review our way of thinking and living. Although there are reasons to believe that our societies are approaching a 'new normality', we should nonetheless resist the temptation to consider as unequivocally original everything that moulds today's reality. Among the supposedly novel features characterizing the post-COVID world is what some have called the disconnect between financial markets and the real economy – also known in the American debate as the Wall/Main Street disconnect.

The notion was popularized in March 2020, when, in the midst of the coronavirus crisis, the S&P 500 index rebounded after the FED announced massive policy interventions in support for asset and credit markets, despite weak signals of economic recovery, as manifested by the continued growth in the weekly unemployment claims (see Figure 1.1). Since then, such a disconnect between soaring stock markets and slowing real economy – sharper in the United States but also present in Europe (Igan et al., 2020) – has been source of debate in the financial press as well as in academic research, as highlighted by the cover page of The Economist May 9th, 2020 ("A dangerous gap: The markets vs the real economy").

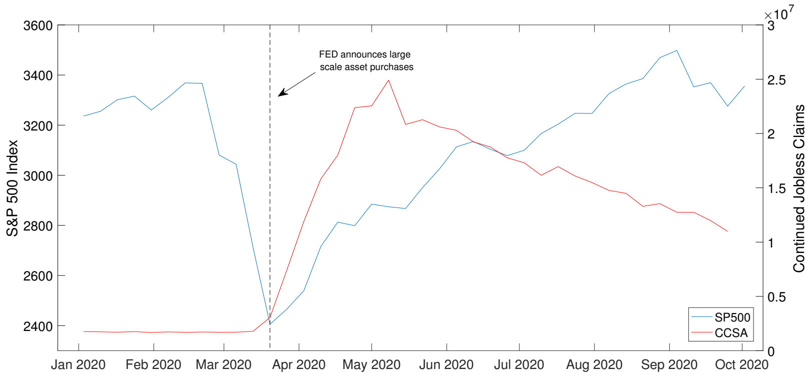


Figure 1.1: The disconnect between financial markets and the real economy. Data: S&P 500 index and continued unemployment claims (seasonally adjusted). Source: FRED. Author's elaboration based on Caballero and Simsek (2020).

According to the conventional view, this effect is just a temporary and natural result of the unprecedentedly vast monetary policies that Central Banks put in place in order to avoid major disruptions in the financial system which would worsen a deep depression. Yet, scholars agree that there is no reason to worry about this apparent puzzle. In fact, as long as asset prices influence aggregate demand with a lag, the asset price overshooting induced by the expansionary monetary policy will lead to an improvement in the macroeconomic conditions, such that the discrepancy between real and financial markets will soon be overcome (Caballero and Simsek, 2020).

In other words, the conventional view treats this evidence as a strange anomaly, which has come to light during these chaotic times that never cease to amaze. Nonetheless, when the sea will have calmed down, the financial market will return to exert its traditional role: the place in which assets are traded and priced at their fundamental value, corresponding to the expected future stream of profits; a measure that – it is argued – correctly reflects the overall economic performance. Guided by forward-looking expectations, thus, investors rationally anticipated the flow of profits that will be made after the COVID-19 slump has given way to recovery.

Different from the conventional view, the behavioural approach would consider the disconnect between the asset price overshoot and the weak economic recovery as a sign of irrational exuberance in stock markets. Far from being the locus where rational, farsighted and well-informed agents operate, behavioural economists argue that financial markets are dominated by boundedly rational, myopic and uninformed individuals, who make decisions under conditions of radical uncertainty. As such, instead of predicting the correct yield a stock is able to guarantee over its entire life, investors seek to foresee and anticipate the market psychology, leading to waves of optimism and pessimism in response to positive or negative news. Ultimately, psychological factors help explain the presence of excess volatility in financial markets that may eventually result in large gaps between the stock price and its fundamental value.

Although I believe that both aforementioned views contain elements of truth, the view that I want to present here looks at things from a slightly different angle. But before we move on, I must go back to my personal experience. Curiously, I started thinking about the changing nature of the relationship between the real and the financial sectors well before the coronavirus pandemic hit the world economy – in fact, from the early days of my PhD research, approximately three years ago. Eager to come up with an original topic for this dissertation, I found myself reading articles on modern challenges in economics non-stop for weeks until I came across two different, apparently contrasting topics that caught my attention – both relatively at the margins of the economic literature: secular stagnation and financialization. Despite the fact that they gained in popularity following the Global Financial Crisis of 2007-8[1], these notions are used to define two long-term trends that characterize the evolution of advanced economies since the early 1990s – especially the US, but with important similarities between countries: on the one hand, the long-lasting decline in the growth rate of real output and productivity, and on the other, the increasing importance of the financial sector in the overall economy, in terms of profits, value added and market capitalization over GDP.

My question then became: how could these two apparently contradictory phenomena co-exist? To my surprise, in both mainstream and heterodox economic literature stagnation and financialization are typically regarded as two separate and independent phenomena, object of two distinct research areas.[2]

Driven by the belief that there's only one reality out there and, as a matter of fact, the economy as a whole is a closed system – that is, everything must come from (and end up) somewhere –, I became increasingly dissatisfied with this fragmentation of the scientific knowledge and began my inquiry, both empirically and theoretically, at the micro and macro level, into the nature of the nexus between finance and production in contemporary capitalism.

The present dissertation is the result of this effort. The goal is thus to investigate the root causes of what I call the 'stagnation-financialization paradox' (see Chapter 3), i.e. a situation in which the economy exhibits a tendency to stagnation in a context of a financial expansion.

[1]Even though regarding the notion of secular stagnation it would be more appropriate to speak of a resurgence of interest, given that it was originally introduced by the American economist Alvin Hansen in the 1930s.

[2]One notable exception was provided by Paul Sweezy and co-authors, who, building on the theory of monopoly capital (cfr. Baran and Sweezy, 1966), elaborated deep and original insights into the ongoing process of financial explosion in relation with the underlying tendency to stagnation already from the late 1980s (see Magdoff and Sweezy, 1987; Sweezy, 1994). To him and the following editor of the *Monthly Review*, John Bellamy Foster, I owe a great intellectual debt.

I must confess that, looking back, I am not entirely sure if I managed to satisfactorily accomplish that objective within the present project. In fact, although the second and third chapters of this manuscript may contain interesting insights on their own and marked fundamental and "inevitable" stages of my intellectual development, I believe that only Chapter 4 (*Concentration, Stagnation and Inequality*), written jointly with Roberta, overcomes the contradictions arising in the previous stages[3] and provides the theoretical framework allowing to solve the puzzle, but without explicitly addressing it. Indeed, ironically, that is the only article in which the financial sector plays a minor role. It is not a coincidence, though, but the direct consequence of the growing awareness that the underlying causes of the disconnect between the real and financial sectors I was looking for have to be firstly sought in the structural changes that the real economy has undergone over the past decades, which constitute the object of study of the fourth chapter, i.e. technical progress, rising market concentration and monopoly power and widening income inequality. Against this background, it is possible to better appraise the role of the transformations that occurred within the financial sector, e.g. the rise of institutional investors in the ownership structure, and the resulting changes in the relationship between the two spheres of the economy, which constitute the focus of Chapters 2 and 3. That being so, the chapters that compose this dissertation can also be read backwards.

We do now have all the ingredients to try and build a unified answer to the question 'how can stagnation and financialization, two apparently contradictory phenomena, co-exist?' In summary, the view that emerges from this manuscript is the following.

The emergence of a financial expansion on the basis of a real stagnation is a side effect of the process of rising concentration, whereby a fewer number of large firms ends up holding increasingly vast market shares. As is shown in Chapter 4, the tendency to concentration is driven by technical progress, that, in so far as heterogeneous firms

[3] This is the reason why the title in Chapter 3 'stagnation-financialization paradox' is followed by a question mark.

do not have equal access the capital-embodied innovations, generates 'technological discontinuities' (Sylos Labini, 1967), i.e. systematic differences in productivity across firms, leading to a reallocation of market shares towards more productive firms. Operating under conditions of oligopoly characterized by technological entry barriers, large firms seek to translate the enhanced market power into higher profit margins by increasing mark-ups. Consequently, as the share of those firms grows over the economy, the process of rising concentration produces a tendency of the profit share to rise and, specularly, of the wage share to fall, which eventually undermines consumption and aggregate demand. In a context of diminishing profitable investment outlets due to weak demand, faced with unused capacity, on the one hand, and excess cash resulting from economic rents, on the other, giant firms have incentives to distribute an increasing share of profits to shareholders, in the form of dividend payment and stock buybacks, to boost the stock price (Chapter 3). As a result, an asset price inflation can occur despite a slowing real economy: the financial expansion is thus fuelled by the mass of profits the increasingly concentrated industry is able to generate and distribute to shareholders and by the investors' expectations that this situation is likely to reproduce itself.

It should be emphasized that the view briefly outlined above attempts to summarize the mechanisms through which the tendencies to stagnation and financialization *could* endogenously and simultaneously emerge out of the normal functioning of an oligopoly economy. Yet, centripetal or centrifugal forces, triggered by socio-economic policies, may actually operate in a way to invert, contain or exacerbate those trends.[4]

In conclusion, going back to the initial discussion, it will now be easier to figure out why, according to the 'macro-structural' view that I propose here, the disconnect between financial markets and the real economy following the COVID-19-induced economic shock is neither to be seen as an abnormal but temporary effect that originates from unprecedentedly aggressive monetary policies nor the sign of an unfounded mar-

[4]See the scenario analysis carried out by means of computer simulations in Chapter 4.

ket optimism that lacks a real foundation. Those factors, i.e. unconventional policies and irrational exuberance, did certainly play a role, but this was to *amplify* the effects of the underlying tendency to stagnation and financialization, whose seeds had already been installed in the functioning of the contemporary oligopolistic and financialized economy, as lucidly anticipated by Sweezy (1994). This interpretation seems to be supported also by the fact that in the US (the country in which the real-financial disconnect is starker, according to Igan et al., 2020) the asset price overshoot has been essentially driven by the market revaluation of a handful of giant corporations (i.e., Alphabet, Amazon, Apple, Facebook and Microsoft – all tech firms), whose total market capitalization accounts for 22% of the S&P 500 index (Igan et al., 2020).

Overview of the thesis

As mentioned above, the goal of this dissertation is to investigate the root causes of the stagnation-financialization paradox, i.e., a situation in which the economy manifests a tendency to stagnation in a context of financial expansion. Throughout the PhD project, I have addressed this question from different perspectives, both micro and macro, by employing different research methods, from econometric analysis to agent-based models.

Chapter 2 investigates the extent to which the tendency to maximize shareholder value, fuelled by stock-based manager compensation, has led U.S. firms to divert resources from real investment to share repurchases to boost stock prices. Using micro-data from U.S. firms' balance sheets and manager compensation between 1992-2017, I estimate two dynamic panel data models: (i) to analyze the effects of share repurchases on investment decisions and (ii) to examine the interaction between stock-based CEO pay and the likelihood of share repurchases. I find that stock buybacks have a negative effect on capital investment with this effect being stronger among large firms operating in non-competitive markets. Moreover, an increase in stock options makes firms more likely to repurchase shares. These findings suggest that stock-based compensation creates incentives for managers to focus on increasing shareholder value by repurchasing shares at the cost of declining real investment.

Based on this evidence, Chapter 3 aims to investigate the conditions under which the tendency to maximize stock market value at micro level gives rise to a disconnect between financial markets and the real economy at the macro level. To do that, the chapter builds a macro-finance agent-based model with a stock market populated by heterogeneous investors, namely patient and speculative. The goal is to analyze how the increasing role of speculative investors in the ownership structure affects managers' planning horizons and R&D investment-buyback decisions and the resulting macroeconomic dynamics. Drawing on Keynes's (1936) view of financial markets and Minsky's (1992) notion of money manager capitalism, the idea is that when the stock market is dominated by a speculative sentiment, managers tend to internalize a short-term view and accommodate investors' demand for high equity returns, by diverting corporate resources from R&D towards share buybacks in order to boost the stock price. Simulation results show that the increasing orientation towards shareholder value leads to a lower and less volatile growth in the real sector, but a higher growth in the financial sector, giving rise to what we call a 'stagnation-financialization paradox'. Yet, in order for this to manifest, it is necessary that the fraction of speculators is not too large and, consequently, the payout ratio too high, otherwise the rate of economic growth is so low that the resulting fall in aggregate profits drags buybacks spending down, causing the financial market to fall.

Simulation results from Chapter 3 reveal that the divergence between real and financial sectors is not a general property of the system, but a particular outcome arising only under certain conditions. Turning to our modelling assumptions, this implies that the increasing tendency to maximize the stock market value at micro level cannot produce, by itself, a systematic disconnect between financial markets and the real economy at macro level. In fact, the resulting changes in macroeconomic conditions in terms of lower growth and lower profits due to the reduced innovative effort eventually constrain the individual firms' ability to artificially boost the stock price by means of share buybacks.

In this sense, the use of the agent-based modelling approach – which conceives the economy as a complex system whereby aggregate outcomes are the result of heterogeneous agents interacting in decentralized markets – allowed me to identify, by means of simulation experiments, the *macro-foundations* of the 'stagnation-financialization paradox', i.e., the conditions under which a real-financial disconnect can actually arise. Namely, when the economy experiences high profits despite low growth. This is so because, in tune with standard financial market model, asset price dynamics ultimately follows the evolution of aggregate profits, which, be contrast, might not to be aligned with the overall economic performance. This result, in turn, led me to investigate more deeply the role of the changes in market structure in relation with distribution and growth, which constitutes the object of study of the next chapter. In fact, as Baran and Sweezy (1966) and Sylos Labini (1967) pointed out long ago, it is under oligopolistic or monopolistic conditions that the economy can exhibit a tendency of the profit share to rise in a context of economic stagnation.

Chapter 4 aims to build a macro-evolutionary agent-based model with endogenous technical change to investigate how changes in market structure arising from technological progress affect income distribution and economic growth. We resume and revise Sylos Labini's (1967) theory of oligopoly and technical progress, according to which market concentration is the outcome of technical change that generates "technological discontinuities", i.e., systematic differences in productivity across firms, leading to a reallocation of market shares towards more productive firms. This is because heterogeneous firms do not have equal access to capital-embodied innovations, but we assume that this depends on the 'knowledge gap', i.e., the difference between the degree of technical advancement of a capital good and the firm's level of technical knowledge. In this way, the process of knowledge accumulation and capital acquisition constitutes the mechanism behind the endogenous formation of market concentration. Regarding the macroeconomic consequences, the model is able to show that, in the absence of countervailing forces, large firms seeking to exert the enhanced market power by increasing markups endogenously determine a shift in the income distribution from wages to profits which eventually undermines demand and growth. Thereby, the tendency to oligopoly at the micro level may give rise to a tendency to stagnation at the macro level, as previously pointed out by Sylos Labini (1967) and Steindl (1976). Furthermore, we find that, while in the short-run the first wave of concentration is determined by (knowledge-base) technical entry barriers, the duration of concentration in the long-run crucially depends on the presence (or lack thereof) of legal entry barriers, which affect the process of diffusion of innovations across firms and, consequently, the evolution of technological discontinuities over time.

In fact, by comparing two alternative scenarios corresponding to different patent system regulations, we find that when capital good firms are allowed to imitate their competitors' technologies, market competition is soon re-established. This is because the imitation activity carried out by K-firms brings about a convergence amongst different techniques in the medium-run, which, by reducing technological discontinuities across C-firms, allows laggards to catch up. Conversely, in the "no-imitation" scenario, the persistent heterogeneity between capital goods is then reflected in the increasingly heterogeneous productivity among firms in the consumption good sector. In such a scenario, because technological discontinuities grow over time, large firms are able to consolidate their dominant position and to extract a higher share of rents, with harmful effects on distribution, demand and growth also in the long run. Thus, our findings suggest that the pattern of economic growth is driven by the dynamic interrelationship between the evolution of technological regimes in the capital good sector and changes in market forms in the consumption good sector, with following non-trivial effects on changes in market power, income distribution and aggregate demand.

Finally, from additional policy experiments it emerges that weak labour unions and weak anti-trust policies, by exacerbating the vicious circle between demand, inequality and concentration, accentuate the stagnation tendency. Similar results are obtained from a restrictive fiscal policy that prevents a fully anti-cyclical management of the public budget, whereas innovation policies aimed at fostering knowledge spillovers across firms risk to be ineffective as long as the technical ability to process it remains unequally distributed in a concentrated industry.

The above-mentioned chapters can be read independently, each providing an individual introduction and conclusion. Finally, Chapter 5 provides short summaries in English, Dutch and Italian of the dissertation. All referenced works appear in a common bibliography at the end of the thesis.

Chapter 2

Are stock buybacks crowding out real investment? Empirical evidence from U.S. firms

2.1 Introduction

A spectre is haunting the U.S. economy - the spectre of stock buybacks.

In March 2014, Laurence Fink, BlackRock's CEO, warns in a letter to S&P 500 corporate executives that "in the wake of the financial crisis, many companies have shied away from investing in the future growth of their companies. Too many companies have cut capital expenditure and even increased debt to boost dividends and increase share buybacks."[5] Yet, by looking at the recent figures, it seems that U.S. corporate executives did not take Mr Fink's concerns too seriously.

In the course of 2018, indeed, S&P 500 companies spent an all-time high of $811 billion in share repurchases, nearly 50% up from 2017, over $200 billion more than the previous record set in 2007.[6] Some have linked the recent upsurge in stock buybacks

[5] The text of the letter by BlackRock's CEO, Laurence Fink, is available online: http://online.wsj.com/public/resources/documents

[6] https://www.goldmansachs.com/insights/pages/top-of-mind/buyback-realities/report.pdf

to the Tax Cuts and Jobs Act (TCJA), a fiscal reform passed by U.S. Congress in November 2017 that triggered massive tax savings on corporate earnings and repatriation of overseas profits; economic resources that, instead of financing new investment projects, were largely redirected to the stock market, potentially fuelling a new financial bubble.[7][8]

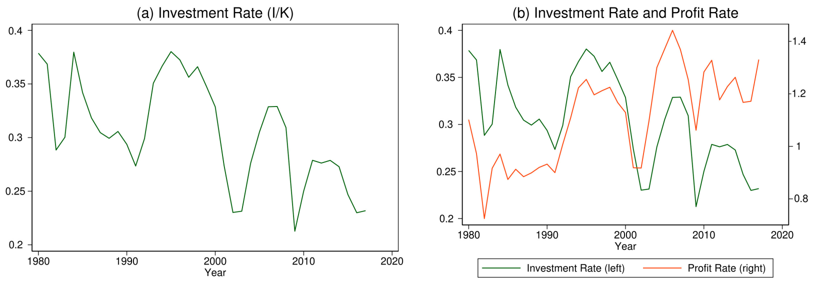


Figure 2.1: Source: Calculation based on Compustat database from WRDS.

Taking a longer-term view, it emerges that the investment rate of U.S. firms has been constantly slowing down over the past four decades, as shown in Figure 2.1; the annual growth rate of gross capital stock for 1695 S&P non-financial corporations was around 32% in the 1980s and declined steadily up to 26% in the 2010s. Yet, from the right panel, it can be seen that the decline in physical investment has occurred despite a high and increasing profit rate, with this gap getting wider after the dot-com crash of the early 2000s and, to a greater extent, after the Great Recession of 2008. This means that, in the last two decades, the U.S. business sector has been systematically under-investing with respect to profitability.

Furthermore, by looking at the evolution of the gross payout ratio in Figure 2.2, it can be seen that, while investment was faltering, U.S. firms have been distributing

[7]Bennett et al. (2019) decompose the effects of TCJA's tax cuts on corporate policies and find that the sharp increase in share buybacks was mainly driven by the cut in the repatriation tax, while tax savings from corporate income were primarily used to pay down debt and finance new capital expenditure.

[8]https://www.washingtonpost.com/business/economy/a-year-after-their-tax-cuts-how-have-corporations-spent-the-windfall/2018/12/14/e966d98e-fd73-11e8-ad40-cdfd0e0dd65a_story.html

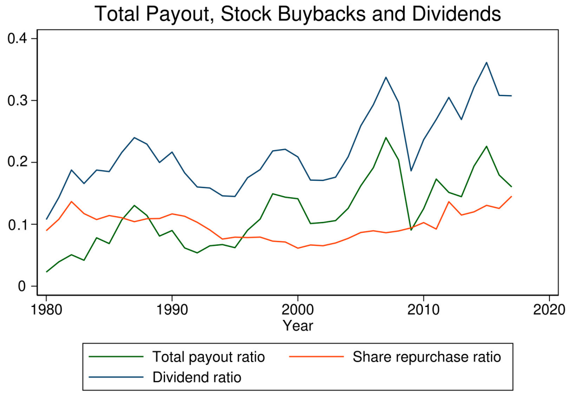


Figure 2.2: Source: Calculation based on Compustat database from WRDS.

an increasing share of profits to shareholders. The total payout almost doubled from 33% in 1995 to 60% in 2016. In this figure, it is also clearly shown that the rise in the payout ratio is primarily driven by the increase in stock buybacks, which, since the mid-90s, have increased, on average, by 20 percentage points – from 14% to 34% –, whereas dividend payment remains roughly constant around 20% of net earnings over the entire period.

Meanwhile, empirical research have documented that the average share-based component, consisting in stocks and stock options, of CEO in S&P 500 firms has significantly increased, going from 25% in 1992 to 60% in 2014 (Bhargava, 2013; Edmans et al., 2017), as shown in Figure 2.3.

This evidence raises a few questions: why should U.S. firms prefer to distribute profits to shareholders by repurchasing shares instead of investing in capital assets? Did the shift towards share-based executive compensation affect managers' incentives structure in favor of short-term market valuation? What is the role of expectations of financial investors on the future development of stock price in influencing firm's investment decisions?

The aim of this chapter is to empirically investigate whether the tendency to maxi-

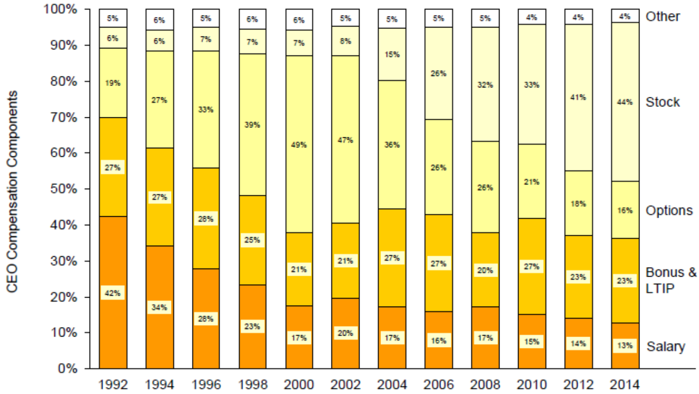


Figure 2.3: CEO compensation by different components in S&P 500 firms, 1992-2014. Source: From Edmans et al. (2017).

mize the stock market value, fueled by stock-based manager compensation, has led U.S. firms to divert resources from capital investment towards share repurchases in order to boost stock prices. Indeed, by simultaneously increasing the demand of shares and reducing the supply of total shares outstanding, stock buybacks are expected to have a positive effect on the share price.[9] With a substantial part of total compensation consisting in stocks and stock options, managers might have a personal interest in creating value for shareholders by repurchasing shares at the cost of declining investment and long-run growth.

Using micro-data from U.S. firms balance sheets and manager compensation, we estimate two panel data models: (i) an investment model to analyze the effects of stock buybacks on capital investment and (ii) a share repurchase model to examine the interaction between stock-based CEO pay and the likelihood of share repurchases. The investment model is estimated by using the Arellano-Bond GMM estimator, which allows to control for both unobserved heterogeneity and the endogeneity problem arising

[9]The actual impact of share buybacks on the stock price ultimately depends on the market reaction, and thus on financial investors' expectations, to a share repurchase announcement, whose effect is ambiguous in the literature (**?**).

from the dynamic setting; whereas for the share repurchase model we adopt a Random Effect-Tobit regression, since this approach is particularly suitable in case of censored dependent variables.

We find that share repurchases have a negative effect on capital investment, with this effect being stronger among large firms operating in non-competitive markets. Additionally, an increase in exercised and un-exercised exercisable stock options makes firms more likely to repurchase shares. Our findings, therefore, suggest that stock-based compensation creates incentives for managers to focus on shareholder value by repurchasing shares, with this coming at the cost of lower investment.

This evidence is meant to provide the empirical motivation for the macro agent-based model presented in Chapter 3, which aims to analyze, by means of computer simulations, under which conditions the tendency to maximize the stock market value at the micro level, by inducing firms to divert resources from real to financial investment, may give rise to a disconnect between financial market and the real economy at the aggregate level.

2.2 Literature review

This section presents the recent developments in the empirical literature on investment and share buybacks, starting from a discussion about the origins, the role and the limits of the principle of shareholder value maximization in corporate governance.

2.2.1 Preliminary debate

Since the emergence of the modern corporation at the dawn of the 20th century, many scholars have questioned whether the separation of ownership and control would give rise to a conflict of interests between shareholders and managers and more broadly entail a qualitative change in the decision making process within the firm.

According to Fama and Jensen (1983) and Jensen (1986), agency problems arise because those who manage the organization do not bear a major share of risk and wealth effects of their decisions; consequently, they are likely to take advantage of opportunistic behaviour that deviate from the interest of the ultimate risk-bearer, i.e. the owner. Therefore, to limit the managers' discretionary power over corporate resources and realign their interests with shareholders', the agency theory contends that publicly-listed corporations need to introduce 'mechanisms of control' that ensure the company is run according to the maximization of shareholder value. These mechanisms include: (i) the constitution of a board of directors appointed by shareholders, (ii) the adoption of share-based management remuneration (alias internal or organizational factors), and (iii) the development of efficient capital markets, or market of corporate control (alias external or market-based factors).

The economic rationale underlying the agency theory is the following: as long as the share price correctly reflects the discounted value of the expected future stream of cash flows, all internal decisions undertaken by the firm should be aimed at maximizing the market value of equity. Accordingly, shareholder value maximization is not only the primary goal of corporate governance, but also the ultimate measure through which each and every company's activity is to be assessed.

Despite its increasing popularity in economics and finance textbooks as well as among policy makers, the agency theory has become object of numerous criticisms over the years.

Scholars from behavioural corporate finance (cfr. Shefrin, 2001) point out that, in a context of 'irrational' markets, rational managers eager to maximize the stock market value may be led to undertake misguided decisions which eventually impair the future growth prospects of the firm. If the stock market is populated by speculative investors, in fact, the emphasis on the creation of shareholder value might induce managers to overlook long-term investment projects, in favour of short-term financial operations (Baker and Wurgler, 2004b, 2013).

This critique is embraced and further extended by Lazonick and O'sullivan (2000), who blame the agency theory for the disappointing economic performances of the U.S. corporate sector throughout the 1980s, a time in which the international competition from developing countries was tightening. The authors argue that the increasing orientation towards shareholder value, fostered by those institutional and organizational factors firmly advocated by agency theorists, have induced a shift in the management strategy from "retain-and-reinvest" to "downsize-and-distribute". While during the glorious thirty years following WWII corporations used to retain and reinvest most of their profits in the production process, the rise of 'shareholder value ideology' encouraged a quest for short-term profits through cuts in the labor force and a rapid distribution to shareholders by means of dividend payment and stock buybacks.

2.2.2 Empirical literature

Alternative hypotheses of low investment

The prolonged period of economic slowdown that is characterizing the development of the global economy in the aftermath of the Great Recession has reinvigorated the research interest in the driving forces of investment and growth. As we have seen in Figure 2.1 and 2.2, the investment rate for the U.S. corporations had been declining even before the financial crisis, while in the same period average profitability and market valuation were growing.

Against the background, Gutiérrez and Philippon (2016) distinguish between two different theories of low investment: "theories that predict low investment *because* they predict low Tobin's Q and theories that predict low investment *despite* high Tobin's Q". Given that over the last twenty years investment has systematically lagged behind Tobin's Q, the authors believe that the second group of theories requires a deeper investigation. Among them, the recent empirical literature has paid particular attention to the following hypotheses: weak aggregate demand, uncertainty, market concentration and financialization.

Bond et al. (2004) highlight that in case of persistent bubbles in stock market, the standard Q-ratio is affected by measurement errors which cast doubt on its explanatory power; in this case, cash flow variables may provide additional information to explain corporate investment. Yet, the interpretation of cash flow variables is not always straightforward, in that the latter can be seen as a measure of either financing constraints (Fazzari et al., 1987) or expected future profitability not captured by Tobin's Q (Bond et al., 2004). To disentangle the effects of cash flow between financing conditions and expected profits, the authors test the effects of professional earnings forecasts from IBES database. Based on a sample of 700 publicly traded UK companies, the results show that, once they control for analysts forecasts, cash flow variable becomes insignificant, meaning that, rather than financing constraints, such a variable reflects the expectations on future profits that are not captured by Tobin's Q. Yet, when alternative cash-flow measures, such as sales growth, are considered, the estimated coefficient turns out to be still positive and significant.

In the Keynesian literature, cash flow variables, like sales, are conceived as a proxy for capacity utilization and thus aggregate demand, which play a crucial role in the determination of the expectations of future profits and investment decisions. Early attempts in this field comprise the 'accelerator investment models' (e.g. Meyer and Kuh, 1957; Evans, 1967) as well as the studies on the Post-Keynesian theory of investment function (Fazzari and Mott, 1986; Bhaduri and Marglin, 1990). Lately, many empirical works have emphasized the role of weak demand and radical uncertainty in explaining the investment decline, especially in the aftermath of the Global Financial Crisis (e.g. Bond et al. (2015) on Italian manufactoring sector; Bussière et al. (2015) on a set of 22 advanced economies).

The aforementioned hypotheses emphasize the role of real factors in the decline of investment, such as weak demand, low expected profits, high uncertainty, etc. Little regard has been paid to financial factors, except for financing constraints which, as we have seen, have played only a limited role. However, it should be noted that the long-lasting decline in the investment rate has occurred in a context of global financial deepening. This unusual coexistence between economic stagnation and financial expansion led many scholars to question the relationship between the real and the financial sector of the economy, with a particular focus on the impact that the development of capital markets had had on ownership structure, corporate governance and investment decisions in non-financial corporations, both in developed and developing countries.

Gutiérrez and Philippon (2016, 2017) investigate the effects of market concentration and common ownership on investment and stock buybacks for U.S. companies. The idea is that firms operating in non-competitive markets do not face the threat of entry firms and thus have weak incentive to innovate and invest. Moreover, those firms whose shares are held by institutional investors, i.e., quasi-indexer institutional ownership, are more focused on short-term market capitalization rather than long-run growth; by reducing manager's planing horizon, common ownership puts pressure on managers to create value for shareholders by increasing payout ratios and financial investment at the cost of lower real investment. The authors claim that, despite the fact that they invest less, "these firms spend a disproportionate amount of free cash flows buying back their shares" (Gutiérrez and Philippon, 2017).

Stockhammer (2004) has had a pioneering role in the empirical investigation on the link between 'financialization' and investment. According to a widely-cited definition put forth by Epstein (2005), financialization is "the increasing role of financial motives, financial markets, financial actors and financial institutions in the operation of the domestic and international economies". In his paper, Stockhammer develops a microeconomic theory of the firm to explain how financialization, by shifting the balance of power towards shareholders, shifts management's priorities towards short-term profits at the cost of a lower desired growth rate. Building on this theoretical framework, he conducts an empirical analysis on the effects of financialization on capital accumulation in four advanced economies, viz. US, UK, Germany and France. The variable used as a proxy for financialization is 'rentier income', that is the ratio of interests and dividends gained from the financial sector over value added. The underlying hypothesis is that an increase in rentier income arising from financial opportunities would create an incentive for managers to invest in financial rather than productive activities, because the latter involves greater a risk and a longer gestation period. He finds that financialization has a negative impact on real investment in the Anglo-Saxon countries, while this effect is negligent in Germany and France.

Similarly to Stockhammer (2004), Van Treeck (2008) carries out an empirical and theoretical analysis to study how the increasing orientation towards shareholder value has influenced the accumulation of capital in several developed countries. Yet, differently from the previous author who focuses on rentier income, van Treeck investigates the role of financial payments, i.e. the sum of interest and dividend, in impeding real investment by reducing the availability of internal funds. He finds a significant negative effect of financialization on investment in U.S., while the effects are somehow mixed for U.K., Germany and France.

While both Stockhammer and Van Treeck's analyses are grounded on a time series framework using country-level data, Orhangazi (2008) assesses the financialization hypothesis through a panel data model using firm-level data from U.S. non-financial corporations. His objective is to jointly test the two channels through which financialization affects investment, i.e. the 'incentive' channel and the 'resource' channel, by employing two different financial variables: (i) *financial profits*, that is, the amount of income gained from financial operations, measured by the sum of interest income and equity in net earnings, and (ii) *financial payouts*, that is, the total payments to the financial sector, given by the sum of interest expense, cash dividends and stock buybacks. The regression results show that financial payments have a negative effect on investment, regardless the type of industry and firm size, whereas the impact of financial profits is negative for large firms but positive for small ones, suggesting that the latter may use proceeds from financial activities to finance real investment. More recently, the financialization hypothesis has received further support from Davis (2018) for the U.S. business sector and Tori and Onaran (2015, 2018b) for the UK and other European countries. Furthermore, Villani (2019) finds that financialization, by promoting a model of accumulation based on shareholder value that discourages long-term investment, has exacerbated the saving-investment imbalance among G7 countries, paving the way to the rise of corporate net lending.

In the aforementioned empirical works, the role of financialization on investment is captured by the stream of financial payments and/or financial profits which firms payout to or receive from the financial market. However, in Figure 2.2 we have seen that the rise in payout ratio of U.S. corporations is primarily driven by the increase in stock buybacks, which since the mid-90s have systematically overcome dividend payments, becoming the primary source to remunerate shareholders.[10] For this reason, we believe that an investigation on the role of stock buybacks and their effect on investment deserve more attention.

Stock buybacks: motives and consequences

The corporate finance literature provides valuable insights into the analysis of the underlying motives of stock buybacks and their effects on firm performance.

A variety of explanations for the rise in share buybacks has been put forward in the empirical literature. A non-exhaustive list includes the following contributions:

- *price support hypothesis*: companies undertake share buybacks in order to boost the stock price and generate abnormal returns, also in presence of overvalued equity (Liu and Swanson, 2016)[11],

[10] In Europe, the dividend payment remains the preferred method to remunerate shareholders, though, since the late 1990s, stock buybacks have dramatically increased also among European firms (Sakinc (2017).

[11] This view is also embraced by the famous American investor Warren Buffet, who in his 2000 Berkshire letter states: "repurchases are all the rage, but too often are made for an unstated and, in our view, ignoble reason: to pump or support the stock price".

- *free cash flow hypothesis*: share repurchases serve to distribute cash flow in excess of that required to fund profitable investment in order to avoid over-investment and mitigate agency problems (Jensen, 1986; Grullon and Michaely, 2004; Lee and Suh, 2011),
- *signaling* (or information content) *hypothesis*: by repurchasing shares, firms send signals about future profitability to investors when markets are incomplete (Massa et al., 2007),
- *catering hypothesis*: firms tend to “cater” to prevailing investor demand for cash payouts by increasing buybacks if they perceive a positive stock market premium, while they cut payouts when the premium is negative (Baker and Wurgler, 2004a,b; Jiang et al., 2013).

As regards the effects of stock buybacks on investment and firm performance, Bhargava (2013) studies the dynamic inter-relationship between CEO pay, share repurchases and investment from a sample of 700 U.S. firms. He finds that while stock-based remuneration schemes, such as exercised and granted options, have a positive impact on firms’ propensity to repurchase shares, stock buybacks are negatively related with real investment, such as R&D and capital assets.

Almeida et al. (2016) examine the impact of EPS forecast on the likelihood of share repurchases and the consequent effect on the real investment. The results show that the probability of repurchasing is higher for those firms that would just miss the EPS forecast in absence of a repurchase program, confirming the idea that buybacks are used as a strategic operation to meet financial targets. Moreover, similarly to Bhargava (2013), they find that EPS-motivated repurchases are detrimental to real investment in so far as share buybacks are largely financed with resources that could have been spent for real, productive investment, such as employment, R&D and capital expenditure.

By providing a comprehensive analysis of the role of financialization in the decline of real investment, the present chapter attempts to build a bridge between the empirical literature on investment and that on stock buybacks. Indeed, the goal is not only to investigate the effects of financialization on investment, but also to shed lights on the underlying mechanisms that may induce firms to be increasingly focused on shareholder value. To do this, we estimate two panel data models: (i) an investment model to study the effects of stock buybacks on capital investment, and (ii) a share repurchase model to explore the role of share-based manager compensation in influencing the likelihood of share buybacks.

2.3 Descriptive evidence

To explore the relationship between investment, share repurchases and stock-based compensation, we first inspect the descriptive statistics from our sample population, by comparing mean values of key variables by groups: (i) repurchasing versus non-repurchasing firms, and (ii) option-paying versus non-option-paying firms. Additionally, the t-test for equal means is performed to check whether such differences are statistically significant.

From Table 2.1 we notice that, on average, firms that repurchase shares (column 1) have a higher profit rate (+2%) but lower re-investment rate (-7%) with respect to firms that do not repurchase shares (column 2). Meaning that, although they earn more, they re-invest less. Furthermore, repurchasing firms tend to pay more dividend (+2%) and accumulate less cash holdings (-2%). Consequently, it is not surprising that repurchasing firms report better financial performance, as reflected by the higher market valuation and EPS, respectively +15% and +91% in percentage points. In summary, share repurchasing firms tend to retain and reinvest a lower share of profit than non-repurchasing firms, despite of their higher profitability and market valuation. Moreover, the higher dividend ratio and lower cash holdings seem to suggest that, consistent with the free cash-flow hypothesis, the richest firms tend to distribute cash

Table 2.1: Repurchasing vs Non-repurchasing firms, t-test. 1980-2017

	(1) Repurchasing m1	(2) Non-repurchasing m2	(3) Difference m2-m1
Re-investment rate	0.37	0.44	0.07***
Profit rate	0.17	0.15	-0.02***
Dividend rate	0.10	0.08	-0.02***
Cash/Assets	0.16	0.18	0.02***
Market-to-Book	2.91	2.53	-0.37***
EPS	1.72	0.90	-0.82***
Observations	15835	15264	31099

Note: *Re-investment rate*: capital expenditure (CAPEX) over gross operating surplus (OIBDP); *Profit rate*: gross operating surplus (OIBDP) over capital stock (PPENT); *Dividend rate*: dividend payment (DVDP) over total asset (AT); Cash/*Asset*: cash holding (CHE) over total asset (AT); *Market-to-Book ratio*: Market value of equity (CSHO*PRCC_F) over book value of equity(AT-LT); *EPS*: net operating surplus (OIADP) over common shares outstanding (CSHO). The group of (non-) repurchasing firms is made of firm-year observations with (zero) positive share repurchase (PRSTKC).

flow in excess to shareholders by repurchasing shares to avoid over-investment and mitigate agency problems.

Table 2.2 shows the difference in mean between option-paying vs non-option paying firms, with the corresponding significance level from the t-test. Similarly to repurchasing firms, stock option-paying firms on average have a higher operating surplus (+4%) but a lower re-investment rate (-8%) than their counterparts. Moreover, share repurchases are considerably higher (+12%) among firms paying stock options to CEOs, which also exhibit significantly higher values of market valuation (+51%) and EPS (+106%). Therefore, in line with our hypothesis, this evidence seems to corroborate the idea that firms paying stock options to managers are more likely to repurchase shares to support market valuation – a hypothesis that will be further explored in the regression model. Finally, the differences in average dividend and cash holdings are insignificant between the two groups. To sum up, we observe similar patterns in investment behavior and operating performance between repurchasing and option-paying firms, vis-à-vis their respective counterparts. Like their repurchasing peers, stock option-paying firms

Table 2.2: Options paying vs Non-option paying firms, t-test. 1980-2017

	(1) Option paying m1	(2) Non-option paying m2	(3) Difference m2-m1
Re-investment rate	0.34	0.43	0.08***
Profit rate	0.19	0.15	-0.04***
Share Repurchase ratio	0.21	0.09	-0.12***
Market-to-Book	3.58	2.36	-1.21***
EPS	2.06	1.00	-1.06***
Dividend rate	0.09	0.09	-0.00
Cash/Asset	0.17	0.17	0.00
Observations	9270	21829	31099

Note: *Re-investment rate*: capital expenditure (CAPEX) over gross operating surplus (OIBDP); *Profit rate*: gross operating surplus (OIBDP) over capital stock (PPENT); *Dividend rate*: dividend payment (DVDP) over total asset (AT); *Share repurchase ratio*: share repurchase (PRSTKC) over common shares outstanding (CSHO); *Cash/Asset*: cash holding (CHE) over total asset (AT); *Market-to-Book ratio*: Market value of equity (CSHO*PRCC_F) over book value of equity(AT-LT); *EPS*: net operating surplus (OIADP) over common shares outstanding (CSHO). The group of (non-) option-paying firms is made of firm-year observations with (zero) positive exercised (OPT_EXER_VAL) stock options.

retain and re-invest a lower share of profits than non-option paying firms, despite a relatively higher profitability and market valuation. There seems to be no substantial differences in dividend and cash holdings, whereas share repurchases are significantly higher among those firms that pay stock options to managers.

In Figure 2.4, average investment and share repurchase rate by size quintiles are compared, where size is defined by firm's total asset (in log). The figure shows that the investment rate is monotonically decreasing along firm size, whereas repurchase rate is monotonically increasing. Therefore, on average, small firms have a higher investment rate than large firms, 27% against 20% respectively, and tend to repurchase a lower amount of shares of less than 1% of operating surplus in contrast to 20% spent by firms in the largest cohort. One can interpret these figures by arguing that small firms invest more because of higher growth opportunities than large firms which, conversely, have reached a mature phase with declining growth prospects. The market structure in which those firms operate also matters. Indeed, large firms tend to be concentrated in less competitive markets, where the decline in competition creates an incentive to adopt collusive behavior to defend their market position at the cost of lower innovation and investment (Gutiérrez and Philippon, 2017).

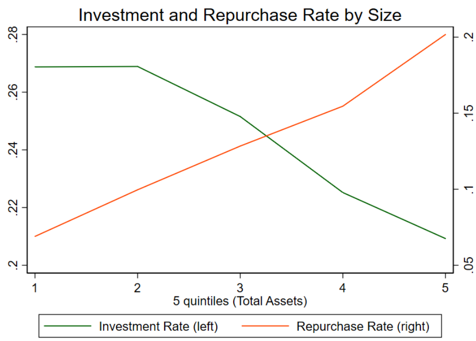


Figure 2.4: Source: Calculation based on Compustat from WRDS.

Table 2.3: Sample mean of selected variables by firm size, 1980-2017

Size	Investment	Repurchase	Profits	Cash	Leverage	MtB
1 Smallest	0.27	0.07	0.14	0.23	0.17	2.26
2	0.27	0.10	0.17	0.21	0.17	2.50
3	0.25	0.13	0.17	0.18	0.20	2.60
4	0.24	0.15	0.18	0.13	0.26	2.90
5 Largest	0.20	0.20	0.17	0.12	0.28	3.38
N	31026	31026	31026	31026	31026	31026

Note: All variables are scaled by total assets, except investment by capital stock.

From Table 2.3 we can also see that, on average, the largest firms not only invest less and repurchase more with respect to the smaller ones, but they also exhibit a higher profit rate, a higher leverage ratio, while they tend to keep a lower share of assets as cash holdings.

From this descriptive evidence it emerges that, although large firms have a greater capacity to raise funds both internally via profits and externally via borrowings than small firms, they retain and reinvest less, but report significantly higher payout ratio.

2.4 Data

To estimate the panel data models on investment and share repurchases, we use two different data sets from U.S. firms, namely S&P Compustat for annual balance data and ExecuComp for annual manager compensation data.

The data cleaning process is carried out in accordance with standard procedures in the literature. We start with a data set containing all firm-year observations for S&P Compustat U.S. firms between 1980-2017. Then we exclude financial (SIC codes 6000-6999) and utility (SIC codes 4000-4999) companies because they are subject to a specific regulatory framework. Moreover, we require the dependent variables (capital expenditure and share repurchase), as well as some main explanatory variables (market-to-book ratio, sales, cash dividend), to have non-missing and non-negative values. Firm-level data are known to be characterized by the presence of large outliers. To tackle this issue, we adopt a twofold strategy: first, all variables included in the regression model are winsorized, that is, observations falling into the upper or lower 1% of each variable's distribution are dropped; second, we exclude firms with permanently negative operating profits, which is a signal of unusual financial troubles. In addition, we require firms to have at least 4 years of life to exclude newly born firms whose economic performance might be impaired with respect to the average firm. After the cleaning process, the resulting data set consists of 31,099 firm-year observations across 1695 firms and 38 years, from 1980 to 2017.[12]

The ExecuComp database provides information about managers' personal characteristics and compensation by income type from 3671 firms since 1992. In order to

[12] As a robustness check, we re-estimate all the regression models presented in Section 2.5 by using before-cleaning raw data sets. The results, available upon request, do not report significant qualitative differences.

compare the two data sets, manager data are rearranged by firm: for each variable the yearly average of top five executives by firm is computed. This method permits to compare ExecuComp with Compustat annual data on firms by using firm's identifier (code 'gvkey') to match common firm-year observations. Following Bhargava (2013), the focus is restricted to the top five executives in that they are likely the most influential individuals in the corporate governance, those who undertake the relevant decisions concerning the business model and the investment strategy of the company. the top five executives are defined by ranking all the company's managers by income (salary plus bonus) and keeping those with the five highest scores. Given the extremely high variance in stock options across firms, the same data screening process used for Compustat data is applied. In this case, because the distribution of stock options is highly skewed towards the left, meaning that many firms do not use stock-based compensation at all, we drop observations only in the upper 1% of the distribution. Except for in-the-money stock option, whose observations falling into the bottom 1% are also cut, given the presence of highly negative values in the left-tail of the distribution. Finally, we exclude missing values for the main explanatory variables included in the regression model, that is exercised stock options, unexercised stock options and in-the-money vested options. The final data set consists of 3,671 firms across 26 years, for a total of 43,659 time-year observations.

Subsequently, the Compustat and ExecuComp data sets are merged using firm identifier and year. Of the total 61,627 firm-year observations, only 13,131 are matched after merging the two data sets, consisting in 1006 Compustat firms exhibiting non-missing values of stock-options for the period of 1992-2017. This is the data set used to estimate our regression models.

Some considerations about the size and the nature of the panel data might be useful. Firstly, it is possible that our panel data is not very representative of the entire population of U.S. firms but is likely to over-represent large firms.[13] Consequently, it

[13]This is due essentially to two reasons: (i) large firms can afford to pay stock options to corporate

is important to bear in mind that our conclusions apply especially to medium-large public corporations. Nevertheless, to prove that the empirical relationship between investment and share repurchases is robust to wider samples of firms, we estimate the investment model (in which stock options are not included) also using pre-merger Compustat firm data which starts from 1980, thereby including both options-paying and non-options-paying firms. Therefore, contrary to other works (Bhargava, 2013), we use an unbalanced panel data in order to avoid excessive sample biases arising from a balanced panel.

The table of summary statistics of the regression variables is available in Appendix A.

2.5 Regression analysis

This section discusses in details the regression strategy used to estimate the investment and share repurchase models, that is the variables definition for each model specification as well as the estimation methods and results.

2.5.1 Investment model

Definition of variables

Let us examine the variables employed in the regression model of the investment function.[14] The investment equation we are going to estimate is

$$(I/K)_{it} = \beta_0 + \beta_1 (I/K)_{it-1} + \beta_2 (REP/TS)_{it-1} + \beta_3 (X)_{it-1} + \eta_t + \mu_i + \epsilon_{it}. \qquad (2.1)$$

managers more than what small firms can do; (ii) private non-listed companies are a priori excluded from Compustat data set.

[14] Compustat variable's label is reported in brackets.

Given that the investment process is an intrinsically dynamic phenomenon, we adopt a dynamic panel data model. Indeed, in so far as firms make investment decisions based on expectations of future returns, which, in turn, are affected by past performances, we expect capital stock to slowly adjust to changing economic conditions. The inclusion of the lagged dependent variable on the right-hand side captures the dynamics of the changes in capital to its desired level, while the first lag of the explanatory variables reflects the role of past performance on the current investment decision.

The dependent variable is the investment rate, given by the ratio of gross capital expenditure (CAPEX) over beginning-of-the-year capital stock (L.PPENT); this is a measure of the annual growth rate of capital stock, before depreciation. The main explanatory variable consists in the share repurchase ratio, that is the gross repurchase (PRSTKC) over the lagged total common shares outstanding (CSHO). We also employ an alternative, more formally correct, measure of share repurchase according to the simulation experiment by Banyi et al. (2008), that is gross share repurchase (PRSTKC) minus preferred stock (PRSK) over lagged total book assets (AT). In line with the empirical literature on investment, we include a set of independent variables ($X_{i,t-1}$) from firms balance sheets, which are presented below, as well as time year dummies to control for macroeconomic shocks.

Among the set of independent variables, first the following cash flow variables are considered: sales (SALES), as a proxy for capacity utilization to capture the demand effects (Fazzari and Mott, 1986) and operating surplus (OIBDP = "operating income before depreciation"), which might both explain financing constraints (Fazzari et al., 1987) or expected future profitability (Bond et al., 2004); both variables are scaled by lagged capital stock (L.PPENT). As an alternative measure of operating performance, ROA is also considered, that is net income (OIADP-XINT-TXT = operating surplus before depreciation minus taxes and interest expenses) over lagged book asset.

Second, to analyze the effects of financing constraints on investment which are not captured by cash flow variables we include the leverage ratio, that is the ratio of total debt (the sum of short (DLC) plus long (DLTT) term debt) scaled by lagged book asset. Other financial measures, such as the market leverage ratio, i.e. total debt over the sum of debt plus market value of equity, and interest expense, i.e. interest and related expense (XINT) over lagged book asset, are also taken into account in additional model specifications.

Moreover, Tobin's Q and the Market-to-Book ratio are used as a proxy for a company's market valuation. Following Gutiérrez and Philippon (2016), Tobin's Q is defined as the market value of equity plus book value of total asset (AT) minus book value of equity divided by book value of total assets, where the market value of equity is given by common shares outstanding (CSHO) times the closing stock price at the end of the year (PRCC_F), while its book value is total assets (AT) minus total liabilities (LT). The Market-to-Book ratio is simply computed as market value of equity over book value of equity as defined before.

Since we are mostly interested in the relationship between share repurchase and investment, the variables just described are treated as control variables, pointing to firm characteristics and operating performance that in some way necessarily affect firm's investment decisions and, as such, must be included in every model specification; leaving them out would cause a problem of endogeneity due to omitted variables.

Yet, there might be alternative explanations of the recent slump in investment which are not captured by our regressors. To test the economic relevance of these hypotheses and to check whether the effects of share repurchase remain significant, we estimate alternative model specifications including additional explanatory variables. For instance, it is argued that the recent slowdown of physical investment can be explained by the rise of intangible assets brought about by technological change and the ICT revolution (Döttling et al., 2018). We test the intangible hypothesis by employing two different variables: investment in intangible assets, that is the ratio of intangible asset (INTA) over lagged total assets and investment in R&D (XRD), defined as R&D expenditure over lagged total assets.

Furthermore, we examine the effects of rising market concentration on investment: a decline in competition might put lower pressure on firms to invest, in so far as the enhanced market power would allow them to maximize profit by rising prices instead of adjusting the productive capacity. To this end, we compute the commonly-used Herfindahl-Hirschman (HH) index, which captures the firm's market share, in terms of sales or market value, with respect to its industry. More specifically, the sales HH index is given by the sum of the squares of firm's sales over total industry sales, where the industry is defined by taking the first two digits of the SIC code (Standard Industrial Classification).

Methodology and results

Our econometric strategy is the following: first we estimate the investment model to analyze the effects of share repurchases on capital investment and, second, we estimate the share repurchase model to examine the interaction between share repurchases and stock options. The rationale is that in the first place we want to prove that the increase in share repurchases, by taking away resources that could be invested in capital assets, have had an adverse effect on real investment; secondly, we want to investigate the determinant factors behind the firm's decision to repurchase, focusing on the role played by stock-based manager compensation. If this second relationship is also verified, we will be led to conclude that the tendency to maximize the stock market value fostered by share-based remuneration schemes encourages managers to increase share buybacks at the cost of declining long-term real investment.

First, we estimate the investment equation in (2.1) through an Ordinary Least Square (OLS) and a Fixed-effects (FE) models. Both estimation techniques are inconsistent in case of dynamic models: in the OLS the lagged dependent variable is positively correlated with the fixed effects in the error term, leading to upward biased estimate; by applying the mean-deviation transformation, the FE estimator removes time-invariant individual effects, but it does not eliminate the "dynamic panel bias" (Nickell, 1981) stemming from the negative correlation between the transformed lagged dependent variable and the transformed error term (Roodman, 2009), leading to downward bias estimate. Yet, as Bond (2002) points out, the fact that the estimated coefficients are biased in two opposite directions constitutes a useful check because it determines the range within which a consistent estimate should lie.

To overcome the endogeneity problem, the first-differenced Arellano-Bond GMM estimator is used. This technique has at least three advantages that make it a suitable estimation methods for our investment model. First, the first-differenced GMM estimator allows to eliminate individual effects by taking the first difference from the model equation. Second, the source of endogeneity is removed by instrumenting the lagged dependent variable with its own lags. The latter, indeed, are uncorrelated with the error term but correlated with the variable itself. Moreover, this method is particularly suitable when the model contains non-strictly exogenous explanatory variables. This is very likely to be the case in our investment model where it is reasonable to assume that firm's cash flow, operating performance and other financial measures are endogenous to investment decisions. Hence, potentially endogenous independent variables are treated in the same way as the lagged dependent variables: their lags will be available as instrumental variables and thus enter the set of instruments.

One problem associated with the first-differenced GMM estimator is that it amplifies the number of missing values which, in the case of unbalanced panel data with gaps, could lead to a non-negligible loss of information and efficiency. This motivates the adoption of a GMM with "forward orthogonal deviation" (FOD) transformation as an alternative estimation technique, which, rather than subtracting the previous observation from the current value – as in the first-differenced case –, it substracts the average of all the future available observations of the variable. Consequently, only the last observation of the sample will be lost.

Table 2.4 shows the regression coefficients of the investment model. The first thing

Table 2.4: Investment Model, 1992-2017

	(1) OLS	(2) FE	(3) diff-GMM	(4) fod-GMM
L.Investment/Capital Stock	0.447***	0.203***	0.216***	0.407***
	(0.0164)	(0.0213)	(0.0666)	(0.0471)
L.Sales/Capital Stock	0.00112***	0.00320***	0.00164	0.000619
	(0.000253)	(0.000666)	(0.00234)	(0.00102)
L.Opeating Surplus/Capital Stock	0.0189***	0.0230***	0.0272**	0.0119*
	(0.00265)	(0.00434)	(0.0109)	(0.00719)
L.Leverage/Assets	-0.124***	-0.141***	-0.523***	-0.260***
	(0.0118)	(0.0205)	(0.124)	(0.0489)
L.Market-to-Book ratio	0.00593***	0.00815***	0.00271	0.00706***
	(0.000672)	(0.000902)	(0.00293)	(0.00145)
L.Share Repurchase ratio	-0.00465***	-0.00150	-0.0138**	-0.0108***
	(0.00108)	(0.00131)	(0.00586)	(0.00339)
Observations	10842	10842	9147	10842
Number of firms		990	960	990
R^2	0.475	0.276		
Time effects	yes	yes	yes	yes
p-value Hansen test			0.583	0.198
p-value A-B test (AR2)			0.124	0.275

Standard errors in parentheses: * < 0.1, ** < 0.05, *** < 0.01.

to notice is that the lagged dependent variable coefficients from the two consistent GMM models, columns 3 and 4, fall within the range defined by the estimates of the OLS and FE models, meaning that these models are not only consistent but also well specified. Secondly, in line with our expectations, the share repurchase variable reports a negative sign, which is significant in three out of the four models, and, most importantly, in both consistent models. This means that a higher share repurchase results in a lower capital investment in the following period.[15]

Now let us focus on the third column reporting the results from the first-differenced GMM model. In this specification, the second lag of the dependent variables and the first lag of the independent variables are included in the instrument set and then collapsed, to limit the number of instruments, which amounts to 163. Thereby, the

[15]Importantly, the Hansen test of over-identifying restrictions does not reject the validity of the instruments used in the model. Additionally, the Arellano and Bond (1991) test rejects the presence of second-order autocorrelation in the first-differenced model equation.

lagged dependent variable is considered as endogenous while the explanatory variables as predetermined. The estimation results shows that operating surplus is positively correlated with investment rate, while leverage and share repurchases are negatively correlated; sales and Market-to-Book ratio, instead, are not statistically significant. As previously argued and reported in the table, the first-differenced GMM model suffers from a low number of observations due to the fact that gaps in unbalanced panel data are magnified after taking a first-difference. This effect can be avoided by implementing a forward orthogonal deviation transformation, whose regression coefficients are shown in column 4. In this specification, all variables are treated as endogenous, with the second and third lags entering the instrument set. It can be seen that not only the sign of the *share repurchase*, *leverage*, *operating surplus* are unchanged, but, in this specification, also the *market-to-book ratio* turns out to be positive and significant, while *sales*, quite surprisingly, remains insignificant.

At this point, as a robustness check, we estimate additional panel data models based on different time periods and by different firm size. The first two columns of Table 2.5 shows the regression results from the investment model for, respectively, the decade before and after the financial crisis of 2007-8. These models are estimated using the FOD-GMM estimator, which proved to be more efficient amongst the consistent estimators in case of unbalanced panel data with gaps.

By looking at the results in Table 2.5, it emerges that the estimated coefficients of share repurchases are negative and statistically significant both the decade before and after the 2007-8 sub-prime mortgage crisis. Interestingly, we also notice that the degree of significance of *operating surplus* and *sales* variables varies across time periods: in the pre-crisis period operating surplus plays a significant role in driving investment while sales becomes relevant in the aftermath of the Great Recession. Indeed, in these periods, the fall in aggregate demand, captured by sales variables, drives drown investment, whereas profits recovers faster and becomes uncorrelated to investment. This evidence confirms the hypothesis that, especially after the financial crisis, weak aggregate demand is a key factor in explaining low investment (Bond et al., 2015; Bussière et al., 2015). Moreover, these results provide support to the notion of missing link between profit-investment (Stockhammer, 2005; Van Treeck, 2008), which could also be observed in Figure 2.2.

The columns 3 and 4 in Table 2.5 show the estimates of investment model for large (3) and small (4) firms, which are defined, respectively, by the top and the bottom quantile of the total assets distribution. Unsurprisingly, the estimated coefficient of share repurchases is a highly significant for large firms while it is insignificant for small firms, meaning that stock buybacks are more detrimental to investment among large firms, while they have no significant effects among the small one. This result could have been partially deduced from Table 2.3 showing that large firms, on average, have spent 20% of their operating surplus between 1980-2017, contrary to the 0.7% of the smallest firms. In addition, we can see that the determinant factors for investment decisions vary substantially across firm size: among large firms, *operating surplus* and *leverage* are significant predictors of investment, whereas among small firms investment are more dependent on *sales* and *market-to-book ratio*. The interpretation might be the following: small firms rely more on domestic demand than large firms, which, on average, have better access to external markets and whose investment are more sensitive to variation in profits and financing conditions, rather than internal sales.

We now estimate two additional model specifications to control for plausible alternative explanations for low investment: intangible assets and market concentration. The aim is to check whether the inclusion of these variable sensibly affects the size or significance of the estimated coefficient of our explanatory variable, in which case previous results would be biased due to omitted variables.

The results shown in column 1 of Table 2.6 show that intangible assets have a negative but not significant effect on capital investment, while the coefficient of share repurchases remain negative and statistically significant. Similar results are obtained

Table 2.5: Robustness check of investment model by time and firm size

	(1) pre-crisis ('98-'08)	(2) post-crisis (08-'17)	(3) Large firms	(4) Small firms
L.Investment/Capital Stock	0.368***	0.249***	0.395***	0.242***
	(0.0599)	(0.0578)	(0.0561)	(0.0831)
L.Sales/Capital Stock	0.001	0.003**	-0.001	0.004***
	(0.00109)	(0.00128)	(0.00150)	(0.00100)
L.Operating Surplus/Capital Stock	0.016**	0.014	0.022**	-0.001
	(0.00845)	(0.00903)	(0.0106)	(0.0112)
L.Leverage/Assets	-0.207***	-0.156**	-0.171*	-0.183*
	(0.0575)	(0.0634)	(0.100)	(0.0949)
L.Market-to-Book	0.007***	0.006***	0.002	0.008
	(0.00187)	(0.00205)	(0.00194)	(0.00517)
L.Share Repurchase/Total Shares	-0.010**	-0.007*	-0.016***	-0.001
	(0.00442)	(0.00323)	(0.00589)	(0.0141)

Clustered standard errors in parentheses: * < 0.1, ** < 0.05, *** < 0.01.

if, instead of intangibles, R&D expenditure is included. Therefore, the rise of intangible assets does not seem to provide additional information on the decline of physical investment among our sample of firms.

As discussed above, another popular explanation of the recent slump in investment in U.S. economy points to the adverse effect of the increased market concentration on firms' propensity to invest (Gutiérrez and Philippon, 2016, 2017).

The results in column 2 of Table 2.6, indeed, show that the Herfindahl-Hirschman index has a negative and statistically significant impact on investment. We now want to understand whether market concentration and share buybacks jointly affect investment. Indeed, it is possible that firms operating in more concentrated industry tends to accumulate extra surplus from rent activities and, consequently, will be more oriented to distribute cash to shareholders by means of share repurchases. This is in tune with Jensen's (1986) "free cash flow hypothesis", according to which agency costs are higher in presence of non-competitive markets in that oligopolistic firms gain substantial economic rents or quasi-rents which should be distributed to shareholders to avoid over-investment problems. In these cases, Jensen argues, "monitoring by the firm's

Table 2.6: Investment Model - 1992-2017 + intangibles & concentration

	(1) diff-GMM	(2) diff-GMM	(3) diff-GMM
L.Investment/Capital Stock	0.229***	0.246***	0.247***
	(0.0748)	(0.0569)	(0.0546)
L.Sales/Capital Stock	-0.000483	0.000793	0.000643
	(0.00266)	(0.00222)	(0.00221)
L.Opeating Surplus/Capital Stock	0.0354**	0.0337***	0.0355***
	(0.0146)	(0.0102)	(0.0101)
L.Leverage/Assets	-0.532***	-0.294***	-0.352***
	(0.183)	(0.0703)	(0.0869)
L.Market-to-Book	0.00336	0.00734***	0.00582**
	(0.00391)	(0.00194)	(0.00234)
L.Intangible assets/Total assets	-0.141		
	(0.167)		
L.Share Repurchase/Total Shares	-0.0196**		
	(0.00920)		
L.Concentration (HHI)		-0.533***	
		(0.194)	
Conc_0×Repurchase			-0.00880**
			(0.00448)
Conc_1× Repurchase			-0.201*
			(0.121)
Observations	8335	9179	9147
Number of firms	953	961	960
R^2			
Time effects	yes	yes	yes
p-value Hansen test	0.659	0.131	0.512
p-value A-B test (AR2)	0.0109	0.975	0.919

Clustered standard errors in parentheses: * < 0.1, ** < 0.05, *** < 0.01.

internal control system and the market for corporate control are more important". To compute the cross-effect of buybacks and concentration, we take the cross product of the two variables, with the latter being transformed into a dummy that takes value one if the firm falls in the top quantile of the Herfindahl-Hirschman distribution and zero otherwise. The results displayed in column 3 show that the coefficient of share repurchases is negative and significant regardless of market structure. Yet, the size of the coefficient is significantly higher in case of highly concentrated markets (when the concentration dummy is equal to one). This evidence provides support to the idea that the negative relationship between share repurchases and capital investment is stronger among firms operating in less-competitive markets.

2.5.2 Share repurchase model

Definition of variables

To analyze whether stock-based remuneration schemes make managers of U.S. firms more likely to buyback stocks, we estimate the share repurchase model given by

$$(REP/TS)_{it} = \beta_0 + \beta_1 (OPT/TS)_{it} + \beta_2 X_{it} + \eta_t + \mu_i + \epsilon_{it}. \tag{2.2}$$

The dependent variable is the share repurchase ratio (REP/TS), which is the explanatory variable used in the investment model, while as a main regressor (OPT/TS) we employ three different measures of stock options, all scaled by beginning-of-the-year common shares outstanding: exercised option (OPT_EXER_VAL), that is the value realized on option exercise; unexercised option (OPT_UNEX_EXER_EST_VAL), that is the value of unexercised exercisable options; in-the-money vested option (OPT_UNEX-_EXER_EST_VAL), that is the estimated value of in-the-money unexercised exercisable options. The latter stands for the estimated gains a manager would earn if she exercised her option. The last two variables, i.e. unexercised options and in-the-money vested option, are of particular interest for our purpose. In the literature (Chen and Wang, 2012), indeed, they are typically regarded as a proxy for “manager hubris”, that is, the manager’s degree of over-confidence about future equity returns. In particular, it is argued that, in so far as over-confident managers expect stock returns to increase in the future, they will delay the exercise of stock options and meanwhile repurchase shares to boost the stock price and gain even higher returns in the next periods. Similarly to the investment model, a set of independent variables reflecting firm characteristics is included, as well as time year and industry dummies.

Methodology and results

We estimate the share repurchase model in Equation (2.2) by using two different techniques: a Random Effects (RE) model and a Tobit regression model. The RE model delivers more efficient estimates than FE model if individual effects are uncorrelated with the regressors. It is quite reasonable to assume that this is the case if we consider that repurchasing and option-paying firms constitute a relatively homogeneous subset of the total population of Compustat firms. Moreover, it is important to bear in mind that the repurchase variable exhibits a significant number of zero observations, meaning that many firms do not buyback stocks at all. In this case, it would be inappropriate to restrict attention to positive observations only by using a linear model (Verbeek, 2008). The discontinuity in the distribution of the y-variable can be captured by employing a censored dependent variable model, such as the Tobit regression model. Indeed, the Tobit model describes, on the one hand, the probability of the dependent variable to be non-zero and, on the other, the expected value of the dependent variable given that it is positive. In addition to that, we also estimate a third model combining both approaches described above in an unique regression equation, that is a Random Effect-Tobit model.

Table 2.7 reports the regression results for the share repurchase model. From the first three rows we can immediately see that *exercised* and *unexercised options* are always significant and positively associated with share buybacks, while *in-the-money options* is insignificant in the RE model, but turns significant in the Tobit model. Thereby, our hypothesis seems confirmed: stock-based compensation has a positive impact on the probability of repurchase. By looking at the coefficients of other independent variables, we notice that *Market-to-Book ratio*, *EPS* and *ROA* enter with positive sign and are always statistically significant. Hence, there is a positive relationship between the probability of repurchase and the firm's profitability and market

Table 2.7: Share Repurchase Model, 1992-2017

	(1) RE	(2) RE	(3) RE	(4) Tobit	(5) Tobit	(6) Tobit
Exercised Options	0.00182**			0.00410***		
	(0.000840)			(0.00135)		
Unexercised Options		0.0137**			0.0392***	
		(0.00574)			(0.00944)	
In-the-money Options			0.000255			0.00136*
			(0.000440)			(0.000697)
Market-to-Book	0.0960***	0.100***	0.0982***	0.120***	0.129***	0.120***
	(0.0123)	(0.0122)	(0.0128)	(0.0174)	(0.0172)	(0.0179)
EPS	0.196***	0.198***	0.197***	0.268***	0.278***	0.271***
	(0.0150)	(0.0151)	(0.0153)	(0.0281)	(0.0283)	(0.0286)
ROA	0.680*	0.746**	0.732**	3.549***	3.723***	3.659***
	(0.359)	(0.360)	(0.359)	(0.755)	(0.764)	(0.762)
Cash/Assets	-0.711***	-0.692***	-0.687***	-0.908***	-0.904***	-0.875***
	(0.129)	(0.125)	(0.127)	(0.202)	(0.197)	(0.200)
Dividend/Assets	-1.661	-1.689	-1.791	-3.894**	-3.933**	-3.980**
	(1.166)	(1.172)	(1.170)	(1.738)	(1.749)	(1.771)
Leverage/Assets	-0.209*	-0.229*	-0.207*	-0.503**	-0.554**	-0.498**
	(0.124)	(0.124)	(0.124)	(0.215)	(0.216)	(0.215)
Size	0.151***	0.158***	0.149***	0.217***	0.233***	0.214***
	(0.0175)	(0.0186)	(0.0177)	(0.0249)	(0.0262)	(0.0250)
var(e.rep_ts)				2.817***	2.816***	2.823***
				(0.130)	(0.130)	(0.130)
Observations	10235	10235	10235	10235	10235	10235
Number of firms	971	971	971			
R^2 overeall	0.293	0.292	0.291			
Time effects	yes	yes	yes	yes	yes	yes
Log-Likelihood				-15606.3	-15598.0	-15613.8
pseudo-R^2				0.0988	0.0993	0.0984

Standard errors in parentheses: * < 0.1, ** < 0.05, *** < 0.01.

valuation. This provides evidence to the hypotheses that stock buybacks are undertaken to support the share price (Liu and Swanson, 2016) and to meet EPS forecasts (Almeida et al., 2016). Moreover, all model specifications report a negative and statistically significant relationship between stock buybacks and *Cash/Asset*, indicating that a decrease in cash liquidity is associated with a higher propensity to repurchase, in tune with the free cash-flow hypothesis. Finally, firm size matters and is positively

Table 2.8: Share Repurchase Model, 1992-2017

	(1) RE-Tobit	(2) RE-Tobit	(3) RE-Tobit
Exercised Options	0.00160**		
	(0.000752)		
Unexercised Options		0.0138**	
		(0.00675)	
In-the-money Options			0.000412
			(0.000397)
Market-to-Book	0.0728***	0.0765***	0.0763***
	(0.0108)	(0.0107)	(0.0110)
EPS	0.234***	0.237***	0.237***
	(0.0103)	(0.0102)	(0.0104)
ROA	2.907***	2.978***	2.968***
	(0.431)	(0.431)	(0.431)
Cash/Assets	-1.196***	-1.173***	-1.167***
	(0.150)	(0.150)	(0.150)
Dividend/Assets	-0.616	-0.639	-0.816
	(1.089)	(1.088)	(1.097)
Leverage/Assets	-0.587***	-0.609***	-0.585***
	(0.140)	(0.140)	(0.140)
Size	0.302***	0.309***	0.300***
	(0.0228)	(0.0233)	(0.0229)
Observations	10235	10235	10235
Number of firms	971	971	971
R^2 overeall			
Time effects	yes	yes	yes
Log-Likelihood	-14766.7	-14766.9	-14768.9
pseudo-R^2			
Rho	0.303	0.303	0.305

Standard errors in parentheses: * < 0.1, ** < 0.05, *** < 0.01.

correlated with the probability of repurchase, as also shown in Table 2.3.

Table 2.8 reports the regression results for the share repurchase model using a Random Effect-Tobit model. This method combines the two approaches described before in an unique estimator which allows to control for both censored dependent variable and unobserved heterogeneity at the same time, provided that individual effects are randomly distributed. The results are largely similar to those observed in Table 2.7, with *exercised* and *unexercised options* being positively and significantly associated with the probability of repurchase, while *in-the-money options* insignificant, as well as *dividend payment.*

In summary, we find empirical evidence that stock-based management compensation is an important motive for share repurchases. Of the alternative measures of stock options adopted in the analysis, exercised and unexercised exercisable options are highly significant in every regression models, while in-the-money options have a lower explicative power once controlled for unobserved heterogeneity. Moreover, we find that share repurchases are positively and significantly associated with Market-to-Book ratio, EPS and ROA. Consistent with price support (Liu and Swanson, 2016) and signalling hypotheses (Massa et al., 2007; Chen and Wang, 2012), these findings reveal that firms with higher market valuation and better financial performance are more likely to repurchase shares.

2.6 Concluding remarks and discussion

In this chapter we explore the motives behind shareholder value maximization and its effect on firm's investment decisions. We argue that, in a context of weak aggregate demand, the tendency to maximize shareholder value, fuelled by stock-based manager compensation, has encouraged firms to divert resources from real investment towards stock buybacks to boost stock prices. This is due to the fact that stock buybacks, by simultaneously increasing the demand of shares and reducing the supply of total shares outstanding, are expected to increase stock prices. With a substantial part of total compensation consisting in stocks and stock options, managers have a personal interest in creating value for shareholders by repurchasing shares with resources that could be invested in productive activities, such as capital expenditure, R&D and employment.

More specifically, using micro-data from U.S. firms balance sheets and manager compensation, in this chapter we estimate two dynamic panel data models: (i) to analyze the effects of share repurchases on capital investment; (ii) to examine the interaction between stock-based CEO pay and the likelihood of repurchases. We find that stock buybacks have a negative effect on capital investment, both before and after the financial crisis, especially among large firms operating in highly concentrated industry. Moreover, the probability to repurchase shares is positively associated with stock options, specially exercised and un-exercised but exercisable ones, confirming that share-based compensation can influence managers' planning horizon and incentive structure, by making them more focused on short-term capital gains for shareholders instead of long-run growth of the company.

This hypothesis is also supported by the positive relation between firm's market valuation and share buybacks, suggesting that firms with a higher stock price are indeed more likely to repurchase shares.

From an empirical perspective, further research is needed to investigate the engines of the 'financialization' of non-financial corporations, here defined as the increasing tendency to maximize stock market value. In particular, this chapter sheds light on the role of organizational factors (e.g. share-based remuneration) in influencing managers' incentive structure and investment decisions. However, a more complete picture of the phenomenon at stake would require an investigation of the role played by institutional factors, such as the increasing influence of speculative investors in the ownership structure, as previously studied by Gutiérrez and Philippon (2016, 2017).

From a theoretical standpoint, our findings suggest that the tendency to maximize shareholder value may have ambiguous effects on the firm's performance and, consequently, on the overall economy: on the one hand, it may induce managers to distribute an increasing share of profits to shareholders, leading to stock prices revaluations and rising asset holders' wealth; on the other, by discouraging long-term investment projects, it may impair firms future competitiveness and growth prospects.

Based on this evidence and drawing on Dawid et al. (2019), in the next chapter we develop a macroeconomic agent-based model to investigate, by means of computer simulations, under which conditions the tendency to maximize the stock market value at the micro level may give rise to a disconnect between financial market and the real economy at the aggregate level, a situation that we call the 'stagnation-financialization paradox'.

Table 2.9: Summary Statistics, U.S. non-financial corporations, 1992-2017

Variable		Mean	Std. Dev.	Min	Max	Observations
Investment/l.Capital	overall	.2755226	.2202772	0	1.405282	N=13131
	between		.1627881	.0347161	1.199221	n=1008
	within		1698172	-.4183661	1.49936	T-bar=13.0268
Sales/l.Capital	overall	10.89269	16.75242	.2695035	101.4943	N = 13131
	between		16.70522	.2725111	101.4943	n = 1008
	within		6.758624	-59.17667	96.09325	T-bar = 13.0268
Operating Surplus/l.Capital	overall	1.254541	1.694654	-2.691603	9.571048	N = 13131
	between		1.571133	-2.318099	9.571048	n = 1008
	within		1.000607	-8.931476	10.124	T-bar = 13.0268
Leverage/l.Assets	overall	.2117312	.180841	0	.7826437	N = 13111
	between		.1531881	0	.7485911	n = 1008
	within		.1106644	-.3051703	.9310447	T-bar = 13.0069
Market-to-Book	overall	3.950975	4.207393	.1005536	29.8311	N = 13115
	between		3.022311	.3081198	23.08858	n = 1008
	within		3.185117	-18.34694	30.68529	T-bar = 13.0109
Share repurchase/Tot. Shares	overall	.9026933	1.518543	0	7.410381	N = 13091
	between		.92524	0	6.540037	n = 1007
	within		1.228272	-5.637344	7.894656	T-bar = 13

Source: Calculation based on Compustat database from WRDS.
Note: N=number of observations, n=number of groups, $T-bar$=average time period.

Chapter 3

The Stagnation-Financialization Paradox? Tackling the micro roots of a macro puzzle in an agent-based model

3.1 Introduction

Over the last three decades, the advanced economies have experienced a decline in the investment rate, accompanied by a slowdown in the growth rate of output and productivity. Summers (2014) argues that despite the enormous scale of the financial bubble in the pre-2008 period, western economies "had manifested unsatisfactory growth in output and employment since that time", advocating the hypothesis of a new secular stagnation. Gutiérrez and Philippon (2016) point out that in the U.S. corporate sector investment remained weak despite high and increasing profitability and market valuation; the average (net) investment-operating surplus ratio went down from 20% between 1962 and 2001 to 10% between 2002 and 2015. In addition, these authors stress that the investment gap is associated with a marked reduction in market competition, a substantial increase in total payouts, as well as a growing influence of institutional ownership. In fact, while investment was faltering, U.S. firms have distributed an increasing share of profits to shareholders in the form of dividend payments and, most importantly, share buybacks. Lazonick et al. (2014) find that, in the period between 2003 and 2012, the companies in the S&P500 spent 54% of their earnings on share buybacks, while another 37% was absorbed by dividend payment. Consistent with Gutiérrez and Philippon's (2016) findings, Gaspar et al. (2012) link the increasing propensity to buy back stocks to the rise of short-term investors in the ownership structure. In particular, the proportion of U.S. equity held by institutional investors jumped from 10% in 1953 to 70% in 2006 (Gillan and Starks, 2007), with the lion's share going to short-term actively-managed mutual funds (Davis, 2008).[16] Far from being a homogeneous group, indeed, institutional investors differ considerably in terms of time horizon and portfolio behavior. Empirical evidence seems to suggest that, whilst the rise of institutional ownership, by tightening governance and closely monitoring managers' activity, may promote innovative effort and firm's long-run performance (Aghion et al., 2013; Bena et al., 2017), short-term investors, by affecting managers' planning horizons, create incentives to reduce R&D spending to meet short-term earnings goals (Bushee, 1998; Brossard et al., 2013) and to increase share buybacks to boost stock price (Almeida et al., 2016; Gutiérrez and Philippon, 2016).[17]

The aim of this chapter is twofold. First, in order to provide a comprehensive understanding of these facts, we propose a narrative that combines Minsky's (1992) view of *money manager capitalism* with Keynes's (1936) description of financial market in the light of the ongoing process of 'financialization' of the economy (Epstein, 2005; Krippner, 2005; Hein et al., 2015). Second, drawing on this theoretical framework, we develop an agent-based model to assess the impact of the increasing role of spec-

[16]For an overview on the evolution of corporate ownership and the rise of institutional investors, see Gillan and Starks (2007), Davis (2008) and Fichtner et al. (2017).

[17]Accordingly, by focusing on 293 companies in the S&P500, Lazonick (2007) documents that, from 2003 to 2006, while total R&D expenditures increased from \$99.7 billion to \$120.4 billion (+21%), total repurchases increased from \$78.8 billion to \$280.8 billion (+256%).

ulative investors in the ownership structure on managers' investment decisions and, consequently, on macroeconomic dynamics in terms of growth, instability and crisis.

According to Minsky (1992), since the mid-1980s, the development of western economic systems has reached a stage in which, in a context of separation between ownership and control whereby companies' shares are publicly traded on the stock market, the vast proportion of equity ownership is held by institutional investors, or *money managers*, whose goal is to collect savings from individuals and invest in financial assets in order to maximize their portfolio returns. To avoid the risk of fire sales and ensuing hostile takeovers, corporate managers are forced to embrace the view of "shareholder value", i.e., maximizing the stock market value of the company (Fama and Jensen, 1983; Jensen, 2001). As the share of short-term investors in the ownership structure grows, however, the tendency to maximize shareholder value may lead to "a wild rush toward short-term profits" (Pasinetti, 2012) and a shift in the mode of allocation of corporate resources from "retain-and-reinvest" to "downsize-and-distribute" (Lazonick and O'sullivan, 2000) - fostering what some have called the "financialization of non-financial corporations" (Stockhammer, 2004; Orhangazi, 2008; Davis, 2018; Tori and Onaran, 2018a).

In Minsky's view, the emergence of money manager capitalism made the well-known Keynes's (1936) distinction between speculation versus enterprise even more relevant today than it was in his time (Whalen, 2017). Lord Keynes argues that the inevitable result of unfettered capital markets is the predominance of speculation over enterprise, whereby the majority of market participants are not concerned with "making superior long-term forecasts of the probable yield of an investment over its whole life, but with foreseeing changes in the conventional basis of valuation a short time ahead of the general public."[18] Under these circumstances, as acknowledged by

[18]In the frequently-cited passage in Chapter 12 of his *General Theory*, Keynes (1936) states that "Speculators may do no harm as bubbles on a steady stream of enterprise. But the position is serious when enterprise becomes the bubble on a whirlpool of speculation. When the capital development of a country becomes the buy product of the activities of casino, the job is likely to be ill-done."

behavioral finance proponents (Shefrin, 2001; Baker and Wurgler, 2013), the emphasis on the maximization of shareholder value, instead of increasing the long-term value of the company, leads managers to adopt a short-term view and eventually undertake corporate decisions aimed at boosting the stock price in the short run, at the cost of jeopardising prospective competitiveness and economic viability.

From a macroeconomic standpoint, we believe that, given the growing influence of institutional investors in the stock market, the source of economic instability arising from real-financial relations is to be investigated not only in the credit channel between firms and banks, but also in the interaction between shareholders and managers. With this in mind, we develop an agent-based model rooted in the financial accelerator framework (Delli Gatti et al., 2010; Riccetti et al., 2013), which stresses the role of credit in shaping short-term business fluctuations, incorporating a stock market, that affects what Keynes would call the 'state of long-term expectations', hence the long-term economic dynamics. In particular, by retrieving Keynes's distinction between speculation and enterprise, we assume that the stock market is populated by heterogeneous groups of investors, i.e., speculative and patient, who differ with respect to their beliefs about the impact of share buybacks on future price, as in Dawid et al. (2019). The core of the macro model builds upon the endogenous growth version of Delli Gatti et al. (2011), where boundedly rational heterogeneous agents, i.e., households, firms and banks, interact over time in decentralized labor, credit and goods markets, following simple, empirically grounded behavioural rules.

Within this setting, we investigate how the increasing share of speculative investors in the ownership structure – which, for the purpose of our analysis, is taken as exogenous – affects managers' planning horizons and R&D investment-buybacks decisions and thus the resulting macroeconomic outcomes. The idea is that when the stock market is dominated by a speculative sentiment, managers tend to internalize the short-term view of speculative investors and accommodate their demand for high equity returns, by diverting corporate resources from R&D investment towards share buybacks in order to boost the stock price. Yet, the macroeconomic effects of this increasing orientation towards shareholder value are not straightforward. To address this question, we carry out a sensitivity analysis in order to see how key real-financial variables respond to changes in parameter θ, which simultaneously defines the ownership composition between speculative and patient investors as well as the resource allocation between R&D and share buybacks, as we will see from the model's equation later on.

Simulation results show that as the fraction of speculative investors in the stock market, θ, grows, on the one hand, the reduced innovative effort implies a lower and less volatile output and productivity growth. On the other, the enhanced propensity to repurchase shares allows firms to support the stock price in spite of an economic slowdown. This situation gives rise to what we call a 'stagnation-financialization paradox.' However, the diverging trends in the real and financial sectors persist as long as the share of speculators does not exceed a certain threshold (i.e., 60%), after which, the stock market begins to drop as well. The reason is that for high values of θ, economic growth is so low that the ensuing fall in aggregate profits drags buybacks down, despite their increase in relative terms, causing the stock market to fall. Therefore, share buybacks can effectively support stock prices despite a slowing real economy resulting from a decline in innovative activity as long as corporate profits are sufficiently high. Further simulation exercises highlight that, in order for this scenario to emerge, it is necessary that the configuration of the ownership structure and the related mode of utilization of surplus are such that the corporate sector can generate and then distribute a sufficient amount of profits to support the stock price despite a slowing real economy.

This chapter provides a modelling framework to study the extent to which real and financial relations shape both short-term business fluctuations and long-term economic development. On the one hand, consistent with Minsky's (1975) 'financial instability hypothesis', business cycles are driven by heterogeneous firms and banks inter-linkages in the credit market, with the interplay of an evolving market structure: firms' leverage and banks' exposure, by promoting the formation of big firms, boost production, but eventually increase the financial instability that is conducive to economic crises. On the other hand, the long-term economic development is affected by the interaction between owners and managers in the stock market: a growing fraction of speculative investors creates incentives for managers to increase share buybacks at the cost of lower R&D investment, with negative effects on productivity and output growth, whereas the impact on the stock market is non-monotonic and can be represented with an inverted U-shaped relationship.

The model belongs to the growing body of literature on agent-based models (ABM) in macroeconomics (Dawid and Delli Gatti, 2018; Dosi and Roventini, 2019). In particular, this chapter contributes to the field of macro ABMs with financial accelerator, focusing on the role of leverage and credit network in the emergence of systemic risk, financial fragility and economic fluctuations (Delli Gatti et al., 2010; Riccetti et al., 2013; Assenza et al., 2015). On the financial side, in addition to the credit market, our model includes an explicit formalization of an artificial stock market, whose fundamental variables driving the share price dynamics (i.e., buybacks and dividend streams) are endogenously generated 'from the bottom up'. This distinguishes our setup from financial market models where dividend streams are assumed to follow an exogenously given stochastic process (Hommes, 2006; Chiarella et al., 2009). Such an experiment was first performed by Dawid et al. (2019). Starting from an industrial organization framework, they build a financial market with heterogeneous expectations upon a decentralized corporate sector in order to analyze the relationship between share-based remuneration, managers' investment decisions and the economic performance, both at firm and industry level. This chapter aims to export and extend the core of their analysis into a simple macroeconomic framework in order to explore the effects of financialization, defined here as an increasing role of speculative investors in the ownership structure, on the economy as a whole. To the best of our knowledge, our model is one of the first macro ABMs incorporating a stock market that exercises a pro-active role on agents behavior and economic dynamics. Similar attempts include Riccetti et al. (2016), in which a stylized stock market constitutes the third factor of the financial accelerator mechanism, on top of leverage and credit network, adding a further layer of instability to the system, as well as the family of models born from the EURACE project. For example, Dawid et al. (2012) and Van der Hoog et al. (2008), where a minimalistic stock market is formalized through an index share containing all firms in the economy and Cincotti et al. (2010), who develop a clearing house with daily determination of market clearing prices. Yet, in none of these models the stock market directly interferes with the firm's decision making process, but acts as a mere reflection of its financial situation or at most amplifies the effects of a shock that originates in other sectors, as in Riccetti et al. (2016). Additionally, by modelling a relatively simple innovation-driven productivity growth process, this chapter shares similar features with evolutionary agent-based models with innovation dynamics and endogenous growth, such as Dawid et al. (2008), Dosi et al. (2010) and Caiani et al. (2019). In most of the works in this field, however, the financial side of the economy is either missing (Russo et al., 2007) or solely composed of a credit market (Dosi et al., 2013). Nonetheless, the importance of the relationship between finance and innovation is widely recognized in the field of innovation economics (Dosi, 1990; Lazonick and Mazzucato, 2013; Dosi et al., 2016). In particular, Mazzucato and Wray (2015) point out that, given the uncertain, collective and cumulative character of the innovation process, technological change requires a long-term, committed and patient capital. Our model aims to integrate these features by developing a simple framework in which the firm's propensity to innovate and repurchase shares depends on the market sentiment resulting from the ownership composition between speculative and patient investors.

The rest of the chapter is organized as follows: Sections 3.2 and 3.3 present the model setup and the analytical framework. Section 3.4 shows the emergent properties of the baseline model and discusses the results from the sensitivity analysis used to address our research question. Section 3.5 concludes.

3.2 Model setup

The structure of the model builds upon *Macroeconomic from the Bottom-Up* by Delli Gatti et al. (2011), while the stock market is based on Brock and Hommes (1998), with the features introduced by Dawid et al. (2019) concerning the link between market sentiment and managers' investment decisions.

3.2.1 The environment

The economy is populated by four classes of agents, that is workers ($h = 1, ..., H$), shareholders ($k = 1, ..., K$), firms/managers ($i = 1, ..., I$) and banks ($b = 1, ..., Bk$), which interact over a time span ($t = 1, ...T$) in four different markets:

- labor market, where firms demand labor supplied by workers;
- credit market, where firms demand loans from banks to finance the production costs in excess of internal funds;
- stock market, where shareholders trade firms' shares based on expectations on future returns, while firms can issue and repurchase shares;
- consumption good market, where both workers and shareholders demand a homogeneous consumption good produced by firms employing only labor.

In each market agents are heterogeneous and boundedly rational in the way discussed by Simon (1972): because of incomplete information and limited computational ability, individuals follow simple but reasonable behavioural rules (i.e., heuristics) in the search for satisfactory outcomes.

The agent-based approach conceives the economy as a complex system, whereby aggregate outcome emerges from the micro behavior of heterogeneous agents interacting in decentralized markets. Thereby, the way in which the structure of interactions is formalized is paramount for the model dynamics (Delli Gatti et al., 2018). In this respect, we follow a well-established procedure in macro agent-based literature, that is the search-and-matching mechanism.[19] In the labor, credit and good markets, every period individuals from the demand and the supply side are picked and randomly matched according to specific protocols, which will be described later on. The stock market, instead, is a traditional asset pricing model with mean-variance optimization setup. Also in there, however, agents are not fully rational, but undertake decisions on the basis of heterogeneous expectations, along the lines described in the behavioural finance literature (Hommes, 2006; Chiarella et al., 2009).

3.2.2 The sequence of events

In the following lines, the sequence of events is described.

1. At the beginning of the period, based on expected demand and relative competitiveness, each firm determines the desired level of price and production, as well as the required workforce.

2. Labor market opens. If the required workforce is greater than the current one, firms post job vacancies on the labor market at a given wage. After the labor matching, some businesses fulfill their labor demand, while others may end up with unfilled vacant positions. In the latter case, planned production will be scaled down to meet the actual labor force; at the same time, some workers may remain unemployed.

3. Credit market opens. If internal funds are lower than production costs (i.e., the wage bill), firms access the credit market to cover the 'financing gap'. Credit conditions depend on the financial situation of the borrowing firms as well as on the credit availability from the lending banks, which have to comply with a capital requirement. After the matching process, if borrowing firms fail to

[19] See Riccetti et al. (2015) for an extensive description.

collect enough resources to cover the financing gap, some workers will be fired and remain unemployed.

4. Firms produce a homogeneous consumption good by using only labor.

5. Consumption good market opens. Producers try to sell their output to consumers, both workers and shareholders. Asymmetric information and search costs imply that some firms may end up with excess supply (while others with excess demand). In this case, they get rid of unsold goods at zero costs; there is no inventory accumulation in the warehouse.

6. Once the good market closes, managers collect revenues and calculate gross profits, after deducting wages and interest payments. A fixed fraction of profits is allocated between share buybacks and R&D investment, based on the stock market sentiment, θ, i.e., the fraction of speculative investors.

7. In the stock market, speculative and patient investors compute optimal assets demand depending on their expectations of future returns. A Walrasian auctioneer collects all investors' demand schedules and sets the market clearing price so that the excess demand is null. After observing the prevailing market price, shareholders adjust their portfolio. At the end of the year (four simulation periods), firms are allowed to issue new shares on the market, the amount of which depends on the cumulative sum of previously repurchased shares and the individual firm's financial condition.

8. Having paid dividends, firms update their net worth, augmented by retained profits, and shareholders update their financial wealth, augmented by dividends and capital gains. If the net worth turns negative, firms go bankrupt and exit the market, while lending banks write off a bad debt from their equity. As a consequence of repeated firms' defaults, banks' capital may turn out to be negative too. A new string of firms/banks replace the bankrupt ones.

3.3 Markets

The following section discusses the behavioural rules of heterogeneous agents, the market protocols that define the structure of interactions across individuals in each market and the law of motion of the system as a whole.

3.3.1 Price and production

At the beginning of each period, based on past sales and relative deviation from average price, the i-th firm sets the desired level of price and production. Because of search costs, consumers can explore only a limited subset of the market. Therefore, they may end up buying the good from a firm even if its selling price is not the lowest. This implies that each firm can exert a certain degree of market power over price and quantity decisions. Following Delli Gatti et al. (2011), we assume that the firm can decide to adjust *either* the quantity *or* the price, via mark-up, to changing business conditions, as defined by following rule

$$Y^d_{i,t} = D^e_{i,t+1} = \begin{cases} Y_{i,t}(1+\rho \cdot U(0,1)) \ \text{ if } \ \Delta_{i,t} = 0 \ \text{ and } \ P_{i,t} > P_t \\ Y_{i,t}(1-\rho \cdot U(0,1)) \ \text{ if } \ \Delta_{i,t} > 0 \ \text{ and } \ P_{i,t} < P_t \end{cases} \tag{3.1}$$

$$\hat{\mu}_{i,t} = \begin{cases} \hat{\mu}_{i,t-1}(1+\rho \cdot U(0,1)) \ \text{ if } \ \Delta_{i,t} = 0 \ \text{ and } \ P_{i,t} < P_t \\ \hat{\mu}_{i,t-1}(1-\rho \cdot U(0,1)) \ \text{ if } \ \Delta_{i,t} > 0 \ \text{ and } \ P_{i,t} > P_t. \end{cases}$$

The equations above state that in case of excess demand, i.e., no unsold goods from the previous period ($\Delta_{i,t} = 0$), the i-th firm will either review the expected demand ($D^e_{i,t+1}$) upwards and consequently adjust the desired scale of production ($Y^d_{i,t}$), if the individual price, $P_{i,t}$, is greater than the average price on the market, P_t, or increase the price, by augmenting the mark-up, $\hat{\mu}_{i,t}$, if the price deviation is negative. Conversely, in case of excess supply, i.e., positive unsold goods from the previous period ($\Delta_{i,t} > 0$), the i-th firm will review the expectations of future demand downwards if the individual price is already lower than the average price, or decrease the mark-up, if the individual price is higher than the average price. Note that the price and quantity adjustments are small and equal to an idiosyncratic random term drawn from uniform distribution and then multiplied by a constant term ($0 < \rho < 1$), defining the speed of adjustment.

Having defined the desired (flexible) mark-up based on business conditions, the final good price is computed by applying the resulting (total) mark-up from equation (3.2) to the unit labor cost, as given by the ratio between nominal wage and productivity, that is

$$\mu_{i,t} = \bar{\mu} + \hat{\mu}_{i,t}, \tag{3.2}$$

$$P_{i,t} = (1 + \mu_{i,t})\frac{w_{i,t}}{\alpha_{i,t}}. \tag{3.3}$$

This allows us to maintain the same price-quantity decision rule as in Delli Gatti et al. (2011) and, at the same time, provide an explicit formalization of cost structure and mark-up behind the price determination.

The i-th firm carries out the production of a homogeneous consumption good with a constant return to scale technology by employing only labor, corresponding to

$$Y_{i,t} = \alpha_{i,t} L_{i,t}, \tag{3.4}$$

$$\alpha_{i,t+1} = \alpha_{i,t} + \epsilon_{i,t}. \tag{3.5}$$

where $\alpha_{i,t}$ is the labor productivity. In line with the 'growth+' version of Delli Gatti et al. (2011) and following the literature on macro agent-based models with endogenous growth (Dosi et al., 2010; Dawid et al., 2012), labor productivity evolves according to a first-order autoregressive stochastic process, where the expected improvements depend on firm's R&D intensity, given by the ratio of R&D expenditure over total sales. In this way, output growth evolves endogenously triggered by productivity-enhancing innovative investment. It must be stressed that, since R&D is a function of realized profits, there is a strong link between the evolution of firms' financial conditions, productivity and market shares; higher profits imply larger R&D spending and greater productivity improvements, which eventually improve firm's competitiveness, sales and growth opportunity.

3.3.2 Labor market

In this market each worker supplies one unit of labor to firms which represent the demand side. The labor contract expires after 8 time periods. Workers with an active contract can be fired as well if the firm's available funds are not enough to meet the labor requirements.

From equation (3.4), we can derive the labor demand, as a function of planned production and productivity, that is

$$L^d_{i,t} = \frac{Y^d_{i,t}}{\alpha_{i,t}}. \tag{3.6}$$

Labor demand corresponds to the workforce needed for fulfilling the desired level of production for a given productivity level. The level of required workforce, $L^d_{i,t}$, is then compared with the actual workforce: $L^o_{i,t} = L_{i,t-1} - \hat{L}_{i,t-1}$, where $L_{i,t-1}$ is the current number of employees at firm i, and $\hat{L}_{i,t-1}$ is the number of employees whose contract has just expired. If the required workforce is larger than the actual one, the firm creates a number of vacancies $J_{i,t}$ to post on the labor market, corresponding to

$$J_{i,t} = \max(L^d_{i,t} - L^o_{i,t}, 0). \tag{3.7}$$

The contractual wage is uniform across firms and evolves according to the average productivity growth, $\bar{\alpha}_t$, or

$$w_t = w_{t-1}(1 + \bar{\alpha}_t). \tag{3.8}$$

The interaction between firms and workers on the labor market is based on the following matching process. Unemployed workers visit Z_l randomly chosen firms; a worker whose contract has just expired will first contact the last employer and then the remaining $Z_l - 1$ randomly sampled firms. Since wages are homogeneous across firms, the search goes on as long as a vacant position is found. Due to search costs that prevent workers from visiting the whole population of business unfits, market inefficiencies may arise. For example, some workers may remain unemployed if the labor demand is not high enough to absorb the entire labor force (i.e., involuntary unemployment), or some firms might not be able to fill all vacant positions if they do not get visited by workers (i.e., mismatch unemployment). In the latter case, the scale of planned production will be reviewed downwards to meet the actual workforce.

3.3.3 Credit market

The corporate financial structure is characterized by a hierarchical system of financing sources, ranked according to their corresponding degree of risk and relative cost. To finance their business, firms rely firstly on internal funds (i.e., net worth) and secondly on external funds, that is proceeds from bank credit, upon which an interest rate is charged. As we will see below, equity issuance is also allowed, the purpose of which is to re-balance the firm's capital structure after many buybacks have occurred, thus preventing the equity from going to zero. Therefore, in this model the primary function of the stock market is to meet financing rather than production needs. Such a classification of financing sources is not only coherent with Minsky's (1975) financial theory of investments, but finds also support in the theory of imperfect information in equity markets, e.g. see Greenwald et al. (1984) and Stiglitz (1985). These authors stress that, in presence of imperfect capital markets, firms that need to rise external funds firstly resort to bank lending, and only later to equity issuance, in that the latter would send a bad signal about "the quality of the firm" to investors, causing the stock price to fall.

After the labor market closes, firms update the level of actual workforce and compute the corresponding wage bill, $W_{i,t}$. If the latter is higher than internal funds, $NW_{i,t}$, then firms resort to the credit market in order to fill the "financing gap", which is equivalent to the firm's credit demand, as given by

$$D_{i,t} = \max(W_{i,t} - NW_{i,t}, 0). \tag{3.9}$$

In every time period, the b-th bank sets the total credit supply, $D^s_{b,t}$, that is, the maximum amount of credit to be supplied to borrowing firms, defined as a multiple of its equity base, through

$$D^s_{b,t} = \frac{E_{b,t}}{v}, \tag{3.10}$$

where $0 < v < 1$ is the loan-to-value ratio, or alternatively the maximum allowable leverage of the bank (Delli Gatti et al., 2011). The parameter v can be interpreted as a capital requirement, constant and uniform across banks, set by a regulatory authority. In this way, the credit supply is endogenous to business cycles and potentially constrained by banks' capital. The effective amount of loans received by the borrowing firm will be determined in the matching process.

Following the financial accelerator literature (Bernanke et al., 1999), the contractual interest rate, $r_{b,i,t}$, proposed at time t by the lending bank b to the borrowing firm i, is computed taking into account the borrower's default risk, defined as a mark-up over a given policy rate, $\bar{r}$.[20] The mark-up is a function of the borrower's financial fragility, as defined by the leverage; the higher the leverage, the greater the perceived borrower's

[20] To ensure that the proposed interest rate is heterogeneous among banks, the constant policy rate is multiplied by a random component on the support $(0, H_b)$, so that firms can actually choose the cheapest offer.

risk, the higher the interest rate requested by banks on an unit of loan:

$$r_{b,i,t} = \bar{r}(1 + \phi(l_{i,t})), \quad \phi' > 0 \tag{3.11}$$

$$l_{i,t} = \frac{D_{i,t}}{D_{i,t} + MV_{i,t}}. \tag{3.12}$$

In this model, since companies are publicly listed, the measure used by banks to assess the financial situation of the borrower is the market leverage ratio, under the hypothesis that the credit demand, $D_{i,t}$, is granted. The market leverage ratio is determined by debt over company's assets value, i.e., liabilities plus market value of equity, as shown in equation (3.12). The reason why we use book, rather than market value of debt is because firms do not issue bonds, but only shares are priced on the market.[21]

The interaction between firms and banks takes place through the usual matching process; each firm can visit a number Z_b of randomly chosen banks, rank them in ascending order based on the proposed interest rate and present the "credit applications" (i.e., credit demand) starting from the bank charging the lowest price. At this point, banks collect the credit applications sent by borrowers, sort them in ascending order based on their financial situation (i.e., market leverage ratio) and extend loans starting from the one with lowest leverage, until the total credit supply defined by the capital requirement is reached.

At the end of the period, the banks' new worth is updated by profits (or losses), consisting in the difference between interest revenues on extended loans minus losses resulting from bad debt of bankrupt companies - assuming banks pay no interest on

[21] This simplifying assumption is fairly common in the field of empirical corporate finance due to the poor availability of corporate bond pricing data.

customer deposits. The bank's equity, thus, evolves according to the following rule

$$E_{b,t+1} = E_{b,t} + \pi_{b,t}, \tag{3.13}$$

$$\pi_{b,t} = \sum_{i \in \Omega} r_{b,i,t} \hat{D}_{b,i,t} - BD_{b,t}, \tag{3.14}$$

where Ω is bank b's loans portfolio, $r_{b,i,t}\hat{D}_{b,i,t}$ is the interest revenue on actual loans towards firm i, $BD_{b,t}$ represents the bank's loss or bad debt, given by the insolvent borrower's equity, which is split among lending banks depending on their relative exposure in terms of extended loan.

3.3.4 Consumption good market

Similarly to standard economic models, in agent-based macroeconomics the household consumption behavior follows a two-stage process (Dawid and Delli Gatti, 2018); each individual determines first the consumption budget and then the composition of the bundle of goods to buy.

In the goods market, consumers are both workers and shareholders, who demand a homogeneous consumption good supplied by firms. Both household types consume a fixed fraction of financial wealth given by accumulated past savings: $C_{f,t} = c^f W_{c,t}$ where $f \in \{h, k\}$ and $c^h > c^k$.

The choice of the consumption good to buy is governed by a (quasi) random search mechanism; households are allowed to explore a subsection of the marketplace and to choose among a range of products depending on their relative price. The search goes on until the entire consumption budget is spent.

The list of Z_c suppliers to be visited by each consumer includes the "favorite" firm, being the one where she shopped in the last period. It follows that, similarly to Delli Gatti et al. (2011), the consumers' choice of the potential partner is not purely random; yet, differently from them, the preferential attachment process is not based on firm size, but on consumer loyalty. This mechanism not only finds stronger empirical support in the literature (Chaudhuri and Holbrook, 2001), but also avoids the formation of unusually large firms that the adoption of a size-based preferential attachment would entail.

Given the absence of a capital good sector, aggregate demand amounts to aggregate consumption, which is obtained by summing up all the individual demands from both groups of households. By accounting identity, aggregate demand is then set equal to aggregate production. The accounting equations at the macro level read

$$C_t = \sum_{h=1}^{H} C_{h,t} + \sum_{k=1}^{K} C_{k,t} \tag{3.15}$$

$$Y_t = C_t. \tag{3.16}$$

3.3.5 Stock market

The stock market draws on an asset pricing model with wealth-based portfolio dynamics, featured by bounded rationality and heterogeneous expectations, well in tune with the literature spurred by Brock and Hommes (1997) and reviewed, among others, by Chiarella et al. (2009). Moreover, concerning the formalization of heterogeneous investors' expectations, we largely borrow from Dawid et al. (2019), to whom the reader is addressed for a more detailed discussion.

The stock market is populated by M investors split into two groups: speculative and patient investors. Let $\theta \in (0,1)$ be the fraction of speculative investors in the ownership structure; for the purpose of our analysis, θ is taken as exogenous, i.e., uniform across firms and constant over time.

Following Dawid et al. (2019), companies' shares are assumed to be traded in separate markets, not to deal with multi-asset portfolios. The evolution of the number of shares outstanding, $N_{i,t}$, is defined as

$$N_{i,t+1} = N_{i,t} - B_{i,t}/Q_{i,t} + EI_{i,t}, \tag{3.17}$$

where $B_{i,t}/Q_{i,t}$ is the amount of repurchased shares, while EI_i indicates the issuance of new equity. To prevent equity from being wiped out by continuous buybacks, indeed, firms are allowed to issue new stocks, thereby collecting proceeds from the market.

The equity issuance occurs at the end of the fiscal year (i.e., four time periods), the amount of which is given by the volume of previously repurchased shares adjusted by a term reflecting the firm's financing conditions, is given by

$$EI_{i,t} = CB_{i,t}(1 + \pi^{EI}_{i,t}), \tag{3.18}$$

where $CB_{i,t} = \sum_{j=1}^{4} B_{i,t+1-j}/Q_{i,t+1-j}$ is the cumulative sum of repurchased shares of firm i over the last four periods, while $\pi^{EI}_{i,t} = 1 - e^{-\zeta ff_{i,t}}$ is the degree of equity adjustment. The latter is an increasing function of the firm's financial fragility, $ff_{i,t} = \frac{W_{i,t} - NW_{i,t}}{NW_{i,t}}$, given by the percentage difference between production costs and net worth.

Note that if firm i is financially fragile ($ff_{i,t} > 0$), that is whenever the wage bill is greater than internal funds ($W_{i,t} > NW_{i,t}$), the degree of equity adjustment is positive ($\pi^{EI}_{i,t} > 0$). Therefore, in order to cover the funding shortage, the firm will issue relatively more shares than the amount previously repurchased ($EI_{i,t} > CB_{i,t}$), with ζ being the intensity of adjustment - and vice versa should the firm be financially robust ($ff_{i,t} < 0$).

Based on a standard mean-variance optimization setup, shareholders myopically maximize a wealth-based utility function to compute the optimal asset demand, $z_{k,i,t}$. The consumption-adjusted wealth dynamics of investor k in firm i is defined as

$$W_{k,i,t+1} = (R - c^k)W_{k,t} + (Q_{i,t+1} + d_{i,t+1} - RQ_{i,t})z_{k,i,t}. \tag{3.19}$$

The first component in equation (3.19) indicates the gross returns on past accumulated wealth, adjusted for the shareholder's propensity to consume out of wealth, c^k, while the second component stands for the excess return on the risky asset, i.e., the demand for firm i's stocks, $z_{k,i,t}$, as measured in terms of capital gains, that is, the sum of future share price, $Q_{i,t+1}$, and dividend per share. $d_{i,t+1}$.

With a CARA utility function, the optimal demand of shares turns out to be a function of the expected mean and variance of future returns and is given by

$$z_{k,i,t} = \frac{\mathbb{E}_{k,t}(Q_{i,t+1} + d_{i,t+1} - (1+r)Q_{i,t})}{\tilde{a}\hat{\sigma}^2_{i,t}}, \tag{3.20}$$

where $\tilde{\alpha}$ is a constant risk aversion coefficient and $\hat{\sigma}^2_{i,t}$ the conditional variance.

Note that financial investors have heterogeneous expectations about future asset returns. In particular, each investor's type is defined according to her expectation about the impact of share buybacks on future stock price, with this being positive for speculators ($\chi_s > 0$), negative for patient investors ($\chi_p < 0$). Formally, the heterogeneous expectations' equation reads

$$\mathbb{E}_{k,i,t}[Q_{i,t+1}] = Q_{i,t-1}\Big(1 + \chi_k \frac{B_{i,t}}{Q_{i,t}N_{i,t}}\Big), \tag{3.21}$$

where $k \in \{s, p\}$, $Q_{i,t-1}$ is the share price in $t-1$ and $\frac{B_{i,t}}{Q_{i,t}N_{i,t}}$ is the fraction of repurchased shares in real terms. Speculators are transient traders, focused on the short-term revaluations of their investments; as such, they interpret share buybacks as a positive signal that the company is willing to return cash to shareholders. By contrast, patient investors are more concerned with the long-run growth of the company; they would prefer managers to invest in productive activities and, therefore, expect buybacks to have a negative impact on future returns. The expectations on future dividends, $\mathbb{E}_t[d_{t+1}]$, instead, are homogeneous among investors and determined as a weighted-average between current and past dividend payments, as in Dawid et al. (2019).

Let $A_{k,i,t-1}$ denote the stock holdings of investor k in firm i at the end of the previous trading session. It follows that the net demand for shares boils down to

$$\Delta A_{k,i,t} = z_{k,i,t} - A_{k,i,t-1}. \tag{3.22}$$

Therefore, ΔA indicates the amount of firm i's shares investors are willing to trade (to buy if positive, to sell if negative) at time t conditional on price Q, as formulated in Bottazzi et al. (2005).

After collecting all the investors' demands, a Walrasian auctioneer sets the market clearing price such that the excess demand is equal to zero. Taking into account that also managers engage in market operations through shares buybacks and that equity issuance, if any, takes place at the end of the period, the market clearing condition reads

$$M\Big[\theta\Delta A_{s,i,t} + (1-\theta)\Delta A_{p,i,t}\Big] + \frac{B_{i,t}}{Q_{i,t}} - EI_{i,t-1} = 0. \tag{3.23}$$

After some algebra carefully described in Dawid et al. (2019), by solving for the share price $Q_{i,t}$, the equilibrium condition in equation (3.23) leads to the following market clearing price

$$Q_{i,t} = \frac{X_{1,i,t} + \sqrt{X_{1,i,t}^2 + 4(1+r)X_{2,i,t}B_{i,t}}}{2(1+r)}, \tag{3.24}$$

with $X_{1,i,t}$ and $X_{2,i,t}$ being, respectively, the second and third factor of the second-order equation, i.e.

$$X_{1,i,t} = \hat{d}_{i,t+1} + Q_{i,t-1} - a\hat{\sigma}_{i,t}^2 N_{i,t}, \tag{3.25}$$

$$X_{2,i,t} = \frac{[\theta\chi_s + (1-\theta)\chi_p]Q_{i,t-1}}{N_{i,t}} + a\hat{\sigma}_{i,t}^2, \tag{3.26}$$

where $a = \tilde{a}/M$. Note that the impact of stock buybacks on the share price is increasing with $[\theta\chi_s + (1-\theta)\chi_p]$ in $X_{2,i,t}$. This expression can be interpreted as the average market sentiment on share buybacks and depends on the ownership composition between patient and speculative investors, θ. If the stock market is dominated by speculative investors ($\theta > 0.5$), there is a positive average market sentiment around share buybacks and, consequently, managers will have more incentives to distribute profits to shareholders by means of share buybacks, as will be discussed below.

3.3.6 Profits, investment-buybacks decisions and net worth

When the consumption good market closes, the i-th firm collects revenues and computes realized profits, $\Pi^*_{i,t}$, after deducting wages and interest payments, that is

$$\Pi^*_{i,t} = P_{i,t}Y_{i,t} - w_t L_{i,t} - r^b_{i,t} D_{i,t}. \tag{3.27}$$

If profits are positive, managers have to decide how to allocate a fraction γ of surplus between R&D and share buybacks, depending on the market sentiment θ, i.e., the fraction of speculative investors in the market. Therefore, the manager's decision over corporate resource allocation is given by

$$B_{i,t} = \theta\gamma\Pi^*_{i,t}, \tag{3.28}$$

$$RD_{i,t} = (1-\theta)\gamma\Pi^*_{i,t}. \tag{3.29}$$

The idea is that when the stock market is dominated by a speculative sentiment (high θ), managers tend to internalize a short-term view and to "cater" to investors' demand for high equity returns by diverting resources from R&D investment to stock buybacks to boost stock price. Indeed, when speculative investors dominate the market, there is a positive average market sentiment around stock buybacks (i.e., $[\theta\chi_s + (1-\theta)\chi_p] > 0$): given the prevailing ownership structure, managers foresee that the share price will increase following a share repurchase program. On the other hand, when the majority of investors is patient (low θ), managers' ability to "time" the market is limited. Consequently, they will prefer to reinvest profit in the production process, by increasing R&D expenditure, despite the stochastic nature of the innovation process.

This can be thought of as a reduced form of an optimization problem in which managers have to decide how to efficiently allocate corporate resources between alternative real-financial investments in order to maximize the market value of the company, as in Dawid et al. (2019). Findings from behavioural corporate finance support the idea that 'rational' managers adapt their decisions in response to swings in market sentiment determined by 'irrational' investors (Baker and Wurgler, 2013). In particular, according to the 'catering theory' (Baker and Wurgler, 2004b), managers are willing to cater to the market demand for high equity returns by rising payouts whenever investors put a stock price premium on payers. Originally conceived for dividends, the catering theory has been lately extended to share repurchases, receiving wide empirical support (cfr. Gaspar et al., 2012; Jiang et al., 2013). There is also evidence showing that an increasing influence of myopic investors in the ownership structure creates incentives for managers to cut R&D to meet short-term earning goals (Bushee, 1998; Brossard et al., 2013) and to increase stock buybacks to boost financial performances (Almeida et al., 2016; Gutiérrez and Philippon, 2016). Furthermore, with this analytical framework we provide a simple formalization of the idea put forward by scholars from innovation economics (e.g. Lazonick and Mazzucato, 2013; Mazzucato and Wray, 2015; Dosi et al., 2016) that technological progress requires a patient and committed finance, focused on the long-term viability of the company rather than short-term financial performance.

Finally, at the end of each period, managers pay out a fraction δ of the remaining profits to shareholders as dividends, while (1-δ) is retained and accumulated to net worth, i.e.

$$Div_{i,t} = \delta(1-\gamma)\Pi^*_{i,t}, \tag{3.30}$$

$$NW_{i,t+1} = NW_{i,t} + (1-\gamma)(1-\delta)\Pi^*_{i,t}. \tag{3.31}$$

3.3.7 Bankruptcy, entry and exit dynamics

Once dividends are paid, the net worth of firms is augmented by retained earnings, while the financial wealth of shareholders is augmented by dividends and capital gains. Should the company incur in a loss that is greater than past accumulated earnings, net worth becomes negative and the firm must declare bankruptcy. To maintain the number of agents constant, bankrupted firms are replaced with a string of new entrants, whose initial endowments reflect the scale of a representative (average) agent in the market. Due to firms' defaults, also banks may accumulate losses resulting from non-performing loans, causing a deterioration of their capital. In times of financial turmoil, it may happen that bank's equity turns out to be negative as a result of repeated failures. In this case, the bank is bailed out by the Government and replaced with a copy of a randomly selected bank.

Symbol	Description	Value
T	Number of time periods	1000
I	Number of firms	100
H	Number of workers	1000
Bk	Number of banks	10
J	Number of shareholders per firm	10
M	Number of total shareholders (J*I)	1000
$[c^w, c^s]$	Propensity to consume workers/owners	[0.80,0.20]
ρ	Maximum growth rate of prices/quantities	0.1
Z_l	Number of trials in the labor market	4
Z_g	Number of trials in the good market	2
Z_c	Number of trials in the credit market	2
v	Capital requirement	0.8
$\bar{r}$	basic interest rate	0.02
γ	Rate of reinvested profits	0.2
δ	Rate of dividend payout	0.2
$\bar{\mu}$	Mark-up, fixed component	0.05
ζ	Intensity of equity adjustment	0.1
χ_s	Impact factor speculative	0.2
χ_p	Impact factor patient	-0.2
$\hat{\sigma}$	Standard deviation coefficient	10
$\tilde{a}$	CARA risk coefficient	0.1
r	rate of return on risk-free asset	0.1
θ	fraction of speculative investors	0.1

Table 3.1: Parameter setting

3.4 Simulation results

In this section, we explore the macroeconomic properties of the model by means of computer simulations. First, we simulate a baseline version based on the parameter setting displayed in Table 3.1. Following a standard procedure in the agent-based literature, the purpose of this exercise is to empirical validate the model by choosing a constellation of parameters that allows to simultaneously reproduce a wide set of stylized facts. Afterwards, a sensitivity analysis is performed in order to address the main research question of the chapter, that is how financialization, here defined as a shift in the ownership composition from patient to speculative investors, affects manager's investment decisions and the resulting macroeconomic dynamics. In doing so, we run multiple simulations and analyse the pattern of key macro variables in response to changes in parameter θ, i.e., the fraction of speculative investors in the stock market.

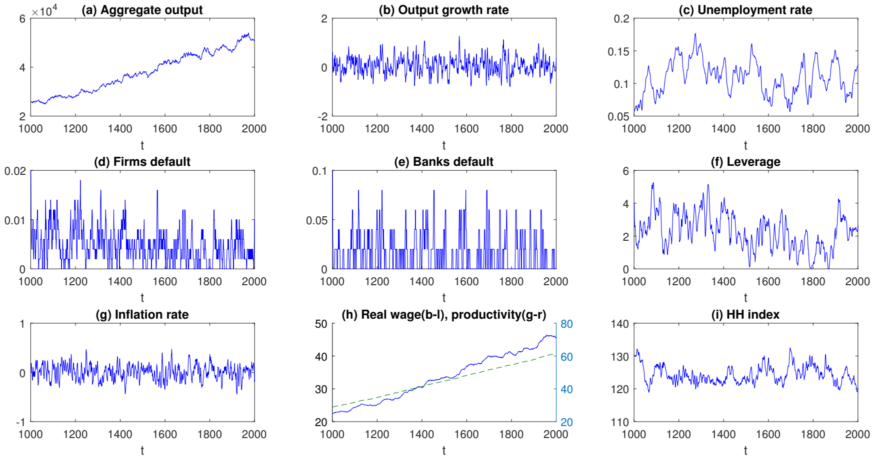


Figure 3.1: Baseline model: aggregate time series from one simulation; only last 1000 time periods are reported.

3.4.1 Baseline scenario

For the baseline version, we assign $\theta = 0.1$ (low propensity to buyback, high R&D intensity) in order to reproduce and further inspect the results of Delli Gatti et al. (2011). Figure 3.1 displays a set of macroeconomic variables obtained from one representative simulation for a time span of 2000 periods; for expository purposes, only the last 1000 time periods are reported.

The dynamics of aggregate output exhibits repeated boom-and-bust cycles along an increasing trend determined by the productivity-enhancing endogenous technical progress. GDP fluctuations are associated with cyclical movements in unemployment and leverage, with subsequent effects on firms and banks defaults dynamics.

By highlighting the last 200 periods, Figure 3.2 gives us a clearer idea of the mechanisms underlying business fluctuations in a financial accelerator model with endogenous growth like this one.

In the expansionary-phase of the business cycle (dark grey area), positive expectations of future demand encourage firms to take on more debt and expand their production by hiring new workers. The following reduction in unemployment boosts aggregate demand and profits which further improves firms' expectations and economic activity. The periods of boom tend to favor the formation of big firms controlling large market shares, as indicated by the increase in the Herfindahl-Hirschman index shown in plot (d). This is because, in so far as productivity growth stochastically depends on past innovative investment, firms with higher profits, by spending more on R&D, are likely to experience faster gains in productivity and competitiveness, resulting in larger market shares and better growth opportunities. Thus, the interplay of credit expansion and technical progress, by promoting the formation of big productive firms that carry out large-scale innovative activity, has a positive impact on aggregate output and productivity growth. This dynamic relationship between finance, innovation, concentration and growth is reminiscent of the Schumpeter's (1942) theory of economic development presented in his *Capitalism, Socialism and Democracy*, also known as 'Schumpeter Mark II'.

However, in line with Minsky's (1986) financial instability hypothesis, "stability is destabilizing": the increase in aggregate leverage makes the economic system more financially fragile and sensitive to idiosyncratic shocks, such as a fall in profits or an increase of the interest rate.

The economic cycle is reversed (light grey area in Figure 3.2) as a number of large firms fails to meet their financial obligations and are forced to exit the market, with contagion effects spreading through the whole economy. When a big firm declares default, indeed, its workers are fired, resulting in higher unemployment rate and weaker aggregate demand. Consequently, surviving firms struggle to sell their output on the goods market and will more likely incur in losses that force them to downsize the labor costs and the scale of production, exacerbating the downturn phase of the cycle. Moreover, the bankruptcy of large firms causes a deterioration of banks' equity, which, in turn, leads to worsening credit conditions for surviving firms, on the one hand, and

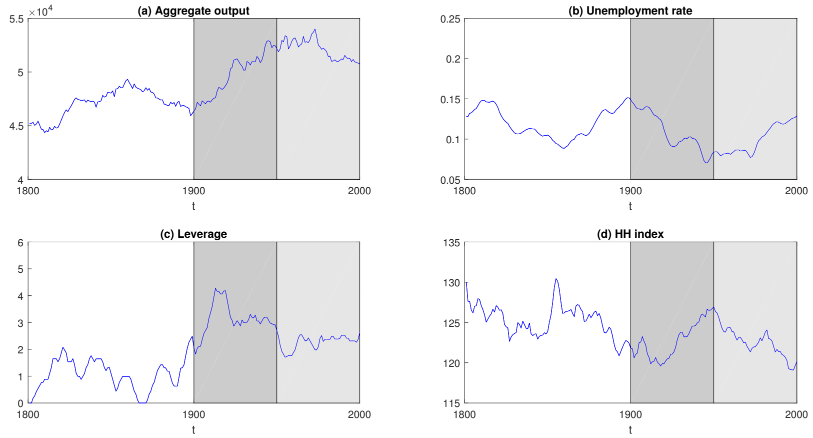


Figure 3.2: The story of a business cycle: GDP, unemployment, leverage and Herfindahl-Hirschman index in the last 200 periods of a representative simulation.

increasing probability of banks' default, on the other, as shown in panels (d) and (e) in Figure 3.1. The period of tranquillity is restored as the wave of bankruptcies clears the market from highly indebted agents, giving way to the emergence of new firms with healthier balance sheets.

Therefore, from Figures 3.1 and 3.2 it emerges that the interplay of an evolving financial structure and the changes in market forms resulting from the endogenous technical progress constitutes the main driving forces of the economic dynamics, both in terms of short-term business fluctuations and long-term growth pattern.

This outcome is confirmed by looking at the cross-correlation structures plotted in Figure 3.3, which shows the behavior of key macroeconomic variables alongside the GDP cycle. Or, more specifically, the correlation coefficients between the cyclical component of GDP at time t and that of selected variables at time t -/+ lags.[22] The figure shows that, in tune with the empirical evidence on business cycle (Stock and Watson, 1999), consumption and unemployment are, respectively, positively and

[22]To isolate the cyclical component from the trend, the Hodrick-Prescott filter is applied to our variables of interest.

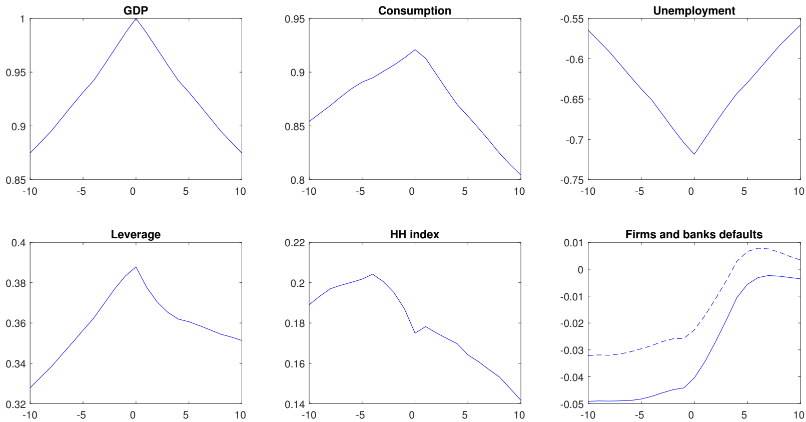


Figure 3.3: Cross-correlation coefficients between HP filtered GDP at time t and selected macro variables at time t -/+ lags. Mean values across 25 Monte Carlo simulations.

negatively related with respect to GDP. Moreover, it can be seen that leverage is procyclical, market concentration is leading, while firms and banks defaults are lagging by 5 lags with respect to the peak in GDP. Meaning that, consistent with previous findings, a high concentration today implies a high GDP at time $t+5$, but a high GDP at time t leads to high default rates in the near future.

3.4.2 Sensitivity analysis

Having established a baseline scenario and investigated its emergent properties, let us now shift the focus on the main research question of the chapter, that is, how the increasing role of speculative investors in the stock market affects managers' investment decisions and the resulting macroeconomic dynamics. To do that, we carry out a sensitivity analysis by running 25 Monte Carlo simulations with different random seeds for each value of parameter θ ranging from 0.1 to 0.9.[23]. The mean values across sim-

[23]Corner solutions are excluded in that the resulting outcomes would be substantially different from the benchmark, thereby hardly comparable with that, consisting in either a non-growing stationary

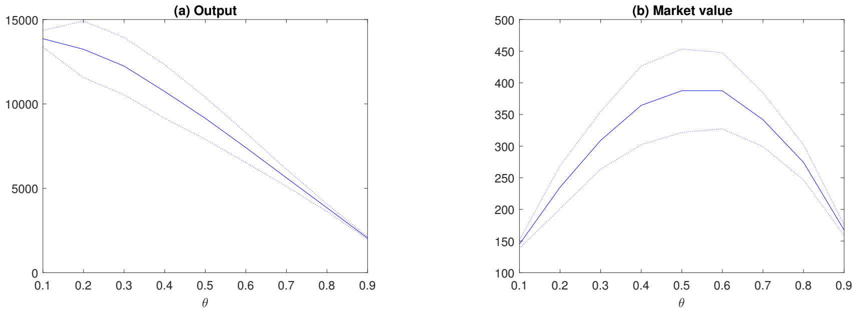


Figure 3.4: Total output and market value by θ. Mean values across 25 Monte Carlo simulations.

	θ	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Y%	mean	0.4432	0.4343	0.4228	0.4236	0.4180	0.4071	0.3917	0.3593	0.3080
	std	1.1466	1.0840	1.0610	1.0235	1.0897	0.9719	0.9811	0.9108	0.8477
MV%	mean	1.5252	1.5619	1.5746	1.6011	1.6225	1.6124	1.5913	1.5937	1.5887
	std	7.2013	6.6496	6.4041	6.5777	6.5729	6.4382	6.3231	6.2871	6.4125

Table 3.2: Output and market value growth rates: mean and standard deviation by θ. Mean values across 25 Monte Carlo simulations.

ulations for selected variables are then collected and reported in the following graphs.

Figure 3.4 illustrates the behavior of aggregate output and market value in response to changes in parameter θ. It emerges that a larger share of speculative investors leads to a lower economic growth, while the impact on the stock market is non-monotonic and can be represented by an inverted U-shaped curve: as θ increases, the market value initially grows, reaches a peak at $\theta = 0.6$, and then declines.

From Table 3.2, we notice that also the volatility of real and financial sectors significantly varies across simulations: the standard deviation of output growth steadily declines along the θ distribution, whereas the stock market volatility, after falling in the initial phase, is rather flat around 6%.

Hence, this first simulation experiment suggests that an increase in the fraction of speculative investors in the ownership structure leads to a lower but less volatile growth in the real sector and, at the same time, a higher growth in the financial

dynamics due to the missing innovation process ($\theta = 1$), or a collapsing stock market for the lack of stock buybacks ($\theta = 0$)

sector, as long as the share of speculators does not exceed a certain threshold (i.e., 60%), otherwise, the total market value begins to fall as well. This is what we call a 'stagnation-financialization paradox'.

To investigate the economic mechanisms behind the real and financial sector dynamics we firstly focus on those variables that, under the control of managers, are directly influenced by the stock market sentiment θ: share buybacks and R&D investment. Figure 3.5 displays the impact of changes in θ on aggregate profits, buybacks and R&D, both in ratios (left panel) and levels (right panel). As a measure of surplus, we use the fraction of reinvested profits, $\gamma\Pi_{i,t}$, which is nothing but the sum of buybacks and R&D investments; all ratios are computed with respect to aggregate sales.

Throughout different simulation runs, the profit to sales ratio is relatively stable, around 4%, whereas the propensities to buyback and to innovate take opposite directions. This is certainly not surprising but the direct effect of our assumption in equations (3.28) and (3.29), according to which, as θ increases, managers divert corporate resources from R&D to share buybacks to cater to shareholders' demand in an attempt to boost the stock price. By shifting the attention to the right-hand side panel where variables are expressed in absolute value, however, we notice that, albeit R&D investment steadily declines, the pattern of buybacks is not constantly increasing; for high values of θ, economic growth is so low that the following decline in profits drags buybacks spending down, despite their increase in relative terms. In other words, the relative increase in the propensity to repurchase is not able to counteract the effects of the fall in actual profits due to sluggish growth, causing the stock market to fall.

These results bring us to a first preliminary conclusion: share buybacks can effectively support stock prices despite a slowing real economy resulting from a decline in innovative activity as long as corporate profits remain sufficiently high. In this sense, what drives financial market dynamics are not stock buybacks per se, but the evolution of aggregate profits, the former being a function of the latter, and given that an increase in the propensity to repurchase alone is unable to support the stock market

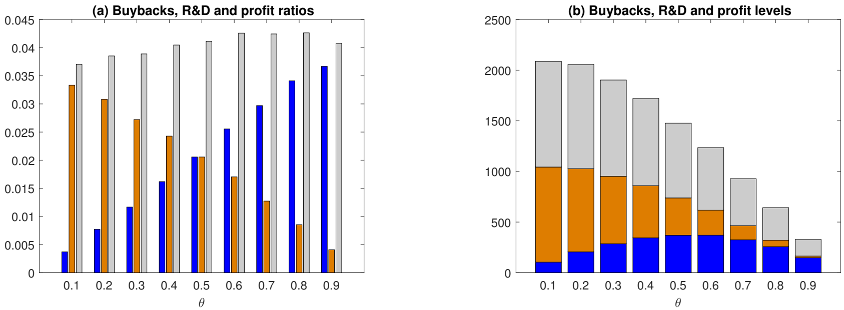


Figure 3.5: Changes in aggregate profits, buybacks and R&D by θ, in ratio to sales (left-hand side) and absolute value (right-hand side). Mean values across 25 Monte Carlo simulations.

in a context of an economic slowdown.

In other words, when the stock market is controlled by speculative investors (i.e., $\theta \gg 0.5$) it would not be proper to refer to a stagnation-financialization paradox in that both the real and financial sectors display a declining trend. If such a paradox is to exist, therefore, it is necessary that the configuration of the ownership structure and the mode of utilization of surplus are such that the corporate sector can generate and distribute a sufficient amount of profits to support the stock price, despite a slowing real economy. In order for this to occur the share of speculative investors should not exceed a certain threshold, i.e., 60%, otherwise a falling tendency is thrust upon both real and financial sectors.

We now extend the sensitivity analysis to a broader set of macroeconomic variables to obtain insights into the effects of rising financialization on the economic system as a whole.

Figure 3.6 presents the simulation results from the economy-wide comparative dynamics exercise. From panels (a) and (b) it can be seen that as the share of speculative investors increases, the following decline in the innovative effort implies a reduction in productivity, real wages and aggregate demand. Hence, the ongoing decline in the real sector translates into worsening workers conditions. Yet, because financial wealth

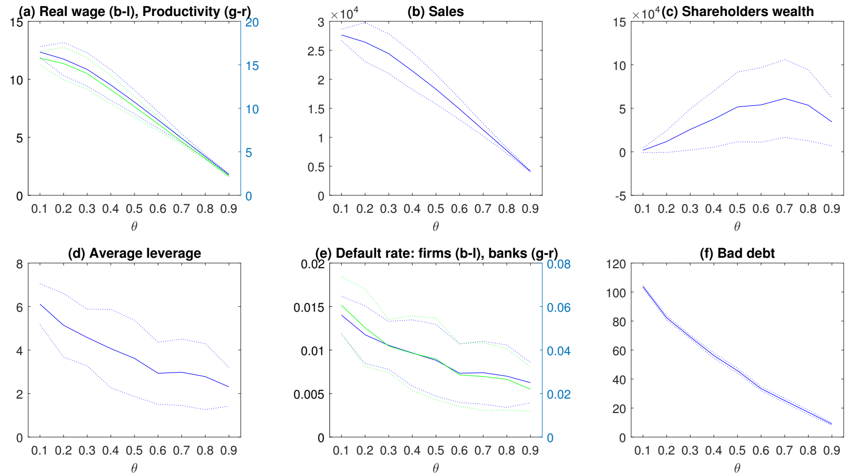


Figure 3.6: Behaviour of selected macroeconomic variables in response to θ, i.e., share of speculative investors in the stock market. Mean values across Monte Carlo simulations.

depends on the stock market dynamics, shareholders do not always benefit from an ever growing propensity to distribute profits: as seen in Figure 3.5, for high values of θ, the economic growth is so low that the ensuing fall in profits inevitably causes the stock market to decline, and so does investors wealth. This result suggests that excessive financialization is detrimental not only for workers, but for shareholders too.

In Table 3.2 we have seen that both mean and standard deviation of GDP growth decline with θ, suggesting that the real sector growth becomes slower and less volatile when financial markets are dominated by speculative investors. This outcome is confirmed by looking at the three bottom panels in Figure 3.6. Indeed, when the prevailing market sentiment is patient and profits are mostly reinvested in the production (i.e., $\theta \ll 0.5$), the output growth is accompanied by an increased financial instability, as manifested by the relatively high levels of leverage, default rates and bad debt in panels (d)-(f). As θ increases, by contrast, the slowdown in the economic activity brings about a decline in the magnitude of financial distress: business fluctuations turn out to be

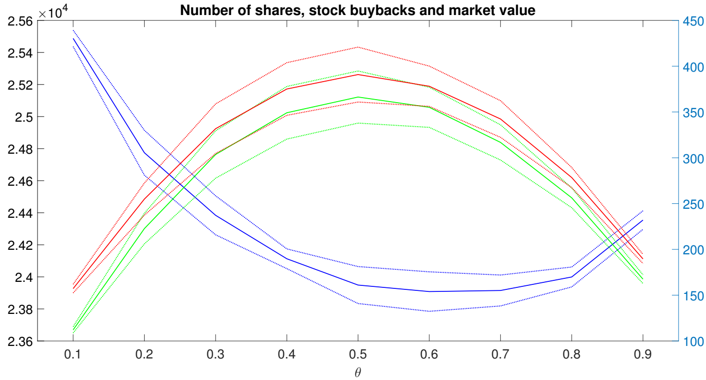


Figure 3.7: Total number of shares (blue), stock buybacks (green) and market value (red) by θ. Mean values across 25 Monte Carlo simulations.

severely limited in so far as weak growth opportunities due to the reduced innovative effort discourage firms to take on debt and expand the production.

In light of these results, consistent with the economic tradition rooted in the theories of Keynes and Minsky, there seems to be a trade-off between economic growth and financial stability: high leverage and bank exposure boost output growth but at the cost of a rising financial fragility, and vice versa. In the absence of an appropriate policy intervention, it does not seem possible to escape from this growth-stability dilemma.

Finally, it is worth noting in Figure 3.7 how the variation in stock buybacks spending (green line) in response to θ not only affects the aggregate market valuation (red line), but also triggers a symmetric change in the total number of shares (blue line). This is given by the fact that stock buybacks systematically exceed the issuance of new shares, resulting in a persistently negative net equity issuance, a stylized fact concerning U.S. corporate sector (Van Rixtel and Villegas, 2015).

3.5 Concluding remarks

This chapter presents a macro-finance agent-based model with credit and stock markets in order to study the impact of financialization, here defined as an increasing influence of speculative investors in the ownership structure, on managers' planning horizon and investment decisions and the resulting macroeconomic dynamics. The idea is that when the stock market is populated by speculative investors, firms tend to distribute an increasing share of profits to shareholders to boost stock prices, at the cost of lower long-run real investments. Simulation results show that, as the fraction of speculative investors in the stock market increases, the reduced innovative effort implies a lower and less volatile growth in the real sector, while the increasing propensity to repurchase shares enables firms to support stock prices in spite of an economic slowdown, giving rise to what we have called a 'stagnation-financialization paradox'. Yet, the diverging trends in the real and financial sectors persist as long as the fraction of speculators is not too large, otherwise the rate of economic growth is so low that the ensuing fall in aggregate profits drags buybacks spending down, causing the financial market to fall. Indeed, our findings highlight that: (i) stock buybacks can effectively support the stock price despite a slowing real economy resulting from a declining innovative activity as long as corporate profits are sufficiently high; (ii) in order for this scenario to manifest, it is necessary that the share of speculative investors in the stock market and the consequent payout ratio are not too high. Under these conditions, the corporate sector can generate and then distribute a sufficient amount of profits to shareholders in order to support the stock market despite a slowing real economy.

From a theoretical viewpoint, this chapter has shown that the increasing tendency to maximize the stock market value at micro level cannot produce, by itself, a systematic disconnect between financial markets and the real economy at macro level. In fact, the resulting changes in macroeconomic conditions in terms of lower growth and lower profits due to the reduced innovative effort eventually constrain the individual firms' ability to artificially boost the stock price by means of share buybacks. In this sense, the use of an agent-based modelling approach allowed us to identify, by means of simulation experiments, the "*macro-foundations*" of the stagnation-financialization paradox, i.e., the conditions under which a real-financial disconnect can actually arise. Namely, when the economy experiences high profits despite low growth. This is so because the asset price dynamics ultimately follows the evolution of aggregate profits, which, on the other hand, might not to be aligned with the overall economic performance. This result, in turn, led me to investigate more deeply the role of the changes in market structure in relation with distribution and growth, which constitute the object of study of the next chapter. In fact, as Baran and Sweezy (1966) and Sylos Labini (1967) pointed out long ago, it is under oligopolistic or monopolistic conditions that the economy can exhibit a tendency of the profit share to rise in a context of economic stagnation.

From an economic policy viewpoint, our results bring about important distributional concerns which would require appropriate policy interventions. If the economy is stuck in a situation in which financial markets can prosper on the basis of a stagnant real economy, the wealth of shareholders and managers with a share-based remuneration schemes will increase at the expense of wage earners' conditions. On the other hand, we have seen that rising growth rates of GDP are associated with a greater financial instability and a higher fraction firms and banks defaults. To break this growth-stability trade-off and to bring the economy out of the stagnation-financialization trap, public authorities ought to intervene both at the micro and macro level by designing a set of rules aimed at ensuring a sound and sustainable development. Based on these findings and in line with the policy brief by Battiston et al. (2018), the policy action should encompass: (a) an anti-cyclical management of fiscal and monetary policy to mitigate fluctuations in the business cycle, (b) progressive tax system to guarantee a more equal income distribution and support consumption demand, (c) a tax on capital gains (e.g. Tobin tax) intended to foster long-term investment horizon in financial markets and discourage speculative attitudes, and (d) a management compensation scheme aimed at prioritizing long-term firm performance in place of short-term financial returns.

Chapter 4

Concentration, Stagnation and Inequality: An Agent-Based Approach

4.1 Introduction

Over the last three decades, advanced economies, particularly the U.S., have undergone major structural changes which manifest themselves in a number of secular trends (Stiglitz, 2019; De Loecker et al., 2020), that is, rising market concentration, widening income inequality and secular stagnation. Empirical research has shown that there is a strong interdependence among these trends (Syverson, 2019), although, in our view, a comprehensive theoretical framework is yet to be developed.[24]

The present chapter aims to fill this gap, by proposing a theoretical framework that allows to systematically analyse the dynamic interrelationship between changes in market structure, income distribution and economic growth. In particular, the goal

[24] Some recent attempts to formalize the relationship between concentration, stagnation and inequality have been made in the mainstream literature, (e.g. see Barkai, 2020; Autor et al., 2020; De Loecker et al., 2020). However, these works are built on static partial equilibrium models, which cannot fully account for the dynamic relationship between the phenomena under consideration.

is to analyse the underlying causes of rising market concentration, by focusing on the interplay of technical change and market power, and its macroeconomic consequences, in terms of distribution and growth.

To do that, we develop an agent-based model rooted in the macro-evolutionary tradition, characterized by endogenous technical change and heterogeneous capital goods equipped with different production coefficients depending on a stochastic innovation process. Yet, differently from other ABMs in this literature wherein the innovation activity is carried out exclusively by capital good firms (K-firms hereafter) to search for new innovations and/or to imitate that of competitors (Dosi et al., 2010; Dawid et al., 2012; Caiani et al., 2019), in our model also consumption good firms (C-firms) can invest in R&D in order to accumulate technological knowledge, which allows them to identify and employ the best techniques produced by K-firms. Indeed, following Sylos Labini's (1967) intuition, the source of concentration lies in the fact that heterogeneous firms do not have equal access to capital-embodied innovations; rather, we assume that this depends on the "knowledge gap", i.e. the difference between the degree of capital vintage's technical advancement and firm's level of technological knowledge. It follows that, *in the absence* of consistent knowledge spillovers and *as long as* capital goods remain considerably different from each other, technical progress generates "technological discontinuities" (Sylos Labini, 1967), i.e. systematic differences in productivity across firms, leading to a reallocation of market shares towards more productive firms. The interwined dynamics of knowledge accumulation and technical change is the driver of the endogenous formation of firms' heterogeneity and "technological discontinuities", paving the way for a shift in the market structure from a competitive to an oligopolistic form.

The link between the microeconomic analysis of oligopoly and technical progress and the macroeconomic analysis of income distribution and growth passes through the changing pricing behavior by large newly-emerging firms.

Operating under conditions of oligopoly characterized by technical entry barriers, large firms seek to translate the enhanced market power into higher profit margins. Following Dosi et al. (2010), the mark-up is set endogenously by firms according to the degree of monopoly power (Kalecki, 1942), as reflected in their individual market share. As the influence of large firms grows over the economy, the rise in the weighted-average mark-up leads to a shift in the income distribution from wages to profits that eventually undermines consumption and aggregate demand (Keynes, 1936), with detrimental effects on investment and long-run growth. Therefore, our model is able to highlight how, in the absence of countervailing forces, the tendency to oligopoly at the micro level may give rise to a tendency to stagnation at the macro level.[25]

Finally, we perform a set of policy experiments, such as competition, innovation, fiscal and labor market policies, in order to identify the best policy mix able to halt the stagnation tendency and to foster a competitive and innovation-led growth process.

First, simulation results show that, whereas in the short-run a first wave of concentration is triggered by knowledge-based technical entry barriers, which constrain firms' access to capital-embodied innovations, the duration of concentration in the long-run crucially depends on the presence (or lack thereof) of legal entry barriers, which affects the process of diffusion of technological innovations across firms over time. Indeed, by comparing two alternative scenarios corresponding to different patent system regulations, we find that, when K-firms are allowed to imitate their competitors' technologies, market competition is soon re-established. This is because the imitation activity carried out by K-firms brings about a convergence amongst different techniques in the medium-run, which, by reducing technological discontinuities across C-firms, allows laggards to catch up. Conversely, in the "no-imitation" scenario, the persistent heterogeneity between capital goods is then reflected in the increasingly heterogeneous productivity among firms in the consumption good sector. In such a scenario, because technological discontinuities grow over time, large firms are able to consolidate their

[25] Baran and Sweezy (1966), Sylos Labini (1967) and Steindl (1976) previously reached a similar conclusion, albeit from different perspectives.

dominant position and to extract a higher share of rents, with harmful effects on distribution, demand and growth also in the long run. Thus, our findings suggest that the pattern of economic growth is driven by the dynamic interrelationship between the evolution of technological regimes in the capital good sector and changes in market forms in the consumption good sector, with following non-trivial effects on changes in market power, income distribution and aggregate demand.

Furthermore, from additional policy experiments it emerges that weak labour unions and weak anti-trust policies, by exacerbating the vicious circle between demand, inequality and concentration, accentuate the stagnation tendency. Similar results are obtained from a restrictive fiscal policy that prevents a fully anti-cyclical management of the public budget, whereas innovation policies aimed at fostering knowledge spillovers across firms risk to be ineffective as long as the technical ability to process it remains unequally distributed in a highly concentrated industry.

The rest of this chapter is organized as follows. Section 4.2 reports findings from the recent empirical literature on macroeconomics and market power. Section 4.3 discusses the alternative hypotheses in the current debate on the causes and consequences of rising concentration; the key elements of our theoretical framework are also outlined. Section 4.4 presents the model setup and behavioural equations. Section 4.5, after confronting the model's properties with real data, illustrates the simulation results from our economic analysis and policy experiments. Section 4.6 concludes.

4.2 Empirical evidence

Rise of concentration Since the mid-90s, more than 75% of U.S. industries have experienced an increase in concentration levels, as measured by the Herfindahl-Hirschman index, with an average growth amounting to 90% (Grullon et al., 2019).

The process of rising market concentration has been accompanied by declining firms entry and business dynamism (Grullon et al., 2019; Gutiérrez and Philippon, 2019).

In the U.S. corporate sector, the decrease in the number of firms is associated with a marked increase in average firm size, measured by total sales, starting from the late 1990s. Furman and Orszag (2018) find that the rate of new business formation has witnessed a one-third reduction since the early 1980s, together with a steady exit rate, suggesting that "firms are larger and older today while also representing an increased share of employment".

Moreover, there is an increasing consensus in the empirical literature that the enhanced market concentration has led to increasing corporate profits and thus changes in income distribution and overall economic performance (Crouzet and Eberly, 2019); yet, why and to what extent this has occurred is still object of debate.

Increase in inequality Plenty of studies have documented a widespread increase in income inequality, particularly since the 2000s, both in the functional and in the personal earnings distribution (Stiglitz, 2012; Piketty, 2014; Karabarbounis and Neiman, 2014; Atkinson, 2015). In the U.S., excluding the top 1% of the distribution, the income share going to wages has plummeted from 75% in 1980 to 60% in 2010 (Giovannoni, 2014): real wages have slowed down since the early 1970s, so does productivity but at lower rates, causing the labor share to decline (Benmelech et al., 2018; Barkai, 2020; Autor et al., 2020).

Lately, empirical research has made attempts to identify a potential link between changes in market structure and income distribution. Grullon et al. (2019) and Barkai (2020) highlight that firms operating in more concentrated industries have experienced extraordinary high profit rates, mainly driven by wider profit margins rather than improvements in operational efficiency. Therefore, in contrast with Autor et al.'s (2020) hypothesis of "superstar firms" that emphasize the role of productivity gains, those authors stress that the increase in U.S. corporate profits can be largely explained by the enhanced market power stemming from rising concentration and entry barriers, which enable firms to set prices not subject to competitive constraints (Stiglitz, 2019).

De Loecker et al. (2020), in particular, find that in the U.S. economy mark-ups remained roughly constant between 1950-1980 and since then have continued to grow, with the average price going from 21% to 61% above marginal cost. According to them, the rise in mark-ups far exceeded overhead costs and is mainly driven by firms in the top half of mark-up distribution, with median and lower percentiles being largely invariant over time.

Additionally, Autor et al. (2017) remark that there is a significant negative relationship between firms' market and labor shares. They illustrate that product market concentration has gone hand-in-hand with employment concentration, which also increased but less than proportionally; meaning that firms achieve larger market shares with relatively small workforce. Additionally, firms operating in concentrated labor markets tend to exert the resulting monopsony power to put downward pressure on wages, especially when unionization rate is low and thus workers' bargaining power relatively weak (Benmelech et al., 2018).

Decline in investment and output growth Despite historically low interest rates, increasing profitability and high funds availability, over the last decades the investment rate of U.S. non-financial corporations has been constantly slowing down, starting from 32% in the 1980s and declining steadily up to 26% in the 2010s (Gutiérrez and Philippon, 2016). According to Gutiérrez and Philippon (2017), such an "investment gap" is stronger in concentrating industries, where, in view of diminishing profitable investment outlets, monopolistic rents are largely distributed to shareholders by means of dividend payments and share buybacks (Gutiérrez and Philippon, 2016, 2017; Stiglitz, 2019).

Crouzet and Eberly (2019) point out that weak capital investment can be only partly explained by the shift in the composition of capital stock from physical capital towards "intangible capital". Nonetheless, they stress that the investment pattern shows significant differences across U.S. industries, despite similar concentration dynamics: it has been rising in structures and related sectors, e.g. oil & gas and telecoms; declining in manufacturing, although the relative importance of this sector over total value added has diminished; declining in high-tech and retail sectors, despite strong increases in sales, profits and market valuations. Based on this mixed evidence, Crouzet and Eberly (2019) conclude that whether concentration is good or bad for the overall economic performance ultimately depends on its sources, as we explain in the next section.

The slowdown of capital accumulation is then reflected in the long-lasting decline in average output growth, which in the U.S. decreased from 3.7% between 1947-1980 to 2.7% between 1980-2017, nearly 30% lower (Stiglitz, 2019). After controlling for demographic changes, per capita income growth also declined from 2.7% to 1.7%, and so did productivity growth, if we exclude a short-lived upswing around the turn of the 21st century, mainly driven by the dot-com bubble (Furman and Orszag, 2018).

4.3 Current debate on market concentration

In the light of the empirical evidence discussed above, it is possible to identify two alternative hypotheses on the causes and consequences of rising market concentration that enliven the current debate, that is "efficiency-enhancing" and "rent-extracting" hypotheses.

4.3.1 Alternative views of rising concentration

According to the *efficiency-enhancing hypothesis*, market concentration is the outcome of technical change spurred by the adoption of more efficient techniques by large ("superstar") firms. By exploiting scales economies and low unitary costs, those firms are able to sustain big upfront innovative investment and thus achieve productivity gains, cost reductions and larger market shares. Consequently, rising concentration, by fostering aggregate productivity and improving the efficient allocation of resources, has a positive impact on the economy, although it may come at the cost of a lower wage share following the introduction of labor-saving innovations (Autor et al., 2017, 2020).

On the other hand, according to the *rent-extracting hypothesis*, market concentration is associated with the enhanced market power resulting from higher entry barriers, either legal or technological, which undermine competition by preventing potential rivals from entering the market (Grullon et al., 2019; Barkai, 2020; De Loecker et al., 2020). The enhanced market power is then reflected in higher mark-ups, leading to a shift in the income distribution from wages to profits. From a macroeconomic perspective, a falling labor share determines a decline in aggregate consumption because "those at the top have lower propensity to consume than those at the bottom" (Stiglitz, 2019). Moreover, due to the lack of competitive threats, firms operating in concentrated industries might have less incentives to innovate, while patent protections may restrict laggards' possibility to imitate, with this resulting in lower investment (Decker et al., 2016; Gutiérrez and Philippon, 2019). As a result, the process of market concentration, by exacerbating income inequality and weakening aggregate demand, is detrimental to economic growth.

In their work on intangible capital and concentration, Crouzet and Eberly (2019) put forward a third interpretation, based on the idea that the two aforementioned hypotheses, rather than mutually exclusive, may be regarded as two alternative equally-likely scenarios that arise depending on the sources of rising concentration. The latter might be "good", if triggered by productivity-enhancing technological innovations, or "bad", if due to entry barriers giving rise to market power.[26] Using U.S. firm and industry level data between 1988-2015, the authors find mixed, sector-specific evidence on the impact of rising concentration on business investment and economic performance, claiming that this would provide support to their thesis.

Like Crouzet and Eberly (2019), we are reluctant to consider the two above-

[26] "The source of rising concentration is thus important for understanding the extent to which rising concentration is efficient or not, and possible policy implications" (Crouzet and Eberly, 2019).

mentioned hypotheses as mutually exclusive. Rather, by adopting a dynamic approach, we interpret them as distinct descriptions of the two stages characterizing the process of market concentration: one dealing with its causes (efficiency-enhancing), the other with its potential implications (rent-extracting). In this way, it is possible to develop a comprehensive theoretical framework in which the effects of rising concentration are not necessarily pre-determined by its sources, as in Crouzet and Eberly (2019), but depend upon the dynamic interaction between two main forces driving the evolution of market structure, that is technical change and market power. Having outlined the *form* of our theoretical approach, let us briefly review its essential features.

4.3.2 Towards a general theoretical framework

To explain the endogenous formation and the dynamic interdependence between the secular trends characterizing modern advanced economies, that is, concentration, stagnation and inequality (Stiglitz, 2019; Syverson, 2019; De Loecker et al., 2020), the theoretical framework underlying our agent-based model, which is presented in the next section, combines old and new contributions in the micro and macroeconomic literature on oligopoly, technical change, distribution and growth.

As regards the first stage of the process of rising concentration, coherent with the "efficiency-enhancing" hypothesis, we resume and revise Sylos Labini's (1967) theory of oligopoly and technical progress. According to that, the tendency to concentration is driven by technical change that generates "technological discontinuities", i.e. systematic differences in productivity across firms, leading to a *reallocation* of market shares towards more productive firms. This is because heterogeneous firms do not have equal access to capital-embodied innovations, as we assume that this depends on the "knowledge gap", i.e. the difference between the degree of capital vintage's technical advancement and firm's level of technological knowledge. By influencing the entrepreneur's investment decision between heterogeneous machines produced by innovators, the knowledge stock, accumulated over time through R&D, constitutes a form of technical barrier to entry, or rather *to use* (Dosi and Nelson, 2010), which underlies the growing divergence in productivity and competitiveness across firms. It follows that, *in the absence of* consistent knowledge spillovers and *as long as* capital goods remain considerably different from each other, the interwined dynamics of knowledge accumulation and technical change is the driver of the endogenous formation of firms heterogeneity and "technological discontinuities", paving the way for a shift in the market structure from a competitive to an oligopolistic form.

Before we proceed any further in describing our theoretical framework, it is worth noting that by the way in which the firm's choice of capital vintages is formalized this chapter creates a bridge between the macro and the micro/industrial evolutionary literature of innovation and technical change. In the macro-evolutionary literature (Dosi et al., 2010; Caiani et al., 2019), in fact, the corporate sector is made of C-firms and K-firms whereby the former buy machine tools from the latter based on their relative price, which is inversely proportional to the respective productivity. This means that, quite oddly, the most efficient machines are also the cheapest ones, thereby everyone can easily access them. Many contributions in the micro-evolutionary literature, instead, stress the role of technological knowledge in the success of innovative activities carried out by (capital good) firms (Cantner and Pyka, 1998; Cohen and Levinthal, 1989; Dawid, 2006). This chapter proposes a synthesis of the two approaches by conceiving the technological knowledge as a means to improve the C-firms' ability to employ the best machines produced by K-firms. As such, the knowledge stock has a similar function as the average skill level of workers in the EURACE model (Dawid et al., 2012): in there, the firm's choice of a capital vintage depends upon the current expectation of its effective productivity, which, in turn, may be possibly constrained by the workers' accumulated capabilities. In this regard, the main difference with the EURACE model is that while in Dawid et al. (2012) the technological knowledge is embedded in the skill level of workers, we put forward an explicit formalization of the process of knowledge accumulation, which evolves over time by means of R&D carried out by research workers, in tune with Cohen and Levinthal (1989).

The theoretical link between the microeconomic analysis of oligopoly and technical progress and the macroeconomic analysis of distribution and growth is the key to understand the transition from the first to the second stage of the process of market concentration. Such a link passes through the changing pricing behaviour by large newly-emerging firms.

In the first competitive stage, because of limited market power, firms act as *price taker* units, with price converging to marginal cost. In such a context, the falling unit labor cost stemming from technical change translates into lower output prices, leading to higher real incomes that foster a self-sustained growth process. At this stage, the rise in concentration resulting from technical progress is in fact *efficiency-enhancing* in that it brings about an increase in productivity growth and better economic performance.

However, the shift towards an oligopolistic market form following the emergence of technical entry barriers implies that large firms end up with a considerable degree of market power, thus becoming *price maker*. In the absence of competitive pressure, the price is not taken as given, but is set endogenously by leading firms, who apply a mark-up over unit labor cost according to their 'degree of monopoly power', as reflected in the individual market share (Kalecki, 1942; Steindl, 1976). It follows that, as the share of large firms grows over the economy due to the establishment of technological discontinuities and entry barriers, the enhanced market power might translate into rising weighted-average mark-up, leading to a shift in the income distribution from wages to profits. From a macro perspective, the resulting slowdown in real wages determines a shortage in consumption and aggregate demand, which entails negative effects on investment and long-run growth. In view of diminishing profitable investment outlets due to weak demand, indeed, large firms are faced with unused capacity, on the one hand, and excess cash resulting from economic rents, on the other. As a result, *in the absence of* countervailing forces, the tendency to concentration eventually gives rise to a tendency of the profit share to rise in a context of a stagnant real economy, as Baran and Sweezy (1966) and Sylos Labini (1967) previously pointed out.

From the dynamic framework proposed here it emerges that market concentration per se is neither to be seen as *efficiency-enhancing* or *rent-extracting*. Rather, as will be clear from the simulation results, the transition from one stage to the other, hence the evolution of market structure and its implication on the overall economic performance, is the result of the (inter)action of a variety of forces at stake, i.e. technical change, the establishment of either legal or technological entry barriers and the exploitation of the resulting market power by oligopolistic firms.

4.3.3 Methodology

From a methodological standpoint, we believe that an agent-based model is a particularly suitable tool to address our research question, that is to examine the endogenous formation and co-evolution of concentration, stagnation and inequality. Indeed, the agent-based computational approach conceives the economy as a complex evolving system, wherein aggregate outcomes are determined by heterogeneous agents interacting in decentralized markets following simple adaptive rules (Delli Gatti et al., 2018; Dawid and Delli Gatti, 2018; Dosi and Roventini, 2019).

Such an approach enables us to treat market concentration as a complex phenomenon, the effects of which may vary depending on the dynamic interaction amongst heterogeneous agents as well as between them and the changing economic environment, e.g. market power, entry barriers, etc. Computer simulations will help us identify the conditions under which market concentration is either *efficiency-enhancing* or *rent-extracting*, by highlighting the underlying economic mechanisms bringing the system from one stage to the other. Furthermore, an agent-based model provides a valuable framework to assess the impact of a wide set of policy experiments both in the short and long run, taking also into account different regulatory or institutional setups (Fagiolo and Roventini, 2016).

While there are quite a number of studies on inequality (e.g. Dosi et al., 2013; Russo et al., 2016; Dawid et al., 2018; Dosi et al., 2018; Cardaci, 2018; Caiani et al., 2019) and, to a lesser extent, on large-scale economic downturn (e.g. Giri et al., 2019), to the best of our knowledge this is the first research in the macro ABM literature that investigates the causes and consequences of rising market concentration, in relation with income distribution and growth.

4.4 Model setup

The model is characterized by: (i) a corporate sector, including N capital good producers (or *innovators*) and F consumption good producers (or *entrepreneurs*); (ii) a household sector, composed of W workers and K capitalists; (iii) a banking sector with one representative bank; (iv) a public sector, namely the Government.

The structure of the model builds upon the macro agent-based model with capital and credit (CC-MABM) developed by Assenza et al. (2015). A few major changes are introduced with respect to the parental model: (i) entrepreneurs' quantity and price decisions are taken separately, being the former based on expected sales, while the latter on the degree of market power; (ii) capital goods are heterogeneous with respect to built-in productivity, whose improvements depend upon a stochastic innovation process à la Dosi et al. (2010); (iii) C-firms also perform R&D in order to accumulate technological knowledge, which enhances their ability to identify and employ the best machines produced by innovators.

Coherent with Assenza et al. (2015), workers and firms are heterogeneous agents and interact in decentralized labor, consumption and capital goods markets, according to the well-established search-and-matching procedure (Riccetti et al., 2015). The general rule is the following[27]: in every market, each individual on the demand side visits a given

[27]Though the structure of interaction for each market is characterized by a specific protocol, as

number of randomly sampled units on the supply side, compares/ranks them based on certain criteria, e.g. price, and chooses the partner ranking in the first position. Because of transaction costs and limited information, markets are incomplete and coordination issue may arise; in the absence of a centralized market-clearing mechanism, the system may self-organize towards a spontaneous order characterized by sub-optimal outcomes and out-of-equilibrium dynamics.

4.4.1 Sequence of events

Throughout one time period of the simulation run, events unfold in the following order:

1. *Production planning and factors demand:* Based on expected sales, C-firms compute desired production, utilization rate and labor demand for both production and research workers.

2. *Capital goods market (1):* C-firms select their potential supplier of machine tools depending on the 'knowledge gap', which measures the distance between the capital goods' technical advancement and C-firms' level of technological knowledge.

3. *Credit market:* If production costs exceed internal funds, C-firms resort to the bank asking for a loan.

4. *Labor market:* Firms can hire and fire production and research workers according to their labor requirements; employees receive a wage.

5. *Production and price:* C-firms produce consumption goods as the minimum between desired and potential output; the price is set by charging a markup over the unit labor cost depending on the firm's market power.

6. *Capital goods market (2):* C-firms with a positive investment demand buy the required capital units from the previously selected supplier. Capital goods are

described below.

produced by K-firms according to a Make-to-Order plan and are made available for the production process starting from next period.

7. *R&D activity (1):* Both consumption and capital good firms implement R&D activity based on previously allocated funds: C-firms update their knowledge stock; K-firms perform product and process innovation as well as imitation activities to develop more efficient vintages of capital goods.

8. *Taxes and subsidies:* Government collects taxes on wages and distribute unemployment benefits to non-working people.

9. *Consumption goods market:* Households set their consumption demand, visit a number of C-firms and buy goods starting from the one charging the lowest price until their budget is satisfied.

10. *Profits and dividends:* Firms collect revenues and distribute part of their profits to capitalists as dividends, on which the Government collects taxes.

11. *R&D activity (2):* Both consumption and capital good firms allocate part of realized profits to the R&D budget that will be used in the following period.

12. *Entry-exit dynamics:* Retained earnings accumulate to the net worth. Should the latter be negative, firms declare default. Bankrupted firms exit and are recapitalized by means of the owner's wealth.

13. *Public deficit and bond issuance:* The Government issues bonds, purchased by the bank, to finance the public expenditure in excess of tax revenues; public debt is updated accordingly.

14. *Bank's profits, dividends and equity:* The bank collects interest payments from borrowings, records non-performing loans and distributes dividends to capitalists. After-dividends earnings pile up to the bank's equity.

4.4.2 Corporate sector

Consumption good firms

Quantity choice C-firms produce a homogeneous consumption good using labor and heterogeneous capital goods. Being unable to observe actual demand, the desired output, $\tilde{Y}_{it}$, is set on the basis of expected sales, S^e_{it}, as computed by means of a simple adaptive rule depending on past forecasting errors, as in Eq. (4.2). Additionally, when planning production orders, firms take into account: (i) the desired inventory level, given by a fraction κ of expected sales, in order to hedge against short-term demand swings (Caiani et al., 2018), (ii) the involuntary inventories of unsold goods, inv_{it-1}, inherited from the previous period, which depreciate at a rate δ^{inv}. Hence, the desired output is defined as

$$\tilde{Y}_{it} = S^e_{it}(1+\kappa) - inv_{it-1}, \tag{4.1}$$

$$S^e_{it} = S^e_{it-1} + \rho(S_{it-1} - S^e_{it-1}). \tag{4.2}$$

Because frictions in the labor or credit markets may possibly constrain firms' factor demands, the actual scale of economic activity is ultimately computed as the minimum between desired and potential output. To produce the consumption good, firms combine labor and heterogeneous capital in fixed proportions, according to a Leontief technology. Assuming labor is the abundant factor, the production function reads

$$Y_{it} = \sum_{v \in V_{it}} \omega^v_{it} k^v_{it} \bar{A}^v_i, \tag{4.3}$$

where V_{it} is the set of capital goods owned by firm i at time t, ω^v_{it} is the utilization rate relative to each capital vintage v, k^v and $\bar{A}^v_i$ are the amount of capital units of type v and the related effective productivity, respectively. As will be shown below, the latter depends on the ability of firm i to exploit the built-in technology of the capital vintage

v.

C-firms respond to short run fluctuations in expected sales by adjusting the rate of capacity utilization as well as the required workforce, whereas the capital stock is modified according to long-run production requirements, in tune with Assenza et al. (2015).

Determination of utilization capacity Having defined the desired level of production, the required utilization rate by capital vintage, ω_{it}^v, and labor demand, N_{it}, are derived from Eq. (4.3). Following Caiani et al. (2018), in each period C-firms rank the available machine tools based on their built-in productivity – $v = 1, 2, 3, ...$ with the first being the most productive – and employ them in the production process starting from those with the highest quality. The desired utilization rate of capital vintage v by firm i is determined according to the following algorithm:

$$\tilde{\omega}_{it}^v = \begin{cases} 1 & \text{if } \sum_{s=1}^{v-1} \tilde{\omega}_{it}^s k_{it}^s \bar{A}_i^s + k_{it}^v \bar{A}_i^v \leq \tilde{Y}_{it} \\ \frac{\tilde{Y}_{it} - \sum_{s=1}^{v-1} \tilde{\omega}_{it}^s k_{it}^s \bar{A}_i^s}{k_{it}^v \bar{A}_i^v} & \text{if } \sum_{s=1}^{v-1} \tilde{\omega}_{it}^s k_{it}^s \bar{A}_i^s \leq \tilde{Y}_{it} \text{ and } \sum_{s=1}^{v-1} \tilde{\omega}_{it}^s k_{it}^s \bar{A}_i^s + k_{it}^v \bar{A}_i^v > \tilde{Y}_{it} \\ 0 & \text{if } \sum_{s=1}^{v-1} \tilde{\omega}_{it}^s k_{it}^s \bar{A}_i^s \geq \tilde{Y}_{it}, \end{cases}$$

where $\bar{A}_i^v$ is the effective productivity of capital good v; see Equation (4.12).

Labor demand C-firms need workers to carry out both production and R&D activities. To preserve the stock-flow consistency of the model, in fact, the R&D budget is used to hire workers who perform R&D activity during the current period. Hence, researchers can be thought of as external consultants employed by the innovative firm to perform temporary R&D projects.

Given the desired capacity utilization, $\tilde{\omega}$, and the constant capital-labor ratio, $\bar{l}_k$, labor demand for production is given by

$$\tilde{N}_{it} = \sum_{v \in V_{it}} \tilde{\omega}^v_{it} \frac{k^v_{it}}{\bar{l}_k}. \tag{4.4}$$

If labor demand $\tilde{N}_{it}$ is greater than the current workforce N_{it-1}, or if R&D investment is positive, firms post vacancies on the job market[28], hence defined as

$$J_{it} = \begin{cases} \max(\tilde{N}_{it} - N_{it-1}, 0) + \max(\frac{RD_{it}}{w_t}, 1) & \text{if } RD_{it} > 0, \\ \max(\tilde{N}_{it} - N_{it-1}, 0) & \text{otherwise.} \end{cases} \tag{4.5}$$

R&D and technological knowledge The R&D budget is determined as a constant fraction of past realized profits, i.e. $RD_{it} = \sigma^c \pi_{it-1}$. The purpose of research activity carried out by C-firms is to accumulate a stock of technological knowledge, which, in turn, improves their ability to identify and employ the best machines produced by K-firms. The idea is that technological knowledge is not entirely a public good, but costly to acquire and process; as such, it requires prior R&D investment (Dosi and Nelson, 2010). Following the seminal work by Cohen and Levinthal (1989), R&D spending has a dual role in the process of knowledge accumulation: (i) to generate new technical knowledge; (ii) to increase the firm's 'absorptive capacity', i.e. its ability to assimilate external knowledge spillovers. Thus, the knowledge stock, z_{it}, evolves according to

$$z_{it} = z_{it-1} + RD_{it} + \gamma_{it}(\psi \sum_{j \neq i} RD_{jt} + J_t), \tag{4.6}$$

where

$$\gamma_{it} = 1 - e^{-\eta \overline{RD}_{it}}, \tag{4.7}$$

$$\overline{RD}_{it} = \xi \overline{RD}_{it-1} + (1 - \xi) RD_{it}. \tag{4.8}$$

[28] If R&D investment is positive, the firm hires at least one researcher.

According to equation (4.6), the knowledge base is generated both internally through firm's own R&D investment and externally by absorbing outside knowledge spillovers. As in Cohen and Levinthal (1989), the latter can be of two types: *intra-industry*, given by other firms' R&D activity, $\sum_{j \neq i} RD_{jt}$, given the degree of knowledge spillovers, ψ; *extra-industry*, namely public investment in basic research, J_t. The absorptive capacity, $\gamma_{i,t} \in (0,1)$, is determined endogenously based on firm's own R&D experience, where $\overline{RD}_{it}$ is the weighted average of current and past R&D spending with exponentially decaying weights, reflecting a sort of knowledge obsolescence. Note that, the fact that the absorptive capacity is firm-specific emphasises the role of firms' heterogeneity in the acquisition process of external knowledge spillovers, regardless of ψ.

Choice of capital vintage The process of knowledge accumulation plays a crucial role in the investment dynamics. In fact, following Sylos Labini's (1967) intuition, heterogeneous firms do not have equal access to capital-embodied innovations, as we assume that this ultimately depends on their accumulated technological knowledge.

To capture this idea, we formalize the choice between heterogeneous vintages of capital goods through a logit model, where the probability for firm i of selecting a machine v is a function of the 'knowledge gap', i.e. the difference between the degree of capital vintage's technical advancement, A^v, and the firm's level of technological knowledge, z_i, both computed as relative position in their respective distribution normalized into the range (0,1). Therefore, we have

$$\mathbb{P}[\text{Firm } i \text{ selects vintage } v] = \frac{\exp\left[-\beta(\hat{A}_j^v - \hat{z}_{it})^2\right]}{\sum_{v=1}^{V} \exp\left[-\beta(\hat{A}_j^v - \hat{z}_{it})^2\right]}, \tag{4.9}$$

where

$$\hat{A}^v = \frac{A^v - A_t^{min}}{A_t^{max} - A_t^{min}}, \tag{4.10}$$

$$\hat{z}_{it} = \frac{z_{it} - z_t^{min}}{z_t^{max} - z_t^{min}}. \tag{4.11}$$

The parameter $\beta \in (0, \infty)$ in Eq. (4.9) represents the *intensity of choice*, determining how fast firms choose a vintage v coherent with their technological knowledge. In words, Equation (4.9) states that the probability for firm i of selecting a given capital vintage v is inversely proportional to the knowledge gap with respect to that particular technology. For instance, let us consider the case of the machine tool at the technological frontier, i.e. $\hat{A}^v = 1$. In this case, the higher the firm's technological knowledge, z_{it}, the lower the knowledge gap with respect to the best technology $(\hat{A}^v - \hat{z}_i)$, the higher the probability for firm i of choosing it.

The underlying motivation is that to access and master the most efficient machines produced by innovators requires a prior build up of an in-house technical capacity. In this sense, the technological knowledge shall be considered as the firm's know-how, that is the set of skills and abilities accumulated over time by means of R&D. As such, it constitutes a form of technological barrier to entry, or rather to *use* (Dosi and Nelson, 2010), which, by influencing firms' access to technological innovations, is the ultimate driver of firms heterogeneity and productivity differentials.

Because the choice of the capital good is stochastic, a firm may happen to buy a machine with a degree of technical advancement relatively greater than her accumulated knowledge, that is $\hat{A}^v > \hat{z}_{it}$. In this case, the knowledge gap acts as a constraint on the effective usage of vintage technology, $\bar{A}^v_{it}$. Thus, the effective productivity associated with a capital vintage v owned by firm i is defined as

$$\bar{A}^v_{it} = \begin{cases} A^v & \text{if } \hat{A}^v \leq \hat{z}_{it}, \\ \frac{2A^v}{1+e^{a_1(\hat{A}^v - \hat{z}_{it})^{a_2}}} & \text{otherwise,} \end{cases} \tag{4.12}$$

with $a_1, a_2 > 1$. The function of the effective capital productivity is displayed in Figure 4.1. Here we can observe that firm i can fully exploit the productivity of vintage v as long as her degree of technological knowledge is higher than or equal to the capital's technical advancement. Otherwise, the knowledge constraints become

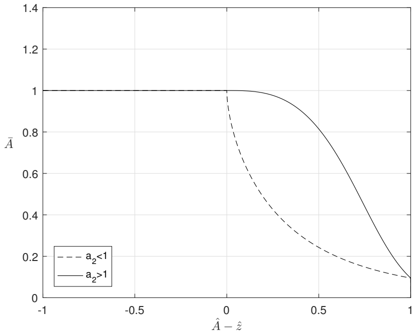


Figure 4.1: Effective productivity of capital vintage, $\bar{A}^v_{jt}$, as a function of the knowledge gap, $\hat{A}^v_t - \hat{z}_{it}$. The slope of the function represents the intensity of the knowledge constraints.

tighter the higher the size of the knowledge gap.

Investment demand Following Assenza et al. (2015), we assume that capital is fixed in the short run: the investment goods acquired in t can be employed in the production process starting from $t+1$. That being the case, the demand for capital by C-firms aims to meet long-run production needs, rather than the short-run market fluctuations.

To determine the investment demand, in particular, C-firms compare the capital requirements necessary to produce the long-run desired output with the current potential output, given the effective productivity of the selected vintage. The demand for capital is thus formalized as

$$I_{it} = \left(\frac{\bar{Y}_{it-1}}{\bar{\omega}} - \hat{Y}_{it}\right)\frac{1}{\bar{A}^v_i}, \tag{4.13}$$

where

$$\bar{Y}_{it-1} = v\bar{Y}_{it-2} + (1-v)\tilde{Y}_{it-1}, \tag{4.14}$$

$$\hat{Y}_{it} = \sum_{v \in V_{it}} (1-\delta) k_{it}^{v} \bar{A}_{i}^{v}. \tag{4.15}$$

The long-run desired production is computed after discounting the weighted-average planned output in equation (4.1) for the target utilization rate, $\bar{\omega}$, whereas the potential output in Eq. (4.15) corresponds to the maximum level of production a firm can achieve by fully employing the entire capital stock owned at time t, depreciated at a rate δ, as in Dawid et al. (2012). In other words, Equation (4.13) states that in case firms are not able to produce as much as they desire with the existing capacity, they will buy the additional amount of capital units from the previously selected supplier at the given productivity.

The law of motion for capital at the firm level, once taking into account the batch of heterogeneous machines, is given by

$$K_{it+1} = \sum_{v=1}^{V_{it}} (1-\delta) k_{it}^{v} + I_{it}. \tag{4.16}$$

Price setting Similarly to Dosi et al. (2010), C-firms set the price by charging a mark-up μ_{it} on the unitary labor cost, i.e.

$$p_{it} = (1+\mu_{it}) \frac{w_t N_{it}}{Y_{it}}. \tag{4.17}$$

In line with Kalecki (1942), the mark-up is determined endogenously and updated every period depending on the firm's degree of market power, as manifested in its individual market share. In particular, the mark-up rule is updated every period according to the rule

$$\mu_{it} = \begin{cases} \mu_{it-1}(1+\mu_t^r) & \text{if} \quad f_{it} > \bar{f}_t \ \& \ \Delta f_{it} > 0 \\ \mu_{it-1}(1-\mu_t^r) & \text{if} \quad f_{it} < \bar{f}_t \ \& \ \Delta f_{it} < 0 \\ \mu_{it-1} & \quad \text{otherwise.} \end{cases} \tag{4.18}$$

Equation (4.18) states that if the market share is above (below) the average share and increasing (decreasing) with respect to the previous period, the mark-up is adjusted by a positive (negative) number randomly drawn from a Folded Normal distribution with parameters $(\mu_{FN_3}, \sigma^2_{FN_3})$).

Profits distribution When consumption good market closes, C-firms collect revenues from sales and compute profits after subtracting total costs. The latter include wage bill, capital depreciation, interest payments on loans and R&D expenditure.[29] When a company earns a surplus, it is able to pay a fraction *div* of profit to the owner, net of dividend taxes. The gross and net profits equations thus read

$$\pi_{it} = p_{it}Q_{it} - (w_t N_{it} + \sum_{v \in K_{it}} \delta \omega_{it}^v k_{it}^v + \hat{r}_{it} L_{it} + RD_{it}), \tag{4.19}$$

$$\pi_{it}^{net} = \max((1-div)\pi_{it}, 0). \tag{4.20}$$

Net profits (or losses) pile up to equity, which evolves as

$$E_{it+1} = E_{it} + (1-div)\pi_{it}. \tag{4.21}$$

When equity turns negative, the firm goes bankrupt and exits the market. Given that, for simplicity, the number of firms is assumed to be constant over time, each bankrupted company is substituted by a new entrant, recapitalized by means of the owner's wealth.

[29] With regards to the interest payments, the rate on loans set by the bank for a specific firm can vary over time, therefore $\hat{r}$ is the weighted average of past interest rates with time-varying weights. The reader is addressed to Assenza et al. (2015) for a detailed explanation.

Capital good firms

Innovation and imitation K-firms produce heterogeneous machine tools using only labor according to a Make-to-Order plan, meaning that the production orders are based on C-firms' investment demand, with no inventory accumulation. Following Dosi et al. (2010), each K-firm is characterized by a technology (A^v_{jt+1}, B^k_{jt+1}), where the former represents the productivity associated with the machine tool produced by firm j, while the latter indicates the labor productivity of firm j itself. Innovators strive to improve the 'quality' of their technologies and reduce the production costs. To do that, they invest a constant fraction, σ^k, of profits in R&D to perform innovation and imitation activities, depending on parameter $\chi \in (0, 1)$, i.e.

$$RD_{jt} = \sigma^k \pi_{jt-1}, \tag{4.22}$$

$$IN_{jt} = \chi RD_{jt}, \tag{4.23}$$

$$IM_{jt} = (1 - \chi) RD_{jt}. \tag{4.24}$$

In line with the evolutionary tradition of technical change (Nelson and Winter, 1982; Dosi et al., 2010; Caiani et al., 2018), innovation and imitation activities follow a two-step stochastic process.

The first step determines whether or not the firm has opportunity to innovate and imitate, defined as a random drawn from a Bernoulli distribution, with parameters Pr^{inn}_{jt} and Pr^{inn}_{jt}, i.e.

$$Pr^{inn}_{jt} = 1 - e^{-\varsigma IN_{jt}}, \tag{4.25}$$

$$Pr^{imi}_{jt} = 1 - e^{-\varsigma IM_{jt}}, \tag{4.26}$$

with $\varsigma > 0$. Hence, the probability to innovate and imitate is positively influenced by the scale of R&D investment.

In the second step, firms having the opportunity to innovate draw from a Folded Normal distribution a pair of technological innovations (Δ_A, Δ_B), defined as productivity gains of the respective production techniques, according to

$$A^v_{jt+1} = A^v_{jt}(1 + \Delta_A), \text{ where}\Delta_A \sim FN(\mu_{FN_1}, \sigma^2_{FN_1}), \tag{4.27}$$

$$B^k_{jt+1} = B^k_{jt}(1 + \Delta_B), \text{ where } \Delta_B \sim FN_2(\mu_{FN_2}, \sigma^2_{FN_2}). \tag{4.28}$$

As for the imitation process, when a K-firm draws the opportunity to imitate, it will search among the Z_{imi} relatively more technically advanced firms and it will randomly pick one of their technologies.

Finally, firms compare the technological opportunities arising from innovation and imitation process and choose to produce the techniques with the highest built-in productivity.

Labor demand As labor is the only input of production, K-firms employ R&D expenditures to hire workers at the prevailing market wage w_t. If labor demand is greater than current workforce, K-firms will resort to the labor market to cover the gap, randomly choosing the required workers from the pool of the unemployed. Otherwise, if there is a surplus of workers, K-firms can get rid of them at zero costs.

Price setting Similarly to C-firms, capital good producers set the price by charging a mark-up over the unit cost of production c_{jt}, being the latter defined as market wage over labor productivity, B^k_j. However, differently from C-firms, the mark-up of K-firms is assumed to be fixed, as in Dosi et al. (2010). Hence, the capital good price is given by

$$p^v_{jt} = (1 + \bar{\mu}^k)c_{jt}, \tag{4.29}$$

where $\bar{\mu}^k$ is the mark-up, constant and uniform across firms, while $c_{jt} = \frac{w_t}{B^k_j}$ is the firm's unit labor cost.

Profits distribution Profits (or losses) are computed as the difference between sales and variables costs plus R&D spending. If K-firms earn a surplus, a fraction *div* of it is distributed to the owner in forms of divided, net of taxes. The gross profits and equity equations by K-firms thus read

$$\pi_{jt} = p_{jt}Q_{jt} - c_{jt}Q_{jt} - RD_{jt}, \tag{4.30}$$

$$E_{jt+1} = E_{jt} + (1 - div)\pi_{jt}. \tag{4.31}$$

4.4.3 Household sector

The households sectors is composed by W workers and K capitalists, the latter being the owners of either consumption or capital good firms ($K = F + N$). Each agent receives an after tax income, Y_{ht}, where

$$Y_{ht} = \begin{cases} (1-\tau)w_t & \text{if employed worker,} \\ (1-\tau)div \cdot \pi_{f,t-1} & \text{if capitalist receiving dividends,} \end{cases} \tag{4.32}$$

where τ is the tax rate on income, $h \in \{w, f\}$ indicates whether agent h is a worker or a capitalist, with $f \in \{i, j\}$ for consumption and capital good producers, respectively. Workers supply one unit of labor in exchange for a wage. The latter is uniform across firms and evolves over time depending on the consumption good sector average productivity growth $g_{A_{i,t}}$ according to

$$w_{t+1} = w_t(1 + \alpha g_{A_{i,t}}). \tag{4.33}$$

Capital income is given by the sum of dividends that capitalists receive both from their own business and the bank, split in equal shares amongst owners.

The household's demand for consumption good is a linear function of disposable income and financial wealth. Based on the well-known Keynesian principle according to which the saving rate is increasing along income distribution, we assume that workers and capitalists have different propensities to consume out of income, namely c_w and c_f, respectively, with $0 < c_f < c_w < 1$. The resulting savings pile up to financial wealth, held in the form of bank deposits D_{ht-1}. The consumption budget can be specified as

$$C_{ht} = c_h(1-\tau)Y_{ht} + c_s D_{ht-1}. \tag{4.34}$$

where $0 < c_s < 1$ is the uniform propensity to consume out of wealth.

Having defined the consumption budget, the choice of the goods to buy is determined through the search-and-matching mechanism described above. The partner's choice by consumers is not purely random though, but is affected by a preferential attachment scheme called "brand loyalty": one of the Z_c randomly visited firms is the company where the household shopped in the previous period.

4.4.4 Banking sector

The bank collects deposits from households at zero interest rate and provides loans to C-firms to cover the financing gap. The credit market largely borrows from our parental model, i.e. Assenza et al. (2015), to which the reader is addressed for a detailed illustration. Here we limit ourselves to provide a summary overview of its essential features.

After receiving credit demands from borrowing firms, the Bank determines both price and quantity of the loan for each borrower depending on her financial situation. The firm-specific interest rate is formulated as an exogenous risk free rate r charged with a markup increasing with the borrower's financial fragility. The latter is measured by the time-to-default, TT, which is inversely related to the firm's leverage l_{it}, i.e. the lower the leverage, the higher the time to default, the lower the interest rate, or

$$r_{it} = g(r, TT(l_{it})), \tag{4.35}$$

$$l_{it} = \frac{L_{i,t}}{E_{it} + L_{it}}. \tag{4.36}$$

Furthermore, the Bank sets a maximum amount of loans to be extended to each borrower on the basis of a tolerance level for the potential loss on credit, determined as a fraction on its own net worth. It follows that the bank may not be able to satisfy entirely firms' demand for loans, in which case, C-firms will be forced to rescale the level of activity due to lack of funds.

4.4.5 Public sector

The public sector is modelled based on Assenza et al. (2015), where the Government levies a constant tax rate on labor and capital income and pays out unemployment benefits to non-working individuals. The unemployment subsidy is computed as a fraction of the market wage. Should public expenditure exceeds tax revenues, the Government finances the resulting deficit by issuing Treasury bonds, bought by the Bank, at a fixed risk-free interest rate.

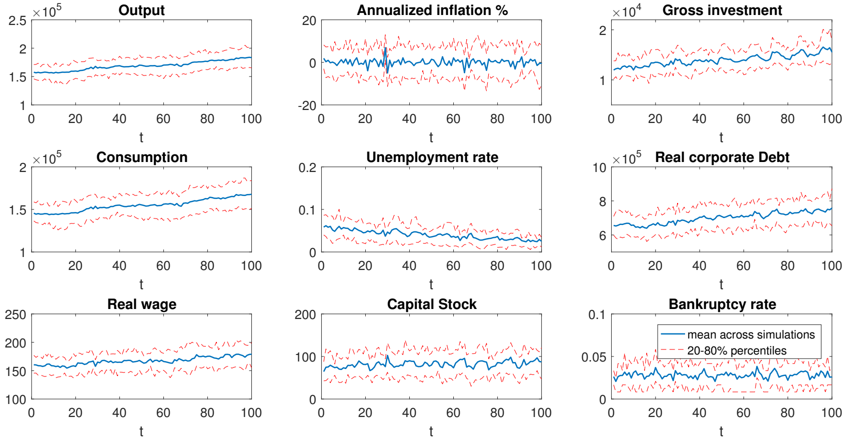


Figure 4.2: Time series of cross-MC means of selected macroeconomic variables. Last 100 periods are reported.

4.5 Simulation results

4.5.1 Empirical validation

To empirically validate the model, we follow a consolidated procedure in the macro ABM literature, also known as "output validation" (Delli Gatti et al., 2018). In the first place, the goal is to establish a baseline model, which will be used as a benchmark for the following economic and policy analysis. To do that, we calibrate the parameters summarized in Table 4.3 (in Appendix) such that the model is able to replicate a wide ensemble of empirical regularities at different levels of aggregation. A set of 25 Monte Carlo simulations with different random seeds is performed for 1000 time periods. The artificial time series are computed by taking averages across simulation runs and then compared with real data. Both simulated and real data are treated with the

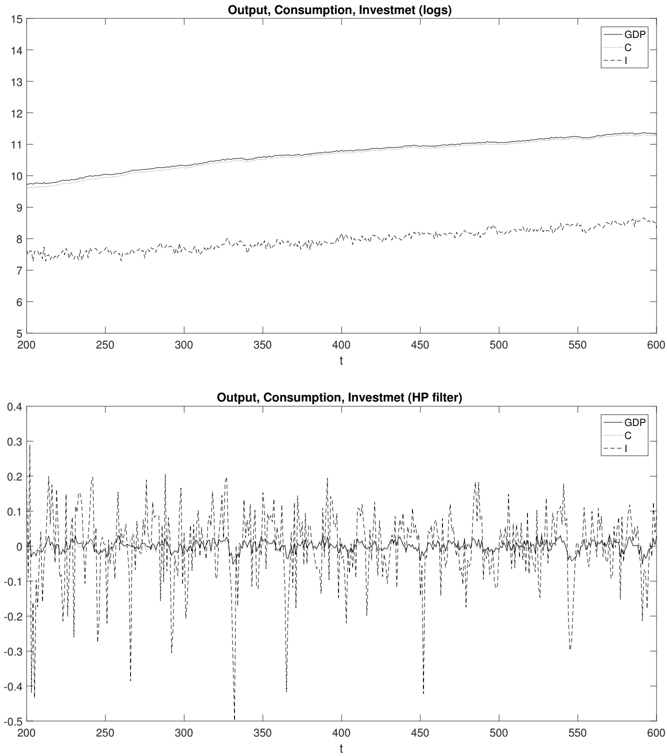


Figure 4.3: Cross-MC average of real GDP, consumption and investment: trend (logs) and cycle

Hodrick-Prescott (HP) filter in order to isolate the cyclical component from the trend. The observed time series were downloaded from the FRED database and accounts for quarterly data ranging between 1955-2013 for unemployment, and from 1947 to 2013 for GDP, consumption and investment.

Focusing on the last 100 periods of a selection of aggregate time series reported in Fig. 4.2, we notice that the model generates a regular self-sustained growth pattern, with ever-increasing trends in both real and financial variables characterized by

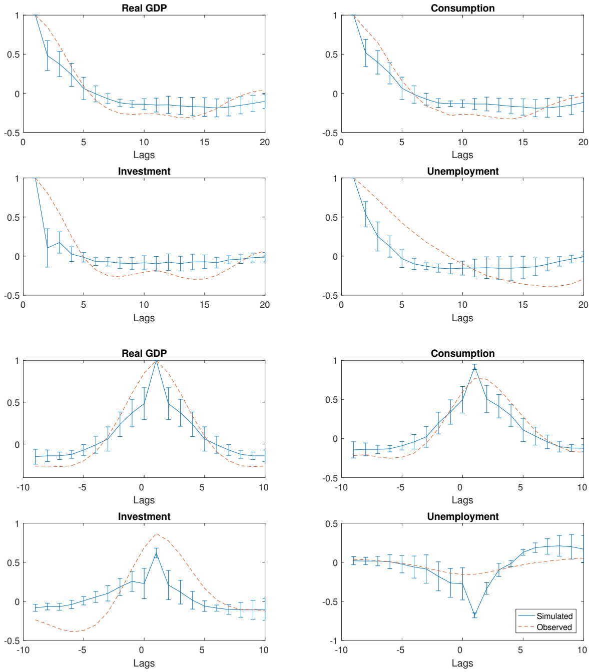


Figure 4.4: Autocorrelation (top) and cross-correlation (bottom) of GDP, consumption, investment and unemployment. All variables are treated with the HP filter to isolate the cyclical component.

persistent short-term fluctuations and recurrent bankruptcies. This is the result of the interplay of the Schumpeterian innovation-fuelled growth process and Minskyian instability-enhancing financial accelerator.

To better appraise this figure, it is worth looking at the time series of trend and cyclical components separately, obtained after applying the HP filter to a set of macroeconomic variables, as shown in Fig. 4.3. The plot illustrates that, in line with the empirical evidence on business cycle (Stock and Watson, 1999), investment is systematically more volatile than GDP and consumption, with all of them growing at positive steady rates.

Following Assenza et al. (2015), Figure 4.4 compares the plots of autocorrelation and cross-correlation of GDP, consumption, investment and unemployment between simulated and observed data. The autocorrelation structure of the two series looks quite similar, except for the investment variable where the first-order autocorrelation coefficient is significantly lower compared to real data.

The cross-correlation plots show that consumption and gross investment are procyclical with respect to GDP, while unemployment rate is anti-cyclical, as evidenced in observed data.

4.5.2 Economic analysis

Given the complex structure of interaction amongst heterogeneous agents and the multiple non-linear dynamic equations, the model does not lead to a closed-form analytical solution. Therefore, to address our research question, we resort to the tool of computer simulations. The main goal of this chapter is to analyse the underlying causes of the endogenous formation of market concentration and its macroeconomic consequences, both in the short and long run. For this reason, first we are going to highlight the emergent properties of the model in the first 250 periods from one representative simulation. Afterwards, we perform Monte Carlo simulations to examine the long-term macroeconomic dynamics and following policy implications.

The story of concentration: a short run focus

Figure 4.5 collects a set of plots displaying the time series of both aggregate and firm-level variables in the first 250 periods from one representative simulation of the model. This allows us to dig into the microeconomic mechanisms underlying the macroeconomic dynamics.

In every simulation run, after a short period of transition, the model endogenously generates a wave of market concentration, that is a situation in which a relatively small number of firms ends up holding a vast share of the market, causing a three-

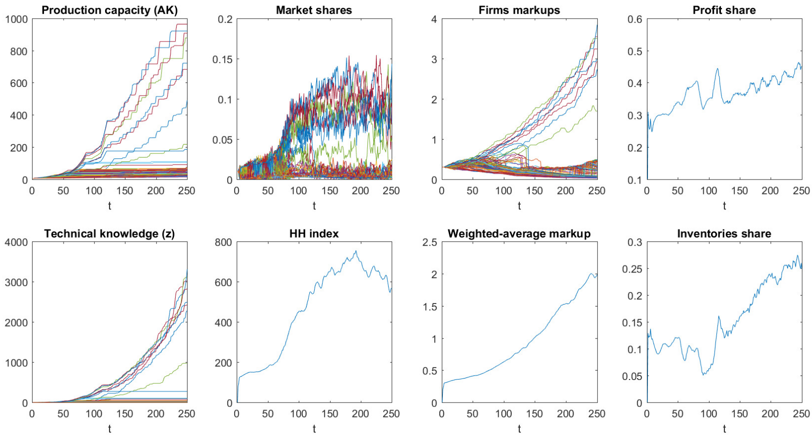


Figure 4.5: Dynamics of selected aggregate and firm-level variables; first 250 periods from one representative simulation.

fold increase in the Herfindahl-Hirschman index. From the left-hand panels, we notice that the leading firms are those that over time are able to develop a better production capacity, using their accumulated technical knowledge to invest in more efficient capital-embodied technologies and thus gaining a competitive advantage. This outcome is reminiscent of Autor et al.'s (2020) notion of "superstar" firms. Yet, contrary to their HANK model wherein firms are initially endowed with different productivity levels, in our agent-based model superstar firms endogenously emerge out of the normal operation of the economy, with no need to initialize firms differently. In the jargon of complexity theory, this is an *emergent property* of the system. Remind that, on the capital goods market, the firms' choice between heterogeneous vintages of machine tools is a function of the "knowledge gap"; firms with a greater knowledge stock are more likely to choose the best capital-embodied techniques. Consequently, throughout the process of capital accumulation, those firms are able to introduce more efficient techniques, improving their production coefficients and becoming more competitive. The tendency of market concentration to rise, thus, spontaneously emerges as a by-product of technical progress that engenders technological discontinuities, as reflected in the increasingly different production structures and productivity levels across heterogeneous firms.

Furthermore, it is important to stress that the relationship between technological knowledge, productivity and market share is reinforced over time due to a positive feedback within the model dynamics: as the extra profits stemming from larger market shares are partially reinvested in R&D, *in the absence of* consistent knowledge spillovers and *given* the heterogeneity among capital goods, the knowledge distribution becomes more and more polarized between leaders and followers, making it difficult for the latter to buy better machines and thus to catch up with the former. Dosi and Nelson (2010) refer to this peculiar feature of technical change as the "cumulativeness of innovative success", whereby innovative advances are based on past realizations of the stochastic process. Moreover, our findings corroborate the authors' presumption that such a 'success breeds success' kind of dynamics is particularly relevant in a world of "knowledge-based dynamic increasing returns". Since the process of knowledge accumulation is history- and path dependent, the lack of investment in R&D may foreclose the future development of technological structure, determining persistent productivity and market shares differentials. Indeed, the 'knowledge gap', by conditioning firms' access to technological innovations on prior accumulation of knowledge stock, constitutes the primary source of technological discontinuities arising across firms, which eventually give rise to productivity differentials and, consequently, an increasing concentration of market in the hands of more productive firms. Note that, as will become clearer in the following discussion, the two underlying assumptions about knowledge spillovers and capital heterogeneity are paramount in order for market concentration to be high and persistent over time.

So far, we have dealt with the underlying causes of rising concentration; now let us shift the focus on the second half of the story, that is its macroeconomic consequences.

From the right-hand panels in Figure 4.5, it can be seen that firms with larger market shares are able to increase their mark-ups. Remind from the pricing equation

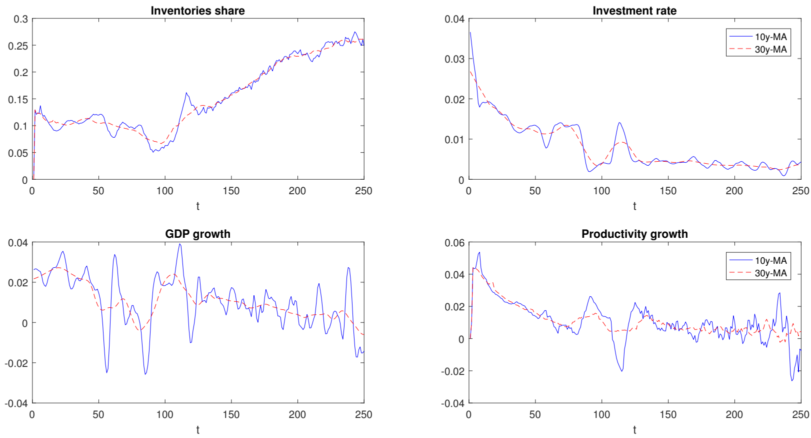


Figure 4.6: Inventories and investment share (5- and 20-years moving average); GDP and productivity growth rate (30- and 50-years moving average).

(4.18) that the mark-up is set according to the firm's degree of monopoly power. In particular, one firm adaptively reviews the profit margin upwards if its market share is high and increasing over time. This is evidently the case for leading firms, which, thanks to the improved productive capacity and low unitary costs, are able to keep rising mark-ups without incurring in a loss of market shares. As the influence of large firms grows over the economy, it follows that the increase in the weighted-average markup, adjusted by individual shares, leads to an increase in the profit share, going from 30% to 45% of total income, approximately the magnitude of the change that western countries have witnessed in the last decades (Autor et al., 2020). In so far as wage and profits earners have different marginal propensities to consume, a redistribution of income from the bottom to the top implies a decline in the aggregate consumption expenditure, which is reflected in the rising share of unsold goods over total output (bottom-right panel).

C-firms interpret the higher inventories share as a symptom of a shortage in aggregate demand and review the capacity utilization rate accordingly. Indeed, from Eq. (4.1), an increase in the warehouse stock has a negative impact on the desired scale of production, which, in turn, affects the utilization rate of the existing plants in Eq. (4.4). In a context of low demand and excess capacity, firms do not have incentive to invest in new capital formation. As a result, the slowdown of capital accumulation leads to lower growth rates of output and productivity, as shown in Fig. 4.6.[30] The 30-years moving average of real GDP growth rate falls from 2.5% to around 0.1%: is not that a tendency to stagnation? For lack of better terms, we are prone to call it in this way. Following the lessons from Sylos Labini (1967) and Steindl (1976), therefore, we have shown that the economic system may spontaneously reach a state of stagnation as a result of changes in market structure and income distribution, triggered by technical progress and market power. As Steindl (1976) puts it, "[t]he tendencies towards oligopoly discovered at the microeconomic level will cause a tendency towards stagnation at the macroeconomic level."

Let us remark that, coherent with the agent-based modelling philosophy (Dawid and Delli Gatti, 2018; Dosi and Roventini, 2019), all the outcomes we have just described are *emergent dynamics* of the model, i.e., regular patterns the system is able to reproduce through the adaptive behaviour of heterogeneous agents interacting in decentralized markets, given the behavioural rules and market protocols discussed in the previous section. In the rest of the chapter, instead, we are going to explore the model dynamics under different scenarios by switching the values of key parameters, in order to capture the role of different regulatory or institutional frameworks on the agents behaviour and macroeconomic outcomes.

Long-term consequences: the role of imitation activity

It has been shown that, in the early stage of a representative simulation, the model endogenously generates a wave of market concentration, driven by technical change,

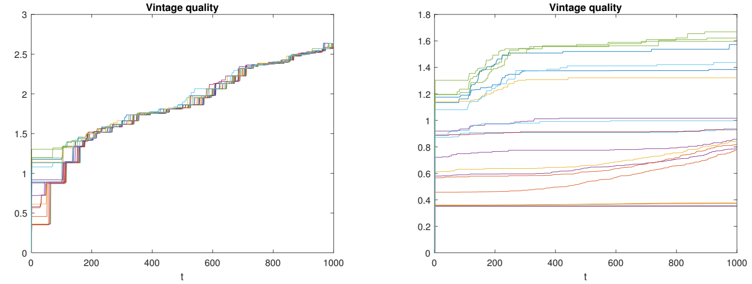
[30]This analysis of investment allows to combine Keynes's theory of effective demand and business cycle with Schumpeter's theory of innovation and economic development, as previously proposed by Dosi et al. (2010).

which impacts on income distribution and economic dynamics. A natural question is: what happens next?

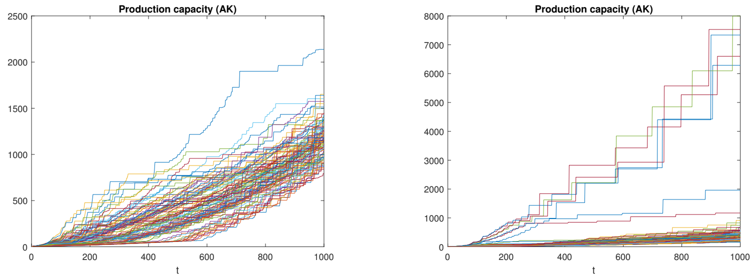
To explore the model properties in the long run, we compare two alternative scenarios which differ depending on whether K-firms are allowed to imitate or not. In the second case, the parameter χ in Eq. (4.23) is set equal to 1 (from 0.5 in the benchmark setting), so that the entire R&D budget is spent on innovation; hence, no imitation activity is carried out. We can think of the alternative scenario as a situation in which a strict innovation patent system is in place, whereby legal entry barriers prevent K-firms from imitating their competitors' technologies. This simulation experiment allows us to fully appraise the role of both knowledge gap and technological discontinuities on the process of market concentration and its long-term effects on the economic performance.

Before looking at the model dynamics at the aggregate level, it is worth dwelling on the evolution of capital goods' technology and production capacity owned by, respectively, capital and consumption goods firm from one representative simulation. Figure 4.7 illustrates that the imitation activity carried out by K-firms brings about a convergence in the medium term capital goods' productivity (a-left), causing a significant reduction in the technological discontinuities (b-left). On the other hand, in the no-imitation scenario, such a convergence does not occur and thus the differences in the technological structure across C-firms are increasing over time (b-right).

Interestingly, it is shown that a strict correlation exists between the technological evolution in the capital good sector and the firms distribution in the consumption good sector: in presence of relatively homogeneous capital goods due to the imitation activity by K-firms, large firms in the C-sector are not able to exploit their "knowledge advantage" to buy relatively more efficient techniques than their competitors, allowing the laggards to catch up. Conversely, a persistently high heterogeneity between capital goods makes the "knowledge gap" mechanism more effective, leading to a more skewed distribution in the consumption good sector. Therefore, these results suggest that in order for technological discontinuities to be high and persistent over time it is necessary



(a) Vintage quality of K-firms



(b) Production capacity of C-firms

Figure 4.7: Imitation (left) vs no-imitation (right) scenarios

that capital goods remain considerably different from each, that is to say, that the imitation activity by capital good producers is limited, e.g. by means of strict patent system regulation.

It will soon become clear that such differences in the technological patterns across firms and sectors entail important implications on the evolution of market structure and income distribution, as well as on the long-term economic performance.

To investigate the role of legal entry barriers on competition, innovation and long-term economic dynamics, we carry out a Monte Carlo analysis by running 25 simulations with different random seeds for each scenario, namely “imitation” and “no-imitation”. After that, the cross-MC averages of key macro variables are computed and compared in Figures 4.8–4.10.

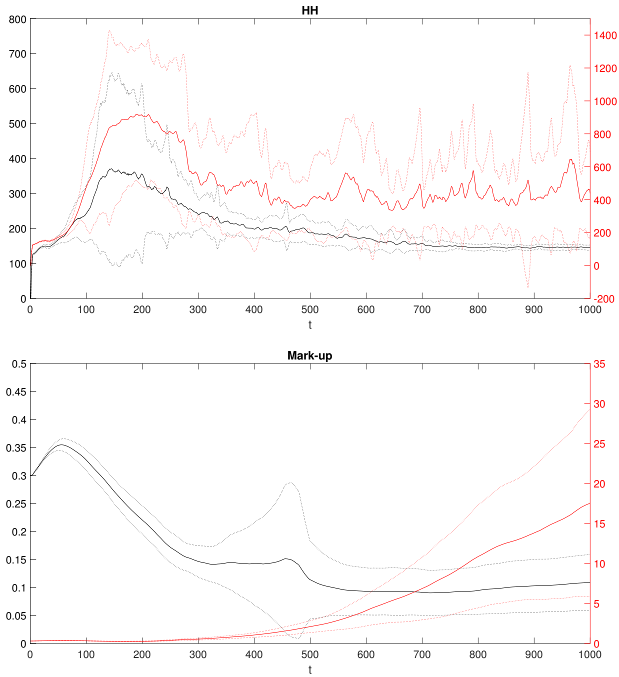


Figure 4.8: Herfindahl-Hirschman index and weighted-average mark-up; imitation (black) vs no-imitation (red) scenario. Mean value across 25 simulations.

After the initial wave of rising concentration, in the imitation scenario (black curve), the market economy quickly returns to a competitive stage, characterized by low HH index and average mark-up, as well as high wage share and consumption. By contrast, when imitation is not allowed (red curve), concentration is still rising, and so is average mark-up, profits and inventories share, while the GDP level is significantly lower compared to the baseline scenario. The length of market concentration, thus, depends on the corporate sector's ability to reproduce technological discontinuities within the system, which, in turn, is related to the process of diffusion of technological innovations across firms, i.e. K-firms' propensity to imitate and C-firms' possibility of exploiting knowledge differentials.

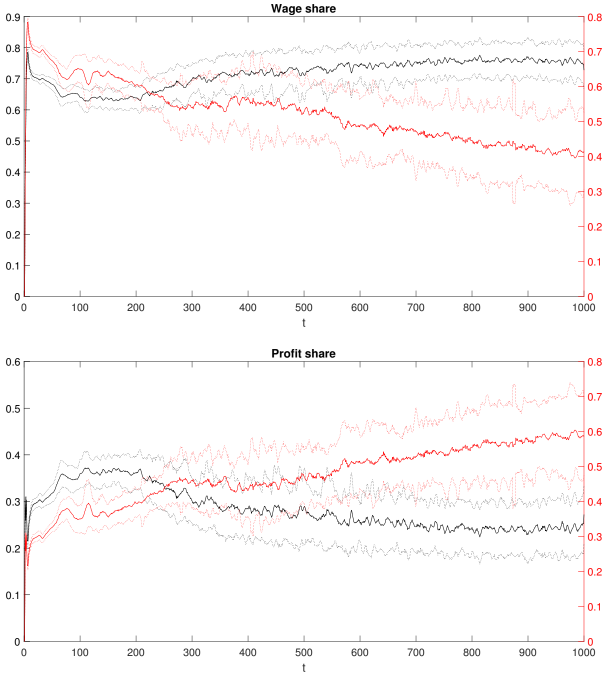


Figure 4.9: Wage and profit shares; imitation (black) vs no-imitation (red) scenario. Mean value across 25 simulations.

Indeed, by reducing the knowledge gap with respect to all machine tools available on the market, the convergence between heterogeneous capital goods brought about by the imitation activity by K-firms undermines the dominant position of oligopolistic firms, which eventually loose their market power and, thus, the ability to extract larger profit margins. As a result, the ensuing reduction in income inequality strengthens aggregate demand and fosters a competitive and self-sustained growth process. Such a counter-tendency does not occur in the no-imitation scenario (right panels). In this case, in fact, the persistent character of technological discontinuities enables giant firms to consolidate their market position to the extent that the ever-growing concentration can unfold its negative effects on income distribution and aggregate demand also in

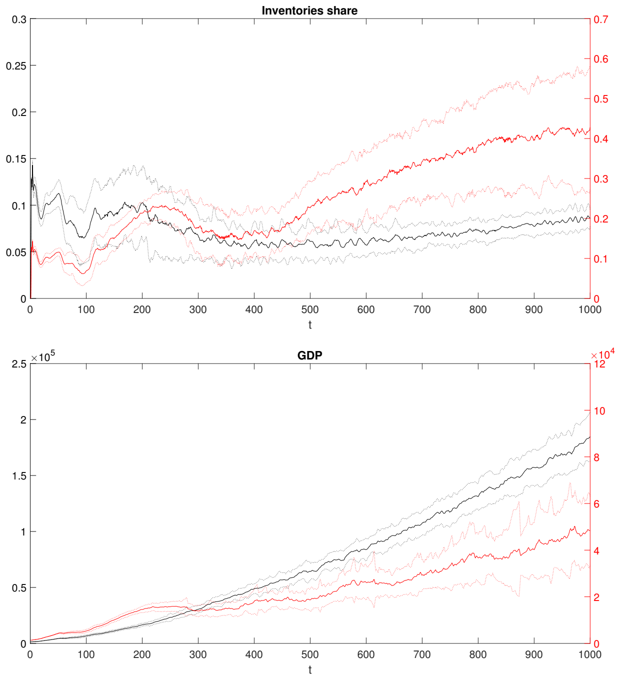


Figure 4.10: Inventories share and GDP; imitation (black) vs no-imitation (red) scenario. Mean value across 25 simulations.

the long run.

Table 4.1 provides a quantitative comparison of the model outcomes under different patent protection systems. Quite strikingly, we find that GDP growth is higher in the no-imitation scenario, even though the cross-simulation volatility is also significantly stronger. All other results are largely consistent with the previous discussion; when K-firms are not allowed to imitate, that is when the emerging technological discontinuities cannot be tackled, the economy experiences a more than double concentration index and a 75% reduction in the last year GDP level as compared to the baseline scenario. Also, under the no-imitation scenario, the chronic excess capacity implies a higher unemployment rate, which, by demanding a higher disbursement of unemployment

	Imitation	No Imitation
GDP growth rate	0.5642 (0.0155)	0.7114 (0.1504)
GDP std	0.0445 (0.0160)	0.0812 (0.0129)
Unemployment rate	0.2148 (0.0055)	0.2267 (0.0166)
HH index	190.217 (21.343)	479.414 (117.222)
Mark-up (weighted-average)	0.2294 (0.0526)	9.040 (4.404)
Profit share	0.2816 (0.0080)	0.4694 (0.0397)
GDP last year	1	0.2546
Consumption/GDP	0.9281 (0.0237)	0.7399 (0.1325)
Inventories/GDP	0.0718 (0.0237)	0.25 (0.1325)
Public deficit/GDP	0.1577 (0.0405)	0.1895 (0.080)

Table 4.1: Statistics for selected variables in the two scenarios: cross-simulation mean and standard deviation (in parenthesis).

subsidies, results in a 3% increase in the public deficit/GDP ratio.[31]

In line with Sylos Labini (1967) and Steindl (1976), our findings suggest that tendency to stagnation arising from an oligopolistic or monopolistic market structure requires a more active role of public policy; the economic system is increasingly dependent on external stimuli to compensate for the structural deficiency in aggregate demand due to the increasingly unequal distribution of income. Albeit from a different framework, the modern theorists of the secular stagnation hypothesis reach remarkably similar policy conclusions.[32] We will further explore the role of fiscal and other policies in the next Section.

[31]Note that, in these simulation settings, the Government is not subject to any fiscal constraints: public budget is left free to adapt to business fluctuations and the resulting public bonds are entirely purchased by the Bank. So to speak, we are in a MMT-kind of world. In the next Section, the effects of alternative policy regimes will be explored.

[32]See Summers (2014) and Krugman (2014) for a discussion about the 'new secular stagnation hypothesis'. For a critical review of its neoclassical theoretical underpinning, see Di Bucchianico (2020).

4.5.3 Policy experiments

In what follows, we will discuss the model outcomes under different policy and institutional regimes. We perform multiple simulations for each policy experiment, whereby one or more parameters of the model are exogenously modified; the results from Monte Carlo analyses are collected in Table 4.2 and compared with the benchmark scenario, the one with imitation (i.e. $\chi = 0.5$), to assess the impact of such policies on macroeconomic aggregates.

Labor market policy. Let us start with a labor market reform aimed at weakening trade unions power. This is captured by a reduction in parameter α governing the wage-productivity elasticity in Eq. (4.33), i.e. the degree to which the nominal wage responds to a change in productivity. As in Dosi et al. (2010), in the baseline scenario $\alpha = 1$, meaning that trade unions are able to fully pass on any increase in productivity to nominal wages. In Experiment 1, we set $\alpha = 0.90$. It can be seen that, compared to the benchmark, a weaker labor union implies a higher profit share, lower consumption, lower and less volatile output growth, all of this resulting in a nearly 20% drop in the last year GDP level. Interestingly, the decline in aggregate demand is associated with a marked increase in the HH index and average mark-up. Thus, there seems to be a negative relationship between demand and concentration which goes in both directions.[33] On the one hand, high concentration implies low demand, due to the negative effect of monopoly power on wages and consumption. On the other, low demand implies high concentration, in that the reduced aggregate spending turns out to be satisfied by a lower number of firms, leading to an even more skewed distribution.

Furthermore, it might be surprising to note that, despite the overall worsening economic conditions, as a consequence of trade union power erosion, the unemployment

[33] As we will see, this is a recurrent feature of our policy experiments.

rate is 0.7% lower compared to the benchmark, with the difference being statistically significant. This might be due to the fact that the slowdown of economic activity hinders the introduction of (labor-saving) innovations throughout the process of capital accumulation, thus resulting in a relatively higher 'low-paid employment'.

Competition policy. The second experiment consists in an antitrust law that lowers the degree of competition in the market by rising transaction costs. Practically speaking, this can be performed through an one-unit reduction in the parameters governing the number of firms to be visited in the consumption good market by households ($Z_c = 3$) and in the capital good market by imitators ($Z_{imi} = 1$). Unsurprisingly, an anti-competitive policy leads to an increase in profit share and monopoly power, both in terms of HH index (+21%) and average mark-up (+91%), with negative effects on unemployment and demand. Whereas the impact on GDP is negative but not statistically significant from the benchmark values.

Innovation policy. Let us now get further insights on the process of knowledge accumulation in Eq. (4.6). In particular, we are going to explore the effects of a change in the degree of intra-industry knowledge spillovers (ψ), i.e. the extent to which other firms' R&D effort affects the individual firm's knowledge accumulation. In other words, a high value of ψ means that the R&D activity of one firm increases the pool of knowledge available to all the firms (Cohen and Levinthal, 1989).

In the first high-knowledge spillover policy (Experiment 3.1), the parameter ψ is increased from 0.1 (benchmark) to 0.9. Yet, no significant effect on the economic performance is seen. This is because, in such a scenario, the ability to exploit outside knowledge spillovers, i.e. the *absorptive capacity*, is endogenous to firms' R&D experience, as shown in Eq. (4.7): notwithstanding the availability of technological information, in presence of an endogenous absorptive capacity, smaller firms do not have the necessary technical skills to exploit them, failing to reduce the technology distance from the leaders.

For the sake of completeness, we investigate the effects of the same innovation policy under an institutional regime characterized by exogenous absorptive capacity ($\gamma = 1$). We can think of it as an ideal world in which all firms not only have access to the same pool of technological information, but are also endowed with the necessary technical ability to process them, so that knowledge differentials substantially disappear. In such a scenario (Experiment 3.2), despite a slight increase in the concentration index, an high-knowledge spillover policy positively affects the aggregate production, if we look at the last year GDP level, while the impact on GDP growth rate is positive but insignificant.

The purpose of this simulation exercise is simply to highlight that a top-down innovation policy, if not coupled with alternative measures aimed at directly or indirectly tacking the technological discontinuities across firms and/or compensating for the negative effects they produce on income distribution and aggregate demand, is likely to be ineffective in stimulating economic growth.

Fiscal policy. Finally, the macroeconomic impact of a restrictive fiscal policy is assessed. Differently from the baseline scenario, wherein public budget freely adapts to business fluctuations in a fully anti-cyclical fashion, the "Maastricht rule" imposes a 3% ceiling on the deficit-to-GDP ratio; whenever the budget deficit exceeds the threshold, the Government is required to cut public spending accordingly. Given that in all previous simulation experiments the (gross) deficit/GDP ratio is about 15%, the budget constraint of 3% is almost equivalent to shutting down the Keynesian engine of fiscal policy. In line with Dosi et al. (2010), indeed, we find that a strict budgetary rule would severely harm GDP, aggregate demand and unemployment, leading to higher income inequality and monopoly power, thereby confirming the previous findings on the negative relationship between demand and concentration.

Policy experiment	GDP gr.	GDP std.	U	HH	Avg. Mu	Π/GDP	GDP_ly	C/GDP	Inv/GDP	Def/GDP
0. Baseline	0.5642	0.0445	0.2148	190.217	0.2294	0.2816	1	0.9281	0.0718	0.1577
	(0.0155)	(0.0160)	(0.0055)	21.343	(0.0526)	(0.0080)		(0.0237)	(0.0237)	(0.0405)
1. Labor market policy										
1.1 Weak labor union	0.5025	0.0323	0.2079	309.777	1.144	0.2905	0.8151	0.9198	0.0802	0.17
	(0.0144)	(0.0023)	(0.0052)	49.179	(0.7456)	(0.0167)		(0.0289)	(0.0289)	(0.0329)
2. Competition policy										
2.1 Weak anti-trust	0.5636*	0.0415*	0.2211	230.060	0.4404	0.2957	0.9745*	0.9139	0.0860	0.1571*
	(0.0216)	(0.0073)	(0.0083)	62.348	0.1880	0.0147		(0.0264)	(0.0264)	(0.0388)
3. Innovation policy										
3.1 High spillovers	0.5641*	0.0453*	0.2152*	185.80*	0.2255*	0.2825*	1.006*	0.9284*	0.0715*	0.1586*
	(0.0150)	(0.0161)	(0.0055)	18.764	(0.0522)	(0.0058)		(0.0230)	(0.0230)	(0.0398)
3.2 High spillovers + ex. AC	0.5718*	0.0415*	0.2148*	231.69	0.3433	0.2824*	1.124	0.9226	0.0773	0.1531*
	(0.0165)	(0.0051)	(0.0071)	43.56	(0.1681)	(0.0132)		(0.0288)	(0.0288)	(0.0362)
4. Fiscal policy										
4.1. Maastricht rule	0.4403	0.0476*	0.8257	236.012	2.300	0.3997	0.1142	0.7457	0.2542	0.0179
	(0.0328)	(0.0027)	(0.0067)	4.207	0.0841	(0.0063)		(0.0546)	(0.0546)	(0.0064)

Table 4.2: Cross-simulation mean and standard deviation (in parenthesis) for selected variables under different policy regimes. A two-sample t-test for equal means with respect to the baseline model is performed: the symbol * indicates that the null hypothesis is not rejected. Variables description: *GDP gr.*, growth rate of GDP; *GDP std.* GDP volatility; *U*, unemployment rate; *HH*, Herfindahl-Hirschman index; *Avg. Mu*, weighted-average mark-up; Π/GDP, profit share; *GDP_ly*, GDP level in the last simulation period; *C/GDP*, consumption share; *Inv/GDP*, inventories share; *Def/GDP*, public deficit-GDP ratio.

4.6 Conclusion

Building on the recent debate on rising concentration, stagnation and inequality (Stiglitz, 2019; Syverson, 2019; De Loecker et al., 2020), this chapter aims at exploring the causes and consequences of rising market concentration, by focusing on the interplay of technical change and market power. In particular, the goal is threefold: (i) to put forward a general theoretical framework that allows to systematically analyse the dynamic interrelationship between changes in market structure, income distribution and economic growth, (ii) to explicitly formalize and investigate the role of accumulated technological knowledge in influencing the firm's access to capital-embodied innovations and thus shaping the market form, (iii) to explore, by means of computer simulations, under which conditions the tendency to concentration at the micro level may result in a tendency to stagnation at the macro level.

To do that, we develop an agent-based model with endogenous technical change and heterogeneous capital goods equipped with different productivity. Differently from other macro-evolutionary ABMs whereby the innovation process is carried out exclusively by capital good firms to discover new innovations (cfr. Dosi et al., 2010; Dawid et al., 2012), in our model also consumption good firms can invest in R&D in order to accumulate technological knowledge, which allows them to identify and employ the best machine tools produced by capital good firms. Heterogeneous firms, in fact, do not have equal access to capital-embodied innovations, as this depends on the "knowledge gap", i.e. the difference between the capital vintage's technical advancement and the firm's accumulated technological knowledge. The interwined dynamics of knowledge accumulation and technical change, thus, constitutes the economic mechanism behind the endogenous formation of technological discontinuities, which, in turn, accelerates the process of rising concentration.

Simulation results show that, in the short-run, the introduction of new innovations in the market generates a spontaneous wave of concentration in so far as firms with relatively higher accumulated knowledge are able to exploit them, thereby achieving productivity gains and larger market shares. Operating under oligopoly conditions, the emerging "superstar" firms seek to exert the enhanced market power by extracting higher profit margins. As the share of large firms grows over the economy, the increase in the weighted-average mark-up leads to a shift in the income distribution from wages to profits (Kalecki, 1942), which eventually undermines demand and growth (Keynes, 1936; Steindl, 1976). A stagnation tendency, thus, endogenously arises out of the normal functioning of an oligopoly economy characterized by knowledge-based technical entry barriers.

Yet, the long-run macroeconomic consequences of rising concentration are not straightforward. Indeed, further simulation experiments reveal that, whereas the first wave of concentration is triggered by technical entry barriers, which constrain firms' access to technological innovations, the length of concentration crucially depends on the presence (or lack thereof) of legal entry barriers, which affects the process of diffusion of technological innovations across firms over time.

To explore the economic dynamics in the long-run, we compare two alternative scenarios corresponding to different patent system regulations which either allow or prevent K-firms to imitate their competitors' technologies.

In the "imitation" scenario, market competition is soon re-established in that the imitation activity carried out by K-firms brings about a convergence amongst different techniques in the medium-run, which, by reducing technological discontinuities, allows laggards to catch up. The ensuing decline in concentration undermines the position of large firms, which are no longer able to use their market power to extract monopolistic rents. Consequently, the restored market dynamism paves the way for a self-sustained growth process.

In the "no-imitation" scenario, instead, the persistent heterogeneity between capital goods is then reflected in the increasingly heterogeneous productivity among firms in the consumption good sector. In such a scenario, technological discontinuities grow over time, allowing large firms to consolidate their dominant position and to extract an increasingly large share of rents, with harmful effects on distribution, demand and growth also in the long run. Thus, our model shows that the pattern of economic growth is driven by the dynamic interrelationship between the evolution of technological regimes in the capital good sector and changes in market forms in the consumption good sector, with following non-trivial effects on changes in income distribution and aggregate demand.

From the policy experiments, we find that weak labour unions and weak anti-trust policies, by sharpening the negative relationship between demand and concentration, accentuate the stagnation tendency. Similar results are obtained from a restrictive fiscal policy that prevents a fully anti-cyclical management of the public budget, whereas innovation policies aimed at sharing technological information across firms risk to be ineffective as long as the technical ability to process them remains unequally distributed in a concentrated industry.

Appendix 4.A Accounting and balance sheets

In what follows we describe the agents' balance sheets and micro/macro accounting identities of the model.

The balance sheet for consumption good firms respects the accounting identity

$$b^k_{it}K_{it} + D_{it} = L_{it} + E_{it}, \tag{4.37}$$

where $b^k_{i,t}K_{i,t}$ is the book value of capital, D_{it} stands for the firm's deposits, L_{it} is outstanding debt and E_{it} is equity, or net worth.

C-firms hold cash liquidity in forms of bank deposit, which evolves as

$$D_{it} = D_{it-1} + \pi_{it} + \Delta L_{it} - \theta L_{it} - p_{jt}I_{it} - Div_{it}, \tag{4.38}$$

where π_{it} is the firm's profits, θL_{it} the debt installments, $p_{jt}I_{it}$ is the cost of new capital evaluated at current price of capital goods. Div_{it} is the dividend payments.

When the firm's equity turns negative, the firm is bankrupted and exits the market. Then, the owner uses his own wealth to recapitalize her.

For the sake of simplicity, K-firms do not borrow from the bank and employ only labor as input of production. Therefore, the balance sheet of K-firms reads

$$D_{jt} = E_{jt}, \tag{4.39}$$

where their liquidity evolves as

$$D_{jt} = D_{jt-1} + \pi_{jt} - Div_{jt}. \tag{4.40}$$

Households' wealth E_{ht} coincides with their deposit D_{ht}, which evolves by adding up their income and subtracting the consumption expenditure.

$$E_{ht} = D_{ht}, \tag{4.41}$$

$$D_{ht} = D_{ht-1} + Y_{ht} - C_{ht}. \tag{4.42}$$

As far as the bank is concerned, her balance sheet is given by

$$R_t^b + L_t = D_t + E_t^b, \tag{4.43}$$

where R_t^b are the bank's reserves, L_t are total loans provided to C-firms and the Government, D_t are households' deposits and E_t^b is the bank's net worth.

Since deposits are not remunerated, the bank's profits only consist of the sum of interest payments by N_F^s solvent borrowers, including the Government, i.e.

$$\pi_t^b = \sum_{s=1}^{N_F^s} r_{st} L_{st} + r B_{t-1}. \tag{4.44}$$

The bank's equity is updated as

$$E_{b,t+1} = E_{bt} + (1 - div_b)\pi_{bt} - BD_t, \tag{4.45}$$

where div_b is the constant fraction of dividends paid by the bank to capitalists. BD_t stands for bad debt, and is the total value of interest payments due by N_F^n insolvent borrowers, i.e. $BD_t = \sum_{n=1}^{N_F^n} L_{nt}$.

The following set of equations illustrate the system of interrelated aggregate balance sheets.

$$R^b = D^H + M^I + M^J + E^B, \tag{4.46}$$

$$M^I = D^I - L^I, \tag{4.47}$$

$$M^J = D^J - L^J, \tag{4.48}$$

where $M^I = E^I - (K + \Delta)$ and $M^J = E^J - \Delta^J$ are money in the hands of, respectively, C-firms and K-firms.

Appendix 4.B Parameter setting

Symbol	Description	Value
W	Number of workers	800
F	Number of C-firms	100
N	Number of K-firms	20
Z_c	Number of C-firms visited by consumer	4
Z_u	Number of firms visited by unemployed workers	5
Z_{imi}	Number of K-firms visited by imitators	2
$\bar{l}$	Capital-labor ratio	2
α	Wage-productivity elasticity	1
$\bar{\omega}$	Desired utilization rate	0.85
κ	Desired inventories rate	0.1
ρ	Sales adaptive expectation parameter	0.25
$c_y^{w,c}$	Marginal propensity to consume out of income	[0.80, 0.20]
c_f	Marginal propensity to consume out of wealth	0.05
c_y^w	Marginal propensity to consume	0.80
υ	Unemployment subsidy rate	0.40
τ	Tax rate on labor and capital income	0.04
div	Firms-bank payout ratio	0.20
δ	Depreciation rate of capital	0.03
δ^{inv}	Depreciation rate of inventories	0.30
$\sigma^{c,k}$	R&D investment propensity	0.30
χ	R&D allocation between innovation-imitation	0.50
ζ	Search capabilites parameter	0.30
η	Absorptive capacity parameter	0.03
ψ	Degree of knowledge spillovers	0.1
β	Intensity of choice of capital vintage	60
r	Refinancing rate	0.01
μ_b	Bank gross mark-up	1.2
β_b	Bank loss parameter	1.2

Table 4.3: Benchmark parameter setting

Chapter 5

Non-technical summary

5.1 Summary in English

The goal of this dissertation is to investigate the root causes of the 'stagnation-financialization paradox', i.e. a situation in which the economy exhibits a tendency to stagnation in a context of a financial expansion. Throughout the PhD project, I have addressed this question from different perspectives, both micro and macro, by employing different research methods, from econometric analysis to agent-based models.

Chapter 2 aims to investigate to which extent the tendency to maximize shareholder value, fuelled by stock-based manager compensation, has prompted U.S. firms to divert resources from real investment to share repurchases to boost stock prices. Using micro-data from U.S. firms balance sheets and manager compensation between 1992-2017, I estimate two dynamic panel data models: (i) to analyze the effects of share repurchases on investment decisions; (ii) to examine the interaction between stock-based CEO pay and the likelihood of share repurchases. I find that stock buybacks have a negative effect on capital investment with this effect being stronger among large firms, operating in non-competitive markets. Moreover, an increase in stock options makes firms more likely to repurchase shares. These findings suggest that stock-based compensation creates incentives for managers to focus on increasing shareholder value by repurchasing shares at the cost of declining real investment and long-run growth.

Based on this evidence, Chapter 3 develops a macro-finance agent-based model with credit and stock market in order to analyse how the increasing role of speculative investors in the ownership structure affects managers' planning horizons and R&D investment-buybacks decisions and, consequently, the resulting macroeconomic dynamics in terms of growth, instability and crisis. Drawing on Keynes's (1936) characterisation of financial market and Minsky's (1992) notion of money manager capitalism, the idea is that when the stock market is dominated by a speculative sentiment, managers tend to internalize the short-term view of speculative investors and accommodate their demand for high equity returns, by diverting corporate resources from R&D towards share buybacks in order to boost the stock price. Simulation results show that the increasing orientation towards shareholder value leads to a lower and less volatile growth in the real sector, but a higher growth in the financial sector, giving rise to what we call a 'stagnation-financialization paradox'. Yet, in order for this scenario to manifest, it is necessary that the configuration of ownership structure and the related mode of utilization of surplus are such that the corporate sector can generate and then distribute a sufficient amount of profits to support the stock price, despite a slowing real economy. Conversely, if the fraction of speculators is too large, the economic growth is so low that the resulting decline in aggregate profits drags buybacks spending down, causing the stock market to fall.

The simulation results from Chapter 3 reveal that the divergence between real and financial sectors is not a general property of the system, but a particular outcome arising only under certain conditions. Turning to our model's assumptions, this implies that the increasing tendency to maximize the stock market value at micro level, fuelled by a speculative sentiment that prompts firms to distribute higher profits to shareholders, can not produce, by itself, a steady upward trend in the stock market at macro level; rather, the resulting changes in macroeconomic conditions in terms of lower growth and lower profits due to the reduced innovative effort eventually constrain the individual firms' ability to artificially boost the stock price by means of share buybacks, or more generally, by managing the payout policy.

Therefore, the model simulations permit to shed lights on the macroeconomic conditions under which a disconnect between real and financial sectors can actually arise, i.e. when the corporate sector is able to generate enough profits to support the stock price despite an economic slowdown. This is because the asset price dynamics ultimately follows the evolution of aggregate profits, which, on the other hand, might not to be aligned with the overall economic performance. The relevant question then becomes: when does this occur? Hence, the focus on the causes and consequences of rising market concentration, which constitutes the object of study of the next chapter.

Chapter 4 aims to build a macro agent-based model to investigate how changes in market structure arising from technological progress affect income distribution and economic growth. We draw from Sylos Labini's (1967) idea that, in so far as heterogeneous firms do not have equal access to capital-embodied innovations, technical progress generates "technological discontinuities", i.e. differences in productivity across firms, leading to a reallocation of market shares towards more productive firms. The model is able to show how large firms seeking to exert the enhanced market power by increasing markups endogenously determine a shift in the income distribution from wages to profits which eventually undermines demand and growth. Thereby, the tendency to oligopoly at micro level may give rise to a tendency to stagnation at macro level, as Sylos Labini (1967) and Steindl (1976) found out long ago. Furthermore, we find that technological barriers against the diffusion of innovations across firms constitute one of the key features leading to persistent technological discontinuities and concentration. Finally, a wide set of policy experiments is performed to shed light on the best policy tools able to halt the stagnation tendency due to rising concentration and foster a competitive and innovation-fuelled growth process.

5.2 Samenvatting (Summary in Dutch)

Het doel van dit proefschrift is om de grondoorzaken van de 'stagnatie-financialiserings paradox' te onderzoeken, d.w.z. een situatie waarin de economie de neiging vertoont tot stagnatie in een context van financiële expansie. Tijdens het PhD-project heb ik deze vraag vanuit verschillende perspectieven, zowel micro als macro, benaderd door verschillende onderzoeksmethoden toe te passen, van econometrische analyse tot agent-gebaseerde modellen.

Hoofdstuk 2 beoogt te onderzoeken in hoeverre de tendens om aandeelhouderswaarde te maximaliseren, aangewakkerd door op aandelen gebaseerde managersvergoedingen, Amerikaanse bedrijven ertoe heeft aangezet middelen af te leiden van reële investeringen naar het terugkopen van aandelen om de aandelenkoersen te verhogen. Met behulp van microgegevens van de balansen van Amerikaanse bedrijven en de beloning van managers tussen 1992-2017 schat ik twee dynamische paneldatamodellen: (i) om de effecten van het terugkopen van aandelen op investeringsbeslissingen te analyseren; (ii) om de interactie te onderzoeken tussen op aandelen gebaseerde CEO-beloningen en de waarschijnlijkheid van terugkoop van eigen aandelen. Ik vind dat het terugkopen van aandelen een negatief effect heeft op kapitaalinvesteringen, waarbij dit effect sterker is bij grote bedrijven die actief zijn op niet-concurrerende markten. Bovendien zorgt een toename van het aantal aandelenopties ervoor dat bedrijven eerder geneigd zijn om aandelen terug te kopen. Deze bevindingen suggereren dat op aandelen gebaseerde beloningen prikkels creëren voor managers om zich te concentreren op het vergroten van de aandeelhouderswaarde door aandelen terug te kopen ten koste van afnemende reële investeringen en langetermijngroei.

Op basis van dit bewijs ontwikkelt Hoofdstuk 3 een macro-financieel agent-gebaseerd model met krediet- en aandelenmarkt om te analyseren hoe de toenemende rol van speculatieve investeerders in de eigendomsstructuur de planningshorizon van managers en beslissingen over het terugkopen van R&D-investeringen en bijgevolg de resulterende macro-economische dynamiek in termen van groei, instabiliteit en crisis. Op basis van Keynes' (1936) karakterisering van de financiële markt en Minsky's (1992) notie van geldbeheerderskapitalisme, is het idee dat wanneer de aandelenmarkt wordt gedomineerd door een speculatief sentiment, managers de neiging hebben om de kortetermijnvisie van speculatieve beleggers te internaliseren en tegemoet te komen aan hun vraag naar hoge aandelenrendementen, door bedrijfsmiddelen van R&D te besteden aan het terugkopen van aandelen om de aandelenkoers te stimuleren. Simulatieresultaten laten zien dat de toenemende oriëntatie op aandeelhouderswaarde leidt tot een lagere en minder volatiele groei in de reële sector, maar tot een hogere groei in de financiële sector, wat aanleiding geeft tot wat we een 'stagnatie-financialiserings paradox' noemen. Om dit scenario echter tot uiting te laten komen, is het noodzakelijk dat de eigendomsstructuur en de daarmee verband houdende wijze van gebruik van het overschot zodanig zijn geconfigureerd dat het bedrijfsleven voldoende winsten kan genereren en vervolgens kan uitkeren om de aandelenkoers te ondersteunen. een vertragende reële economie. Omgekeerd, als de fractie speculanten te groot is, is de economische groei zo laag dat de resulterende daling van de totale winsten de terugkoopuitgaven naar beneden haalt, waardoor de aandelenmarkt daalt.

De simulatieresultaten uit Hoofdstuk 3 laten zien dat de divergentie tussen reële en financiële sectoren geen algemene eigenschap van het systeem is, maar een specifiek uitkomst die alleen onder bepaalde voorwaarden ontstaat. Als we kijken naar de aannames van ons model; impliceert dit dat de toenemende neiging om de beurswaarde op microniveau te maximaliseren, gevoed door een speculatief sentiment dat bedrijven ertoe aanzet om hogere winsten aan aandeelhouders uit te keren, op zichzelf niet kan leiden tot een gestage stijgende trend in de aandelenmarkt op macroniveau; de resulterende veranderingen in macro-economische omstandigheden in termen van lagere groei en lagere winsten als gevolg van de verminderde innovatie-inspanning beperken uiteindelijk het vermogen van de individuele bedrijven om de aandelenkoers kunstmatig te verhogen door middel van het terugkopen van eigen aandelen, of meer in het algemeen, door het beheren van het uitbetalingsbeleid.

Daarom laten de modelsimulaties het toe om licht te werpen op de macro-economische omstandigheden waaronder een scheiding tussen de reële en financiële sectoren daadwerkelijk kan ontstaan, d.w.z. wanneer het bedrijfsleven genoeg winst kan genereren om de aandelenkoers te ondersteunen ondanks een economische vertraging. De reden hiervoor is dat de dynamiek van de activaprijzen uiteindelijk de evolutie van de totale winsten volgt, die aan de andere kant wellicht niet in overeenstemming is met de algemene economische prestaties. De relevante vraag wordt dan: wanneer gebeurt dit? Vandaar de focus op de oorzaken en gevolgen van toenemende marktconcentratie, die het onderwerp van studie vormt van het volgende hoofdstuk.

Hoofdstuk 4 beoogt een macro-agent-gebaseerd model op te bouwen om te onderzoeken hoe veranderingen in de marktstructuur als gevolg van technologische vooruitgang de inkomensverdeling en economische groei beïnvloeden. We putten uit het idee van Sylos Labini (1967) dat, voor zover heterogene bedrijven geen gelijke toegang hebben tot innovaties in kapitaal, technische vooruitgang "technologische discontinuïteiten" genereert, d.w.z. verschillen in productiviteit tussen bedrijven, wat leidt tot een herverdeling van de markt. aandelen naar productievere bedrijven. Het model kan laten zien hoe grote bedrijven die de grotere marktmacht proberen uit te oefenen door markups te verhogen endogeen een verschuiving in de inkomensverdeling van lonen naar winsten bepalen, wat uiteindelijk de vraag en de groei ondermijnt. Daardoor kan de neiging tot oligopolie op microniveau aanleiding geven tot een tendens tot stagnatie op macroniveau, zoals Sylos Labini (1967) en Steindl (1976) lang geleden ontdekten. Bovendien vinden we dat technologische barrières tegen de verspreiding van innovaties tussen bedrijven een van de belangrijkste kenmerken vormen die leiden tot aanhoudende technologische discontinuïteiten en concentratie. Ten slotte wordt een breed scala aan beleidsexperimenten uitgevoerd om licht te werpen op de beste beleidsinstrumenten die de stagnatie tendens als gevolg van toenemende concentratie kunnen stoppen en een concurrerend en door innovatie aangedreven groeiproces kunnen stimuleren.

5.3 Sintesi (Summary in Italian)

L'obiettivo di questa tesi è investigare le cause di fondo del 'paradosso della stagnazione-finanziarizzazione', ovvero una situazione in cui l'economia manifesta una tendenza alla stagnazione in un contesto di espansione finanziaria. Nel corso del progetto di ricerca condotto dutante il dottorato, ho affrontato questo argomento da diversi punti di vista, a livello sia micro che macro, utilizzando metodologie di ricerca differenti, dall'analisi econometrica ai modelli ad agenti.

Il Capitolo 2 mira ad indagare in che misura la tendenza alla massimizzazione del valore degli azionisti, incoraggiata da schemi di remunerazione dei manager basati su azioni, ha spinto le imprese quotate americane a distogliere risorse dagli investimenti reali alle attività finanziarie, come il riacquisto di azioni proprie, al fine di alimentare il prezzo delle azioni. Combinando i dati di bilancio delle imprese quotate con quelli relativi alla remunerazione dei manager durante il periodo 1992-2017, l'articolo mira a stimare due modelli panel data dinamici con l'intento di: (i) analizzare gli effetti di un incremento di riacquisto di azioni proprie sugli investimenti reali; (ii) esaminare l'interazione tra il pagamento di *stock-option* ai manager e la probabilità di riacquistare azioni proprie. I risultati delle regressioni mostrano che i riacquisti di azioni proprie sono negativamente correlati con gli investimenti in capitale fisico, specialmente tra le grandi imprese operanti in mercati poco competitivi. In aggiunta, un maggiore utilizzo di *stock-option* per remunerare i manager comporta un aumento della probabilità di eseguire riacquisti di azioni proprie. Questi risultati suggeriscono che i meccanismi di compensazione basati su azioni creano un incentivo per i manager a focalizzarsi sulla creazione di valore azione a breve termine mediante operazioni di riacquisto di azioni proprie a dispetto di investimenti reali di lungo termine.

Sulla base di questa evidenza, nel Capitolo 3 sviluppo un modello ad agenti macrofinanzario con mercati del credito e delle azioni al fine di analizzare come il ruolo crescente degli investitori speculativi nella struttura proprietaria influenzi l'orizzonte temporale dei manager e le decisioni di riacquisto azioni e investimenti in R&S e le dinamiche macroeconomiche risultanti. Attingendo alla concezione di mercato finanziario proposta da Keynes (1936) e alla nozione di Minsky (1992) di capitalismo *money manager*, l'idea è che quando il mercato azionario è dominato da un sentimento speculativo, i manager tendono a interiorizzare la visione a breve termine degli investitori speculativi e soddisfare la loro domanda di rendimenti azionari elevati, dirottando le risorse aziendali dagli investimenti in R&S verso il riacquisto di azioni proprie al fine di aumentare il prezzo delle azioni. I risultati della simulazione mostrano che il crescente orientamento al valore per gli azionisti determina, da un lato, una crescita più bassa e meno volatile nell'economia reale, dall'altro una crescita maggiore del mercato finanziario, dando origine a quello che chiamiamo un 'paradosso della stagnazione-finanziarizzazione'. Tuttavia, affinché questo scenario si manifesti, è necessario che la configurazione della struttura proprietaria e la relativa modalità di utilizzazione del surplus siano tali che il settore aziendale possa generare e quindi distribuire una quantità di profitti sufficiente a sostenere il prezzo delle azioni, nonostante un'economia reale in rallentamento. Al contrario, se la frazione di speculatori è troppo grande, la crescita economica è così bassa che il conseguente calo dei profitti aggregati trascina verso il basso la spesa per i riacquisti, provocando la caduta del mercato azionario.

I risultati della simulazione del Capitolo 3 rivelano che la sconnessione tra i mercati finanziari e l'economia reale non è una proprietà regolare del sistema, ma un risultato particolare che si verifica sola a determinate condizioni.

Passando alle ipotesi del nostro modello, ciò implica che la crescente tendenza a massimizzare il valore degli azionisti a livello micro, favorita da un sentimento speculativo che induce le imprese a distribuire maggiori profitti agli azionisti, non è in grado di produrre, da sola, una costante tendenza al rialzo del marcato azionario a livello macro; piuttosto, i conseguenti cambiamenti delle condizioni macroeconomiche in termini di minore crescita e minori profitti dovuti al ridotto sforzo innovativo finiscono per limitare la capacità delle singole imprese di aumentare artificialmente il prezzo delle azioni mediante riacquisto di azioni.

Pertanto, le simulazioni del modello consentono di fare luce sulle condizioni macroeconomiche in cui può effettivamente verificarsi una disconnessione tra i settori reale e finanziario, ovvero quando il settore delle imprese è in grado di generare profitti sufficienti per sostenere il prezzo del titolo nonostante un rallentamento economico. Questo perché la dinamica dei prezzi delle attività segue in ultima analisi l'evoluzione dei profitti aggregati, che d'altro canto potrebbero non essere allineati con l'andamento complessivo dell'economia. La domanda rilevante diventa quindi: quando avviene questo? Da qui il focus sulle cause e le conseguenze della crescente concentrazione del mercato, che costituisce l'oggetto di studio del prossimo capitolo.

Il capitolo 4 mira a costruire un modello macroeconomico ad agenti per studiare come i cambiamenti nella struttura di mercato derivanti dal progresso tecnologico influenzino la distribuzione del reddito e la crescita economica. Attingiamo dall'idea di Sylos Labini (1967) secondo cui, nella misura in cui le imprese eterogenee non hanno uguale accesso alle innovazioni incorporate nei beni capitali, il progresso tecnico genera "discontinuità tecnologiche", cioè differenze di produttività tra le imprese, portando a una ri-allocazione delle quote di mercato verso le imprese più produttive. Il modello è in grado di mostrare come le grandi imprese che cercano di esercitare il potere di mercato accresciuto aumentando i mark-up determinano endogenamente uno spostamento nella distribuzione del reddito dai salari ai profitti che alla fine mina la domanda aggregata e la crescita. In tal modo, la tendenza all'oligopolio a livello micro può dare origine a una tendenza alla stagnazione a livello macro, come Sylos Labini (1967) e Steindl (1976) ebbero già modo di evidenziare molto tempo fa. Inoltre, troviamo che le barriere tecnologiche contro la diffusione delle innovazioni tra le imprese costituiscono una dei fattori chiave che determinano discontinuità tecnologiche persistenti e, di conseguenza, una concentrazione di mercato crescente. Infine, viene eseguita un'ampia serie di esperimenti politici per far luce sui migliori strumenti di politica economica in grado di arrestare la tendenza alla stagnazione dovuta alla crescente concentrazione e promuovere un processo di crescita competitivo e guidato dall'innovazione.

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