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Of Fairies and Governments: An ABM Evaluation of the Expansionary Austerity Hypothesis

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WORKING PAPER SERIES Nº 2018-13

DEPARTMENT OF ECONOMICS, FEA-USP
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Paradoxically, the expansionary austerity hypothesis may find greater support in a theoretical framework that places an emphasis on the role of uncertainty for investment decisions not subject to a savings-in-advance constraint than in a more standard supply-led macroeconomic theory. This paper builds a demand-driven agent-based model featuring contagion across firms to explore whether fiscal consolidations may become expansionary due to a positive effect on investors' expectations, which could be the result of a dominant public discourse on the need for austerity. Simulations suggest that while a wave of optimism affecting a small proportion of firms may lead to short-run positive output effects in the economy, these effects are not sufficient to neutralize the negative macroeconomic impacts of cutting government spending. These findings are in keeping with the scantiness (or absence) of empirical evidence in favor of the expansionary fiscal contraction hypothesis.

Keywords: Expansionary fiscal consolidation; contagion; confidence; ABM; Keynesian Macroeconomics.

JEL Codes: E12; E22; E37; E71; H30.

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1. Introduction

One of the most debated concepts in economics as of late, the confidence level of businessmen is nonetheless not properly incorporated into mainstream macroeconomic models. As popular as it is controversial, the importance of the confidence level in the determination of several macroeconomic variables is capable of putting at the same side renowned Keynesians and radical members from the U.S. Republican Party, while stimulating deep divergence among Post-Keynesians.

An ontological basis which structures the Keynesian argument in favor of the central role played by confidence in economics can be found in the concept of uncertainty. As phenomena which cannot be reduced to objective probability calculations are abundant in economics, the unfolding of any individual action is infinite and "we have, as a rule, only the vaguest idea of any but the most direct consequences of our act" (Keynes, 1937, p. 213). Under such circumstances, it is not only unpredictable how the economic environment in which each agent is embedded will change, but it also becomes unfeasible to fully evaluate the consequences of any practical individual action.

However, Keynes (1937, pp. 214-215) considered that this relative ignorance about the future was avoided by practical men by using tools such as i) assuming that the current prices and production levels are based on reasonable predictions about the future, ii) considering disproportionately the present as a guide for foreseeing the future, and iii) conforming to the average opinion or behavior, which may be better informed than your own. The problem is that this behavior, "being based on so flimsy a foundation, it is subject to sudden and violent changes (…) At all times the vague panic fears and equally vague and unreasoned hopes are not really lulled, and lie but a little way below the surface."

Therefore, under uncertainty, the decisions of economic agents depend heavily on their expectations. Taking this crucial insight seriously implies the need to acknowledge the central role that psychological factors may play in economic decisions, and to consider how agent's confidence level can by itself shape economic results.

Although this discussion has survived outside the mainstream in theoretical debates since at least the 1920s, the academic quarrel on this issue gained a new historical impulse since the 2000s, with the emergence of some empirical papers advocating the expansionary fiscal austerity hypothesis. Contradicting the existing economic consensus, this hypothesis in its most typical version argues that the reduction of government spending may be able to generate expansionary effects on the economy by increasing the confidence of agents. The idea behind this hypothesis is that those confident agents would increase their spending more than the government had reduced its own, which would more than compensate the initial contractionary outcome (Alesina et al, 2012).

As reported by Krugman (2012), the discourse of what he calls the "confidence fairy" has gathered many enthusiastic supporters and, especially in Europe, has played a central role in the elaboration of macroeconomic policies, even with little or no explicit theoretical basis. However, even if we agree that the empirical foundations on which expansionary austerity is justified are weak and that most conservative circles cannot

explain this hypothesis by using any variant of their theoretical framework, we believe that there is a deep and complex theoretical debate regarding this issue when we discuss it under the understanding of the economy as an adaptive complex system with uncertainty. In other words, we argue that if we ignore this hypothesis as a mere rhetorical device that conservative leaders use to justify and implement austerity policies chosen *ex-ante* for political reasons, we may miss a timely opportunity to discuss fundamental theoretical questions related to this issue from a Keynesian perspective.

A telling indication of the depth of this debate was the recent quarrel on the subject between two of the most important Keynesian authors of the day: the Nobel Prize winner, Paul Krugman, and Keynes' most famous biographer Robert Skidelsky. In a debate organized by the New York Review of Books (Krugman et al. 2015), Krugman radically opposed to Skidelsky's view that stimulating the economy through fiscal policy could prove ineffective in a context where public opinion is convinced by the arguments supporting the need for austerity. A few months later, Skidelsky (2015b) has changed his mind.

Although the defense of the preponderance of objective factors made by Krugman may prove empirically right, it does not necessarily follow that the inability of expectations to reverse the direction of economic results determined by their objective aspects is a theoretical law. We cannot neglect a priori the possibility that under certain conditions these results may be reverted by expectations. In addition to that, the perception that a complete reversal of the expected trends does not take place is not sufficient evidence to prove that expectations are not able to substantively influence the extent of the effects of the supposedly "right policies". After all, when we consider the expectations of agents in reaction to policy changes, the results of the latter actually become indeterminate on purely logical terms.

We expect to contribute to this debate by using an Agent-Based Model (ABM) which was originally developed in Oliveira (2018) to simulate how some relevant macroeconomic variables respond to fiscal contractions. We consider a context in which firms' investment and production decisions depend on their confidence level, which improves when government expenditures are cut. Even though ABMs are not the only possible analytical framework to investigate the expansionary fiscal austerity hypothesis, we trust that conceiving of and analyzing the economy as an open-ended complex system populated by a myriad of adaptive and heterogeneous agents interacting in a decentralized way, can indeed generate useful insights to more fruitfully study phenomena related to confidence and, more generally, to economic uncertainty.

In order to discuss the expansionary fiscal austerity hypothesis, in the next section we review the empirical literature that disseminated this hypothesis and also discuss the possible theoretical foundations for it in mainstream macroeconomics. We then proceed to review the Krugman-Skidelsky debate, which has opened the theoretical possibility for expansionary austerity in a Keynesian framework. In Section 4 we describe a summarized version of the structure of our ABM, while in Section 5 we report and discuss our simulation results. The final section features concluding remarks.

2. The Expansionary Fiscal Austerity Hypothesis

After a renewal of Keynesian thinking ignited by the 2007-2008 financial crisis, in the early 2010s the economic policy debate in the U.S. and several other developed economies became almost obsessed with the effects of the fiscal deficit on macroeconomic performance. In the eyes of most commentators, only severe austerity could restore fiscal sustainability, economic stability, and growth.

Writing in the Financial Times in mid-2010, the German finance minister Wolfgang Schauble (2010) justified fiscal austerity as follows: "[. . .] restoring confidence in our ability to cut the deficit is a prerequisite for balanced and sustainable growth. Without this confidence there can be no durable growth. [. . .] This is the lesson of the recent crisis. This is what financial markets, in their unambiguous reaction to excessive budget deficits, are telling us and our partners in Europe and elsewhere."

The empirical literature which is used to justify this view dates back to the analysis made by Giavazzi and Pagano (1990) about the alleged benefits of fiscal consolidation in Denmark and Ireland in the 1980s. Their argument that government spending and deficit reductions would be able to generate positive short-term effects on employment and growth was radically opposed to the established knowledge since the Keynesian Revolution. Nonetheless, empirical works attempting to find similar regularities have multiplied over the last 30 years. Although the latest evidence on the subject contradicts the expansionary fiscal austerity hypothesis and exposes the fragility of the several methodologies employed in these studies, it is relevant to understand the justifications behind this hypothesis, in order to study it in the context of our model.

The empirical literature on the relationship between fiscal deficits, debt and economic growth can be divided in four main groups. The first (i) has investigated the consequences of particular episodes of large fiscal consolidation or stimuli on macroeconomic variables (e.g. Alesina and Ardagna (2010, 2017)). The second group (ii) of authors has focused on the dynamic impact of the so-called "discretionary component" of government expenditure and/or taxes on output and economic growth using a VAR approach (see for instance Blanchard and Perotti (1999)). The third set of studies (iii) has examined the impact of the fiscal deficit or the debt level on interest rates and/or economic growth in the long-run by using cross-country evidence (Reinhart and Rogoff (2010)). Finally, the fourth group (iv) has focused on the cyclical component of fiscal deficits (as opposed to the "discretionary component") in order to investigate the other direction of causality, namely how responsive, if any, is fiscal policy to the state of the economy, and whether it helps stabilize output fluctuations in a counter-cyclical fashion.

Although the work of Giavazzi and Pagano (1990) can be classified in the first of these groups, the most preeminent work following this approach is Alesina and Ardagna (2010). Assuming that fiscal adjustments would be necessary after the post-crisis stimuli of 2008, the authors follow a line previously presented in Alesina and Perotii (1995), and seek to explore the different effects of different fiscal adjustment compositions. Keeping the main result defended in Alesina and Perotti (1995), Alesina and Ardagna (2010) argue that fiscal adjustments made through the reduction of spending would be more

likely to be successful (in order to reduce debt and the proportion of debt to GDP) than adjustments made via tax increases.

Alesina and Ardagna (2010) also study cases of fiscal stimuli. According to their results, stimuli carried out through tax cuts would be more efficient at raising the level of growth than stimuli granted through higher levels of expenditures. Following the simple comparison of averages made in Alesina and Perotti (1995) to defend that episodes of fiscal consolidation would not harm growth, Alesina and Ardagna (2010) contend that reductions in expenditures would be less likely to have recessive consequences than adjustments made through taxes.

Although Alesina and Ardagna (2010) suggest that stimuli should be carried out by reducing taxes and adjustments through the contraction of government outlays (which evidently implies a government with less participation in the economy) it was the work produced by Reinhart and Rogoff (2010) that constituted the main evidence in support of a negative long-run effect of debt accumulation on economic growth.

Belonging to the group [iii] presented above, the study by Harvard professor Carmen Reinhart and the former IMF chief economist Kenneth Rogoff presented a dramatic situation: countries with debt greater than 90% of their GDP would suffer declines in their level of growth of more than 1% per year. For countries with external debt greater than 60% the situation would be even worse, with a drop of 2% of their growth per year. In their interpretation, this would be evidence of an acceptable upper limit for countries' debts, from which the costs of the debt would become unbearable.

In a political context of intense debate in developed countries regarding the stimulus policies employed during and after the 2007-2008 crisis, Reinhart and Rogoff (2010) gained fame and relevance, being quoted by politicians as the Speaker of the United States House of Representatives, Paul Ryan, and during the 2012 presidential campaign, to defend austerity policies (Alexander, 2013). Yet, surprising the entire academic community, Thomas Herndon, then a PhD. candidate at the University of Massachusetts Amherst, discovered in 2013 errors in the spreadsheet used by the authors, the absence of some relevant data and, in Herndon et al. (2013), criticized the methodology used in Reinhart and Rogoff (2010). Using the corrected data, Herndon et al. (2013) dismantled the view that there is an extremely dangerous ceiling for public debt, and showed that the growth of countries with debts above 90% of GDP is similar to that of their peers.

If the results obtained by Reinhart and Rogoff (2010) ended up demoralized by the academic community, the methodology used by Alesina and Ardagna (2010) has also proven highly controversial. Jayadev and Konczal (2010) point out that in all the examples of successful fiscal adjustments (generally defined as decreases in the primary deficit of more than 1.5% of GDP) studied in Alesina and Ardagna (2010), countries were growing strongly the year before the year of adjustment. Further, among the 48 episodes in which deficits were cut in a slump, more than half saw reductions in their growth rates in the years following the fiscal adjustment as compared with the years preceding it. Even in the remaining cases, the increase in growth was often not sufficient to lower the debt-to-GDP ratio in the subsequent years.

The possibility that Alesina and Ardagna (2010) overestimated the expansionary impact of austerity policies is also highlighted in a study of the IMF (2010). In particular, it is argued that the contractionary effects of many episodes of fiscal consolidation were offset by exchange rate devaluations and expansionary monetary policy. Once it is controlled for the role of monetary policy and international trade, the results of an autoregressive model in growth rates for a panel of fiscal actions taken in 15 advanced economies during 1980–2009 indicate that fiscal consolidation episodes have typically been contractionary.

Seven years later, Alesina et al (2017) published a new econometric study in which the expansionary austerity hypothesis has vanished. Based on a narrative dataset of episodes of fiscal consolidations in 16 OECD countries – an updated version of the database used in Romer and Romer (2010) – , the authors still conclude that spending cuts are less harmful than tax hikes, but there are no more positive effects on output in the long-run. According to the new results, while the negative effect of a cut in government consumption disappears after two years, a tax- based fiscal consolidation is still contractionary after four years. Moreover, another set of estimations show that investors' and consumers' confidence – unlike consumption and investment growth – respond positively to a cut in government spending, and negatively to an increase in taxes.

From a theoretical point of view, the traditional Keynesian insight that increasing government outlays is able to raise the current level of output through a multiplier effect on demand and to raise the future growth of the economy through an accelerating effect has been downplayed or plainly denied several times in the neoclassical literature (and even sometimes in the post-Keynesian literature, under certain specifications). Among other reasons, the view that increased public spending would generate a crowding-out effect of private spending seems to be the most common.

Indeed, in models which have full employment as an assumption, the rise in any of the components of aggregate demand cannot raise the total output of the economy. As, in this case, the economy is already using its full capacity and the expansion of one component of the demand must, for example, cause an inflationary pressure that depress (in real terms) one or many of the other components of the demand. In addition to that, models which base the determination of their interest rates on loanable funds' theories tend to argue that government debts create a competition for the savings available in the economy, implying that higher deficits tend to increase the interest rate and harm private consumption and investment.

Another similar idea, but applied to models dealing with open economies, argues that raising government expenditures would have negative consequences for the national trade balance. The reason for that would be that these new expenditures would either raise the relative prices, increasing the country's exchange rate and crowding-out part of its exports, or raise its external debt, affecting the future available income of the country. Finally, another fairly common argument is based on the Ricardian equivalence insight, whereby individuals would make their decisions considering their permanent income, meaning the income they expect to receive in their entire lives. The immediate result of that idea applied to government expenditures is that when governments increase the amount they spend, individuals are led to save the same amount of

resources, as they guess that they will have to repay these expenditures through taxes in the future.

At this point, it becomes clear the theoretical problem faced by the expansionary fiscal austerity hypothesis, under any of the more traditional neoclassical justifications presented above. As the above explanations seem to be mutually exclusive, for they start from different theories and model closures, one can argue that the most 'extreme' result that can be theoretically justified by them individually (even under rather artificial assumptions - such as full employment) is the one that states that fiscal policy does not matter, since it leaves the level of economic activity unchanged. This extreme result can be derived using, for example, an inter-temporal optimization model, a full employment assumption or a vertical LM curve in the Hicksian framework; even though the most common opinion in the mainstream is that raises in the government expenditures crowd-out only partially private expenditures - at least in the short run.

Therefore, to justify the idea that the positive effect on demand of government expenditures would not only be reduced or nullified but reversed, as the empirical hypothesis of expansionary austerity argues, it is necessary to use more 'heterodox' hypotheses. A few less standard arguments in that direction can be found in the recent literature.

The first one involves the reaction of financial markets to the government deficit, but is related to how the market perceives the ability of the government to service its debt in the future, or the risk of default. Without assuming a loanable funds theory of the interest rate, a higher deficit in this case could be enough to wake up "bond vigilantes" and reduce the price of government bonds (in primary and secondary markets). By definition, a lower price would be reflected in a higher interest rate paid on government debt. Depending on the term structure of the interest rate, this increase could also reduce interest-elastic components of private spending, via usual credit channels, or lead to a debt crisis (with strongly contractionary effects).

The second argument is somewhat related to the first one, but is concerned with the direct response of "investor's confidence" to the deficit, without the need to assume changes in the interest rate. According to this view, expressed for instance by the German Finance Minister Schauble (2010), the perceived risk of default by the government and the greater uncertainty about future prospects would make a higher deficit affect animal spirits, reducing investment and economic growth. Fiscal austerity would be needed in this case to restore the conditions for capital accumulation.

Therefore, the confidence component is a key element for the main plausible theoretical explanations, even under extreme conditions, for the feasibility of the expansionary fiscal contraction hypothesis. While traditional models may explain the weakening of the positive effect of government expenditures on demand, the reversal of this effect seems possible only under an analytical paradigm in which there may be disproportionate and/or irrational reactions (in a purely economic sense) by the decision makers. Specifically, the dynamics of contagion in an environment of uncertainty are central to the study of this phenomenon. As the model described in section 4 was developed using a methodology that addresses several of these issues, we trust that it

is well equipped to test the possibility of emergence of such dynamics under a given set of conditions.

3. The Krugman-Skidelsky debate

The depth and theoretical necessity to examine the expansionary austerity hypothesis using a framework which conceives of the economy as a complex system facing an uncertain future was reinforced by the recent quarrel on the subject between two of the most important Keynesian authors of the day: the Nobel Prize winner, Paul Krugman, and Keynes' most famous biographer Robert Skidelsky. Their divergence had already been shown in Krugman's (2009) review of “Keynes: The Return of the Master”, in which Skidelsky (2009) presents Keynes's trajectory and the relevance of his analysis in the aftermath of the 2008 financial crisis. While Krugman (2009) expresses his preference to follow Keynes (1996 [1936]), on the understanding that "the core of his theory was the rejection of Say's law," Skidelsky had demonstrated a greater inclination to adopt Keynes's (1937) position about the main contributions of the General Theory, stating that "Keynesianism is, or should be, essentially about uncertainty and how it leads to economic instability."

This central position given to uncertainty, fundamentally linked to the importance of belief in Keynesian thought, helps explain the skeptical stance adopted by Skidelsky (2015a) - in a first chapter of his debate with Paul Krugman. In that article, Skidelsky presents the hypothesis of expansionary fiscal austerity as follows:

“The Keynesian remedy, the argument went, ignored the effect of fiscal policy on expectations. If public opinion believed that cutting the deficit was the right thing to do, then allowing the deficit to grow would annul any of its hoped-for stimulatory effect. Expecting that taxes would have to rise to “pay for” the extra spending, households and companies would increase their saving. Fearing sovereign defaults, bond markets would charge governments punitive interest rates on their borrowing.”

Skidelsky notes “that fiscal tightening has cost developed economies 5-10 percentage points of GDP growth since 2010. [And] [a]ll of that output and income has been permanently lost.” However, Skidelsky seems to accept that the argument that “[b]y committing themselves to fiscal tightening, finance ministers gave themselves scope for some fiscal loosening. Proclaiming fiscal virtue enabled them to practice fiscal vice. They could create a fiscal illusion by cutting less than they promised.”

His admission of this claim would be one face of what Skidelsky (2015a) called the "mess into which macroeconomics has gotten itself. Once beliefs and expectations are introduced into economics, as is surely reasonable, the results of fiscal policy become indeterminate. Too much depends on what people think the results of the policy will be.” Thus, in this view, the success of the "right” monetary and fiscal policies would depend on public expectations of their effects.

In a debate organized by the New York Review of Books (Krugman et al. 2015), Krugman radically opposed to Skidelsky's skepticism. In that debate, Krugman denied that the confidence level of the firms could by itself change the final direction of any specific public policy, presenting a view strongly rooted on the idea that the objective factors of the economy are ultimately responsible for determining its main results. For the Nobel laureate Krugman, the idea that austerity policies could be expansionary

would not only be a misnomer, but an innovation with no connection to economic theory. On the other hand, expectations would have, in the author's view, a much smaller role than it is conventionally assigned nowadays. According to his view, it would suffice for the Central Banks to do their job, distancing their economic recommendations from their political affiliations, and turning to simpler macroeconomic models, to maintain the economy stable.

During the debate, Skidelsky followed the line of thought presented in Skidelsky (2015a), and disagreed with Krugman's more objective position. He also criticized the mathematical methodological authoritarianism of economics and indicated that, by the time they get properly considered by economic theory, expectations will bring economic theory to a post-crisis period, without any established insight into what the right policies to recover from recessions are. After all, following the argument with which he finished his previous article:

"As a Keynesian, I firmly believe that market economies need to be stabilized by policy. But Keynesians have to face the uncomfortable truth that the success of stabilization policies may depend on the business community having Keynesian expectations. They need the confidence fairy to be on their side."

It so happens, however, that in the months following his first article and the debate, Skidelsky suddenly got convinced by the position advocated by Krugman. After acknowledging that the results of austerity policies defended by Alberto Alesina and Kenneth Rogoff have been disastrous after the crisis, Skidelsky (2015b) changed his mind:

"On reflection, I think I was wrong. The confidence factor affects government decision-making, but it does not affect the results of decisions. Except in extreme cases, confidence cannot cause a bad policy to have good results, and a lack of it cannot cause a good policy to have bad results, any more than jumping out of a window in the mistaken belief that humans can fly can offset the effect of gravity."

Nonetheless, as the growing concern with firms' confidence in the economic debate illustrate, this position is far from consensual. Moreover, the comparison between the effects of government policies on macroeconomic variables and the laws of natural science seems particularly inappropriate - and even surprising for an author like Skidelsky who vehemently emphasizes the role of uncertainty in economic dynamics.

4. Model structure and results

The economy described by our simulation model is composed of five sectors all populated by boundedly rational agents, which follow simple heuristics in a decision-making context of incomplete and asymmetric information. The model contains:

- A capital goods sector, composed by one monopolistic firm. It employs workers to manufacture capital goods and perform in-house R&D activities. In each period, the monopolist advertises, sells and produces homogeneous capital goods, using only labor. However, the performance of in-house R&D activities can improve the productivity of the capital goods used to produce consumption goods in the upcoming periods, ensuring that the capital goods being used in each period remain heterogeneous. Moreover, the monopolist pays taxes to the government based on their net profits and reserves.

- A consumption goods sector, composed by a collection of heterogeneous consumption firms, which compete for market share. They produce homogeneous consumption goods, using labor and capital goods manufactured by the capital goods monopolist. In order to decide how much to produce and invest, they take into account their history of sales and profits and also interact with each other locally in a way that shapes their demand expectations. These decisions regarding Investment and production (and hence hiring of labor) also take into account the financial and technological constraints faced by the firms, but whenever it is needed, and up to a certain threshold, they borrow money from the banking sector to implement their desired level of production and investment. Moreover, the consumption goods firms pay taxes based on their net profits and their reserves.
- A banking sector, composed by one monopolistic bank. While firms are below their maximum indebtedness level, it lends money passively to the consumption goods sector, charging non-linearly-increasing interest rates.
- The government, which collects taxes from the consumption and the capital goods firms and pays unemployment benefits to the unemployed households.
- A collection of households, who sell their labor to the consumption/capital goods firms in exchange for wages. Unemployed households receive a dole from the government, and spend (whenever it is possible) everything they so receive (and anything they have possibly accumulated from previous periods) in consumption goods. The working households are homogeneously productive, and can work both in the consumption sector and in the capital/R&D sector. However, they are heterogeneous in any other respect, asking and receiving different wages, and consuming different amounts of goods.

The different groups of agents summarized above interact in our simulation during each period in four markets:

- A capital goods market: the monopolistic capital firm sells capital goods, on demand and with advanced payment, to the consumption firms.
- A consumption goods market: the consumption firms sell their homogeneous consumption goods to the households, under imperfect competition and according to their (endogenously time-varying) market shares.
- A labor market: the consumption and the capital goods firms hire workers to produce their respective goods and, in the case of the latter, to perform in-house R&D activities, with each sector following its own dynamics.
- A credit market: consumption firms borrow money from the monopolistic bank whenever their cash flows are not enough to cover all the expenses associated with their chosen levels of production and investment.

Having presented the general framework in which each of our agents will interact, we need to describe more specifically their behavior in different dimensions and exactly how they interact in our model. Our goal is to keep their behavior as close as possible to what empirical studies reliably suggest it to be in the real world. In this vein, we usually try to justify as much as possible the choices we made in building the model, using the empirical literature. Furthermore, we often care to mention what existing contribution(s) in the ABM literature, if any, we are borrowing from or extending in the modeling of the behavior of each agent in the economy.

4.1 Capital goods sector

In the beginning of each period, the capital goods monopolist presents to the consumption firms the productivity and price of the capital goods it will produce in this period. The productivity of the equipment manufactured in period t will be given by:

$$\text{Productivity}_t = \max\left(\text{Productivity}_{t-1}, \text{Innovation}_t\right)$$

where "Innovation" is the productivity developed in last period's innovative process (if any).

Following Dosi et al. (2010), and consistent with the empirical evidence presented in Fabiani et al. (2006) showing that prices are usually determined using a markup rule, the monopolistic firm establishes the prices for which their capital goods will be sold by applying to their unit labor costs a variable referring to their markup.

This markup increases slightly whenever the productivity of the equipment sold increases[1]. This provides an incentive to the capital goods monopolist to keep spending resources on P&D activities, as it appropriates for itself a part of any efficiency gain.

Once the latest vintage capital goods have been advertised, the monopolistic firm receives orders from the consumption goods sector, receiving the payments in advance. The empirical evidence presented in Bromiley (1986) suggests that it is usual for capital goods firms to have much of its demand agreed and secured by longer-term contracts. As a result, once the agreements are signed, they assure a kind of guaranteed demand.

Following the literature (Possas et al. (2001), Dosi et al. (2010)), the monopolist splits the value collected by selling its goods into three parts. Firstly, it hires workers to produce the amount of capital goods ordered by the consumption goods sector. Subsequently, it computes its revenue and labor costs, to evaluate its gross profits. A share of these profits is spent in R&D activities, as the monopolistic firm hires workers to perform these activities. Finally, the firm reckons its net profits and pays taxes on its profits and wealth.

The specification describing the innovation process follows Dosi et al. (2010) and Possas et al. (2001), and therefore joins a long stream of developments on the subject that followed the seminal contribution of Nelson and Winter (1982). However, as we are dealing with a monopolist who is always at the technological frontier, and we abstract from the existence of a fringe of potential imitators, the model does not feature imitation as a further source of technological change.

Under these specifications the only sector of the economy which can improve its production efficiency is the consumer goods sector. The reason is that the equipment bought from the capital goods firm to produce consumer goods may have its efficiency improved at each period. Yet the production of each of these capital goods continues to require the same amount of workers throughout the simulation, given that the respective labor coefficient is a fixed parameter.

[1] The value of this and other important parameters of the model, and the initial conditions of the main variables can be found in tables A and B in the appendix to this paper.

As explained in Dosi et al. (2010): "We model innovation as a two steps process. The first one determines whether a firm obtains or not an access to innovation – irrespectively of whether it is ultimately a success or a failure - through a draw from a Bernoulli distribution", whose probability of success is given by:

$$\mathrm{P}(\mathrm{SucessInov_t}) = 1 - (\exp(-\tau \frac{\mathrm{NumberWorkersInov}}{\mathrm{NumberWorkersTotal}}))$$

where τ is a parameter which controls how easy it is for scientists' research to result in innovations. This equation means that the access to innovative discoveries becomes more likely when the firm hires more workers to perform in-house R&D activities. If the firm is successful, it draws the equipment's incremental productivity from a normal distribution[2]:

$$\Delta\mathrm{Productivity_t} = \mathrm{Productivity_{t-1}} + \mathrm{Normal}(\mu, \sigma)$$

where μ is the average and σ is the standard deviation of this distribution. As this draw may yield a negative value, not every innovation is implemented in next step's capital goods advertisement and production. By this we try to represent the fact that in addition to the inherent difficulty to generate new knowledge, there is in innovative investment the risk that, even when innovations are created, they fail to accomplish their goals.

Finally, in the end of each time period, the monopolistic firm delivers the capital goods ordered and previously paid by the consumption firms. Moreover, the capital-producing monopolistic firm computes its profits and transfers to the government a part of its reserves, as a fee on capital and profits imposed by the government.

4.2 Consumption goods sector

The collection of heterogeneous consumption goods firms start each period receiving from the capital sector an advertisement message containing the prices and productivity level of the machines the monopolistic capital firm will manufacture in that period. Before placing their orders, the consumption goods firms compute their financial constraints to invest and produce the amounts they desire.

The process which determines the consumption firms desire to produce and invest is the core element of our model. In order to assure the attention it deserves, we pause for a while the brief explanation of our model, to concentrate on this aspect.

4.2.1 Expectations

In our model, the desired production level in a given time period t depends on the expectations each firm has about the demand for its production in t. Meanwhile, its investment expenditures depend on each firm's expectations about the demand for its production in t+1. This is because investment goods ordered in t will be delivered only in the end of each period. This lag is not just a Kaleckian inspiration[3], but it is also

[2] Dosi et al. (2010) use a beta distribution, for greater flexibility. However, this decision doesn`t seem to be crucial for our qualitative results, and the normal distribution can also generate periods of productivity growth which can be either positive or negative.

[3] We are inspired here by Kalecki (1971, chap. 1) both in assuring a lag between investment decisions and their deliveries, which in one of Kalecki's model is crucial for the emergence of cycles, and in distinguishing between three stages in investment activity. As Kalecki explains: "Three stages should be distinguished (…): (i) investment

described by Bromiley (1986) as being observed in the real world. According to him, investments take time between being planned, implemented and then mature. Hence, firms are compelled to designate its maximum productive capacity always in advance.

As usual in the literature (e.g., Dosi et al. (2010), Possas et al (2001), Caiani et al. (2016)), in our model firms form adaptive expectations. Our choice of expectations based on past performance, instead of the forward-looking rational expectations figuring prominently in the mainstream literature, is based on innumerous pieces of empirical evidence. As shown in Gennaioli et al. (2016), models using rational expectations have been proved empirically problematic and the behavior observed among investors has preliminary validated the adaptive expectations' hypothesis.

In the same way, Caballero (1999) maintains that sales' growth explains pretty well the level of investment, while Davar and Gill (2007) show that investors' preferences are strongly related to the performance of current investment. One possible explanation for this is described in Dreman et al. (2001). According to them, under uncertain conditions there is a propensity for choices to be guided by the "representativeness heuristic". In this heuristic, which is found in psychological studies, "forecasts are made to be similar to (…) salient features of the observed data. The recent performance of stocks [in our model "sales"] is much more salient than the historical performance, hence likely to become the representative standard by which future returns are forecasted". Therefore, it is typical for the current performance of sales to dictate the standards according to which firms will base their choices, which they will do by extrapolating the present to the future[4].

However, as elaborated in Gennaioli et al. (2016), expectations, in addition to the factors that we can rationalize by looking at the data (as previous sales), also seem to rely on other – less rational- motives. For example, optimism with the national economy seems to be positively correlated with the firm's investment and "firm's expectations and sentiments appear to be a key driver of investment activities" (p.19). In this vein, there is an extensive behavioral literature on how psychological aspects influence economic decisions, as in Kahneman and Tversky (1979), and on the various ways in and through which economics is connected with psychology, as described and summarized by Rabin (1998).

Psychological factors are not only relevant, but they also have a tendency to be persistent, as observed by Hermalin and Isen (2000). A plausible explanation for this observed non-rational behavior can be found in Dreman et al. (2001). They argue for the importance of the "Affect Heuristic", according to which "images, associated with positive and negative affective feelings, guide judgment and decision-making." As a consequence, the kind (and content, we would add) of news broadcasted by the media

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orders, i.e., all types of orders for investment goods for the sake of reproduction and expansion of the capital equipment (…); (ii) production of investment goods (…); (iii) deliveries of finished equipment per unit of time".

[4] An extremely similar explanation is found in Keynes (1936, cap.12)"It is reasonable, therefore, to be guided to a considerable degree by the facts about which we feel somewhat confident, even though they may be less decisively relevant to the issue than other facts about which our knowledge is vague and scanty. For this reason the facts of the existing situation enter, in a sense disproportionately, into the formation of our long-term expectations; our usual practice being to take the existing situation and to project it into the future, modified only to the extent that we have more or less definite reasons for expecting a change."

in the moment of an investment can affect disproportionately the investor's image and thereby influence his decision-making. In the authors' words, "in the process of making a judgment or decision, people are assumed to consciously consult or unconsciously sense an "affect pool" containing all the positive and negative feelings associated with the representations (images) of the object being judged." (p. 129).

For our purposes, however, the reasons why firms' "humor" (which we shall call "optimism") impact on their decisions are less important than the implications of such an impact. The fundamental point we want to make here is that not only there is robust empirical evidence that the level of optimism of an individual firm influence affects its production and investment decisions, but also that the level of optimism of other firms (and the society at large) affect the level of confidence of the investor and thereby his investment and production decisions.

Motivated by these considerations, we follow Lima and Freitas (2007) to add an element of level of optimism to the formation of expectations of the consumption goods firms. The level of demand these firms expect to face in t is given by:

$$\mathrm{ExpectDem}_{t}^{t} = \mathrm{Optimism}_{t}(\varphi + \omega)$$

while the demand they expect to receive in t+1, which determines their investments is given by:

$$\mathrm{ExpectDem}_{t+1}^{t} = \mathrm{Optimism}_{t}(\varphi + 2\omega)$$

where φ is a reference value used as a basis, based on the demand faced in previous periods (with most recent period having disproportionally more weight), and ω is the tendency of this reference to vary over time. In the simulations of this paper, these patterns are defined based on the last five periods.

The level of optimism, in turn, varies according to the firm's profit in the last period and its local interaction with other firms. Specifically, the level of optimism in t is equal to its level in t-1 added (diminished) by a positive parameter when the firm's profit in t-1 was higher (lower) than the firm's profit in t-2. Moreover, the level of optimism in t-1 is also added (diminished) by another positive parameter when the firm's optimism in t-1 was lower (higher) than the average optimism detected across three other firms with which it randomly interacted locally. In behaving this way, firms are affected both by the "affect heuristic" and the "representativeness heuristic" described in Dreman et al. (2001).

This interaction among firms in the determination of their confidence levels (which influence their expectations, thus affecting their production and investment levels) is one of the main innovations proposed by our model. Inspired by Kalecki, we understand that including this dynamic is justified not only by the empirical and psychological evidence presented earlier, but also for rational reasons, which lead firms to base their choices in what they know about their competitors in the moment they decide their production and investment levels[5].

[5] Among many, one passage where Keynes explains how agents' decisions under uncertainty can be influenced by their peers can be found in Keynes (1937, p. 214): "Knowing that our own individual judgement is worthless, we

4.2.2 Coming back to the description of the model

We follow Possas et al. (2001) in specifying that the desired level of production by the consumption goods firms is the one which assures supply for the expected level of demand and the keeping of a fixed proportion (of the expected demand) of inventory. Meanwhile, the desired level of investment in t is determined by the addition of the expected demand in t+1, and the desired inventory level in t+1. If this sum is larger than the firms' future installed maximum capacity (the current less depreciation), the firm's desired investment is the one which assures this desired maximum productive capacity in t+1. If that sum is smaller than the future maximum installed capacity, the firm chooses not to invest in t, because, as Kalecki (1968, chap.9) puts it, "at the beginning of this period the firms have pushed their investment plans up to a point where they cease to be profitable".

In fact, Gennaioli et al. (2016) demonstrates that directors' expectations are better predictors both of expected and real investment than other usual explanations, such as Tobin's q, discount rates and measures of financial constraints and uncertainty. In this vein, Caballero (1999) states that business' cash-flows and sales' growth seem to be much more important to explain firms' investment decisions than Tobin's q. We are also following this same literature, when we assume that investment is a sunk cost, namely, that once firms buy machines there is not a secondary market available to resell them, if they need to recover a share of their investment.

The effective production and investment are restricted by technical and financial constraints. If the resources available (firm's reserves and bank credit) are smaller than the expected wage costs, the firm does not invest in this period. Otherwise, it orders and pays to the capital sector as many machines as it can afford to pay, or as it desires (whatever is smaller).

Firms always prioritize the usage of internal resources, accumulated from previous periods. It is only in case these resources are not enough to cover expected wage costs and the desired investment costs that the firm relies on the monopolist bank for a loan. In that case, the firm takes on credit until the first of the following occur: (i) the maximum indebtedness tolerable by the firm's board is achieved, (ii) the maximum indebtedness or minimum market share tolerable by the bank is achieved, (iii) the interest rate charged by the bank gets larger than the firm's markup, or (iv) the resources sufficient to finance the desired level of production and investment are obtained. In the event of any of the circumstances (i) to (iv) the firm reduces the resources committed with investment and, when this possibility is exhausted, it decreases its effective production level. This mechanism is in line with the evidence presented in Bromiley (1986), who mentions that investment tends to be the first component to be diminished in a firm under financial fragility.

Moreover, our modeling is also in keeping with the evidence presented, for instance, in Fazzari et al. (1988), according to which financial factors are not the main determinants of investment in the aggregate, but they matter for specific groups of firms (in our case, they matter for firms with small reserves). In addition, we follow Bromiley's

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endeavour to fall back on the judgement of the rest of the world which is perhaps better informed. That is, we endeavour to conform with the behavior of the majority or the average."

(1986) ideas that there is a maximum indebtedness that firms' boards allow their companies to take, and, as will be explained in the description of the banking sector, that internal funds have a cost advantage, when compared to credit.

After paying the capital sector, the consumption firms hire workers and allocate them to produce using their equipment, ensuring that the more productive machines are employed first. The production of consumption goods then takes place, with every occupied machine producing as many goods as its productivity permits.

To specify how firms set prices we follow Fabiani et al. (2006, pp.3), according to whom "firms operate in monopolistically competitive markets, where prices are mostly set following markup rules and where price discrimination is common." Hence, we are inspired by Kalecki's (1971, chap. 5) approach to price determination to delineate a modified version of the replicator dynamics presented in Dosi et al. (2010) and Possas et al. (2001).

Under imperfect competition, each firm sets its own price, by which all available production will be potentially sold in this period. Each firm applies its own markup rule as follows:

$$MkUp_t = MkUp_{t-1} + \alpha_1\left(Price_{t-1} - AvgPrice_{t-1)}\right) + \alpha_2(MktShare_{t-1} - MktShare_{t-2}) + \alpha_3(MktShare_{t-1} - \left(\frac{1}{NumbFirms}\right))$$

where α_1 is a negative parameter, which gives the sensitivity of the firm's markup to the price of the competitors with whom it Interact locally. On the other hand, α_2 is a positive parameter giving the sensitivity of the firm's markup to the evolution of its own market share. The positive parameter α_3 represents the tendency of firms whose market share is higher than the average to use their market power to charge prices higher than their competitors.

Given firms' heterogeneous prices, we can establish each firm's market share. In our replicator dynamics, the market share varies according to the difference between one firm's competitiveness and the weighted (by the market share in t-1) average of all firms' competitiveness:

$$MktShare_t = MktShare_{t-1} + \vartheta(FirmCompetetiveness_t - AvgCompetetiveness_t)MktShare_{t-1}$$

where ϑ is a positive parameter which denotes the respective rate of adjustment. Thus, when a firm is more price-competitive than the average, it enhances the proportion of the total demand to which it can sell its production.

Once the market share of each firm is determined, we can allocate aggregate demand among firms. When a firm is unable to satisfy all its orders, using its production and inventories, this unattended demand is not redistributed for other firms in the same period. Therefore, there is the possibility that in some periods some resources are not spent, as consumers may try to buy from firms which couldn't attend all their demand. These resources are accumulated until the next period, when they are added to the next aggregate demand to be redistributed among firms.

After being paid for its sales, an individual consumption goods firm pays back any money they have borrowed from the monopolistic bank, adding the interest charged. It then computes its gross profits and pays a proportion of its reserves to the government. Finally, a simulation period ends when consumption-goods-producing firms receive their new machines ordered from the monopolistic capital-producing firm in the beginning of the period. The oldest machines are discarded (their lifetime is defined by a parameter), as a depreciation mechanism.

4.3 Banking sector

To keep the focus on the issue of how the level of confidence of investors affect macroeconomic outcomes, the banking sector is a simple one. It is composed by one monopolistic bank, which does not pay interest on deposits and grants credit passively, lending money to consumption goods firms lacking enough internal financial resources to produce and invest at their desired levels.

The interest rate varies positively and non-linearly with an indicator of indebtedness given by:

$$\frac{TotalLoans}{(FirmRevenue_{t-1} + FirmRevenue_{t-2} + FirmRevenue_{t-3})/3}$$

This specification is intended to capture the increasing risks and costs associated with borrowing money, as a proportion of the firm's internal capital, as suggested in Kalecki (1968, chap. 8). This specification is also in keeping with the evidence presented in Bromiley (1986) that internal funds have cost advantages for firms, when compared to credit funds.

Similarly to the procedure adopted by the board of the firm, the bank also defines a maximum indebtedness level above which it ceases to lend money to firms. The idea is that above that level, banks are afraid of the firms' solvency, and stop taking the risk to lend. Also, the bank constrains credit for firms below a given market share, which is in line with the difficulties faced by small firms in the real world. For firms which have not paid all their debts in the last period, the bank lends only enough for them to pay wages and hence be able to produce, in an attempt to help these firms to pay their debts. Yet, no further credit is granted to these firms to cover investment expenditures.

4.4 Public sector

The government plays only two roles in our model: collecting taxes and paying unemployment benefits. Yet its presence is of course essential for the experiments on the validity of the expansionary fiscal contraction hypothesis we will conduct through simulations.

As in Dosi et al. (2010), in the end of each period the government interacts with the consumption and capital goods sectors, charging a proportion of their net profits and reserves as taxes given by an exogenous tax rate. These resources are employed to pay each unemployed a benefit. Thus, the government acts in an anti-cyclical manner, transferring a certain proportion of the average wage in that period as an unemployment dole to each unemployed, spending more when there are more unemployed and less in

boom periods. As a result, the government's budget is the variable that adjusts to the others.

4.5 Households

The economy is populated by a fixed number of households (workers/customers), who are responsible for all productive activities in the economy and, also, for the entire demand for consumption goods. Although the productivity of the working households is homogeneous, the wage they will demand in the beginning of each period to accept a job offer by a consumption goods firms is nonetheless heterogeneous[6].

The working households establish their desired wage using a similar, but modified, version of the one suggested in Dosi et al. (2010). This desired wage is determined as follows:

$$DemandedWage_t = DemandedWage_{t-1} + \beta_1(AvgProductivity_{t-1} - AvgProductivity_{t-2}) + \beta_2(UnemploymentRate_{t-2} - UnemploymentRate_{t-1}) + \beta_3(DummyEmployed_{t-1}) + \beta_4(WageShare_{t-1} - WageShare_{t-2}) + \beta_5(ConcentrationIndex_{t-2} - ConcentrationIndex_{t-1})$$

where β_1 measures workers' ability to appropriate any efficiency improvement represented in the economy, β_2 measures the sensitivity of workers' desired wage to the unemployment rate, β_3 indicates an exogenous amount that workers add to (subtract from) their desired wage in the previous period when they were employed (unemployed) in that period. Meanwhile, β_4 denotes the sensitivity of the desired wage to a change in the wage share, and β_5 measures the extent of the downward pressure exerted on the desired wage when market concentration becomes higher. All these parameters are strictly positive.

The first sector to hire workers is the capital goods one. The capital-producing monopolist first hires as many workers as it needs to manufacture equipment and, only after that, hires workers to perform R&D activities. This monopolist is informed about the average wage workers are demanding in the current period, and hires as many workers as it needs by applying a markup on this average.

It draws workers randomly and offers them wage compensation. In our simplified model, no worker turns down the offer received from the capital-producing firm. The reason is that they know that they are being offered a higher wage than they can reasonably expect to be offered in the consumption goods sector (although the worker in question may have demanded an even higher wage previously).

By the end of each period, the unemployed working households receive an unemployment benefit from the government, whereas the employed ones receive their negotiated wage. Following one of Kalecki's main assumptions (e.g. Kalecki (1971, chap. 15)), which is also made in our reference models in the existing literature (Dosi et al. (2010) and Possas et al. (2001)), we suppose that workers necessitate to spend all

[6] Although there may be some questioning about homogeneous workers receiving different wages (which could be justified by the imperfect competition in the labor market and the matching process which we have developed), the most important is understanding that the role of this heterogeneity in our model is to bring one more cost heterogeneity to our model's core: the consumption goods firms.

the wage income they earn in each period. This need will not be satisfied only when consumption firms either do not produce enough goods and/or does not have enough inventories available to meet the aggregate demand placed by workers. In this case, the remaining funds are equally distributed among all workers to be added to next period's individual demand.

5. Simulations

We simulate the model described in the previous section with the government, a monopolist bank, a monopolist firm producing capital goods, 32 firms producing consumer goods and 3,000 workers / consumers, over 6,500 periods. The code of this model was written and its simulations are run in the Laboratory for Simulation Development (LSD) program, developed by Marco Valente specifically to deal with economic ABMs[7]. The results of our simulations presented below are average results from 10 markets simulated simultaneously with the same specifications and parameters, although the random initial values are different for each agent in each market, and specific changes will be applied to our baseline model as experiments.

The consumer goods firms initiate the simulation following a Zipf distribution for their sizes, as suggested in Axtell (2001). In our case, this means that the largest firm starts the simulation with twice the market share (20%), reserves ($ 200,0000), previous period revenues ($ 3,000) and demand from previous periods (1,500 goods) than the second and the third largest firms. These, in turn, are twice as large as the next four firms, and so on.

The main reason why we adopt this distribution, in spite of starting our simulations with firms of the same size – as is more common in the literature-, is that in reality firms interact starting from heterogeneous conditions of sizes and shares of the market. As there is a high degree of path dependence in our model, it seems that starting with an unrealistic initial level of competition could generate excessively high levels of competition, even in the long run.

Apart from this difference in the initial size of each firm, most of the other parameters and initial values are homogeneous, or at least were taken from the same random probability distribution. Amongst those, the most important parameters and initial conditions of the capital goods monopolist, the government, the bank, and also of each worker and the consumption goods firms, can be found in the appendix to this paper.

In order to gain some insights on the effects of policy changes and shocks in a simulated economy like ours, it is fruitful to define and observe the results of a baseline model, with which we can run our experiments and compare our results. This comparison amongst different versions of the same baseline model can bring us some patterns on how each change affects the main macroeconomic variables.

Even though a complete description of the results and structure of the baseline version of the model can be found in Oliveira (2018), it is worth recalling some of the main stylized facts of the empirical literature, which the model is able to replicate. With

[7] More information about the program, its free download and manuals can be found at: http://www.labsimdev.org/Joomla_1-3/index.php?option=com_content&view=article&id=11&Itemid=6

this in mind, a first feature that should be noted is the persistent (but not exponential) growth in real GDP in the simulations. Moreover, we should keep in mind that the GDP is subject to quasi-regular cycles, which tend to take 15 periods to return to their initial point.

This same robust cyclical growth pattern is observed in most of our most important macroeconomic variables, such as the total wage bill and the investment level (both real and nominal). Also, as expected, we obtain cyclical but stable results for the unemployment rate (16-31%), the total number of machines in the economy, the degree of capacity utilization of machines (79-89%) and the share of government expenditures as a percentage of GDP (19-26%). While the total number of machines remains relatively stable, their productivity grows in jumps (as expected from innovative processes) and, showing a similar rate of growth, the average wage evolves in such a way that workers are able to appropriate part of the economy efficiency gains.

Both in our baseline model and in our experiments, the real value of each variable is calculated using a Paasche price index, which, for the baseline model, exhibits in the long run an almost constant price level, with a small deflation. Also stable in the long run are the average optimism of the consumption goods firms, the debt/GDP ratio of the government and the Herfindahl index as a measure of market concentration for the consumption goods firms. Finally, it is worthy of mention that, as in many ABMs in the literature, our model also replicates the evidence presented in Backus and Kehoe (1992), that aggregate investment is much more volatile than aggregate consumption and output, with the latter two to vary similarly.

5.1 Optimism shocks and the Expansionary Fiscal Austerity Hypothesis

As discussed in the previous section, the expectations of the firms depend on a very unstable confidence level, which is subject to unpredictable and abrupt changes – not always related to purely economic aspects of the world. By incorporating an optimism level for each firm, our model allows the running of several experiments that deepen our understanding of some of the possible macroeconomic consequences of such a feature of firms' expectations. In what follows we explore some (among many other) possibilities, using shocks to optimism and government policy.

Even though the use of shocks in ABMs is controversial[8], for it abandons one of its main qualities – the certainty that all complex emergent behaviors that arise are indirect consequences (only) of the interaction of endogenous features coming from the micro (agent) level-, we believe that the cautious use of this device can be fruitful and rewarding in ABMs, as it contributes to a deeper exploration of the transmission and propagation mechanisms in the model. Moreover, the fact that shocks are exogenous perturbations does not necessarily mean a hindrance, as no model is capable of reproducing endogenously all aspects of reality – and the very admission of the concept of uncertainty reminds us of the instability and unpredictability inherent to the economic system.

[8] Actually, even in the mainstream literature Romer (2016) has criticized the fact that this instrument has been excessively used in DSGE models to mask, with a superficial aspect of scientific explanation, behaviors which cannot be explained by the model.

Bearing in mind all these caveats, we explore the effects of a pessimism shock in the period 2,500 in our model. This exogenous shock, which can be persistent or not, can be interpreted in a number of ways: as bad news capable of undermining the confidence of the firms, as an irrational panic hitting the economy unexpectedly, or even as a pessimistic reaction of the firms following a policy change made by the government - as suggested by Keynes (1996 [1936], p.170).

As there are different, and equally insightful, ways to apply this pessimism shock, we run three different experiments of 10 simulations, following the specifications of our baseline model. As a first test (i), we observe the consequences of a shock that brings the optimism of all 32 consumption goods firms to its minimum level (0.5) during only 1 period. In a second test (ii), we study the consequences of this same 1 period shock, but confined to only 12 consumption goods firms. In our last test (iii), we observe the effects of a persistent wave of pessimism affecting as before 12 consumption goods firms, but now lasting 25 periods and not just 1 as in (i) and (ii).

These different specifications allow us to investigate the consequences of a moment of generalized pessimism, but also permit us to gain some insight into the capacity of a pessimistic focus located in just a few firms to spread to the whole system. As we can see in Figure (1), the localized shock of only one period (ii) does not change the average confidence level of the consumption goods firms in the medium run. It seems that, under this specification, the pessimistic sector of the economy is not able to contaminate its competitors and, after a few periods, it is influenced by them and returns to its previous optimistic position. However, this does not mean that this shock does not exhibit any long-term consequences. As is shown in Figure (2), for a series of relevant variables the pattern that emerges in the long run is closer to the patterns observed after the shocks (i) and (iii), than to the results coming from our baseline model.

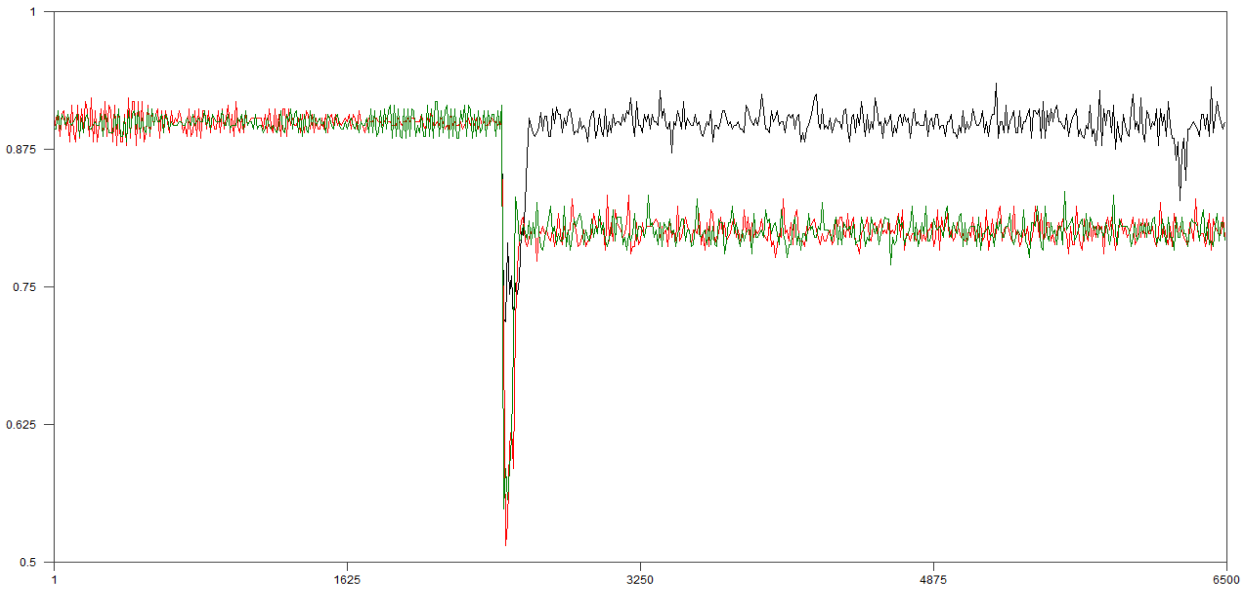

Figure 1: Firms Average Optimism Level in test i (green), test ii (black), test iii (red) – Pessimism Shocks

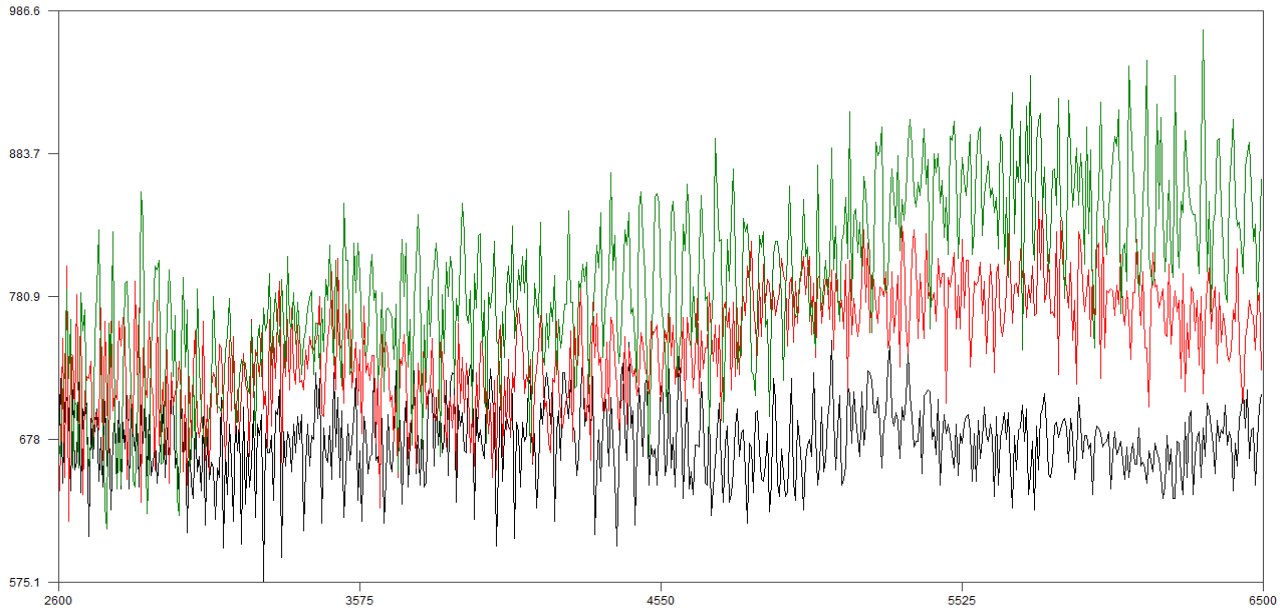

Figure 2: Starting at 2,500, Number of Unemployed in baseline mode (black), test ii (red), test iii (green) – Pessimism Shocks

These hysteresis effects can be observed in case (ii), for example, for the unemployment level (on average around 795 in cases (i) and (iii), 745 in case (i) and 676 in the baseline version), for the level at which the government debt/GDP ratio stabilizes (around 20% higher than before), for the government expenditures as a proportion of GDP (almost 2% higher than in the baseline model) and, to a lesser extent, for the real GDP (almost 5% lower, on average). Not to mention the short run blast in the unemployment level, and the mini crisis that takes place just after the shock.

While in this case with a pessimism shock that lasts only one period and is localized in few firms we have hysteresis effects in only some variables and the previous average level of optimism is restored rapidly, in cases (i) and (iii) the initial pessimism shock is persistent. This is evidence in favor of the idea that generalized pessimism shocks, even if lasting only one period, and pessimism persistent waves, even if localized in only part of the economy, can have long lasting consequences for macroeconomic variables. The lower confidence levels of agents have, in such cases, effects on a fairly comprehensive set of variables. Not only the variables already affected in case (ii) are even more disturbed in cases (i) and (iii) (see Figure 2), but we can also observe that the variables more directly related to the demand expectations of the consumption goods firms are dramatically modified.

As shown in Figure 3, indicators such as the average level of inventories and the average expectation of demand for goods, remain at levels much lower than previously. An interesting consequence of that is a higher tendency for workers to accumulate some wealth to be spent in next periods (Figure 4), as now firms operate with a smaller margin for their inventories and have a higher probability of being surprised by demand levels higher than their maximum capacity of delivery.

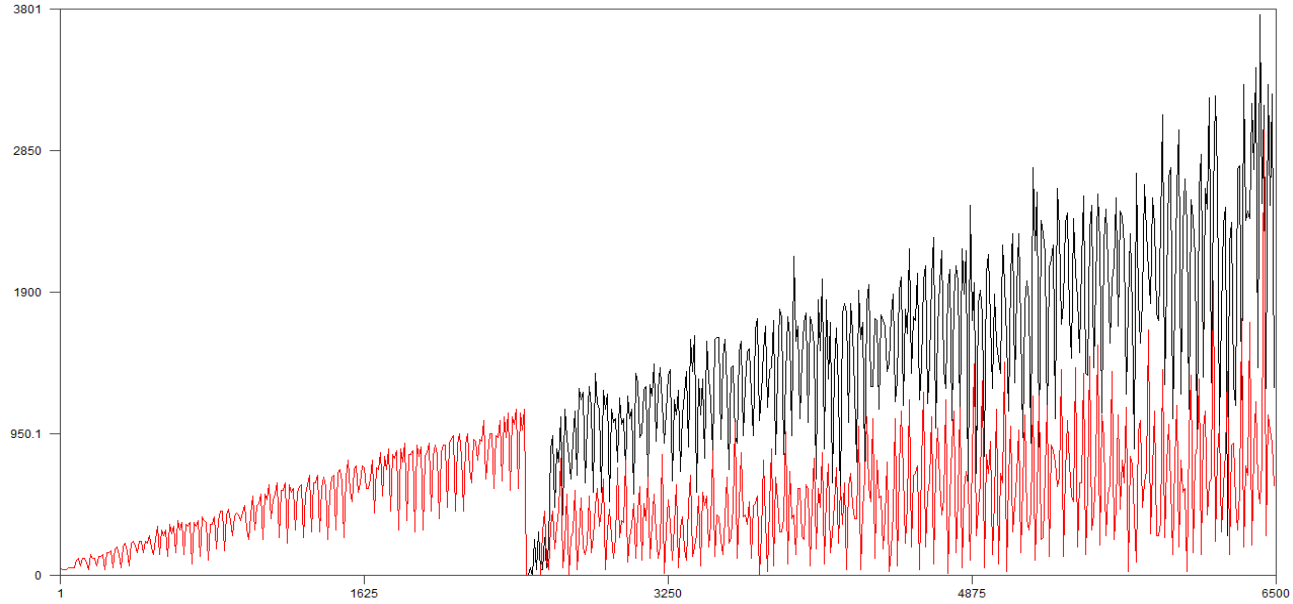

Figure 3: Average Level of Inventories in test ii (black) and test iii (red) – Pessimism Shocks

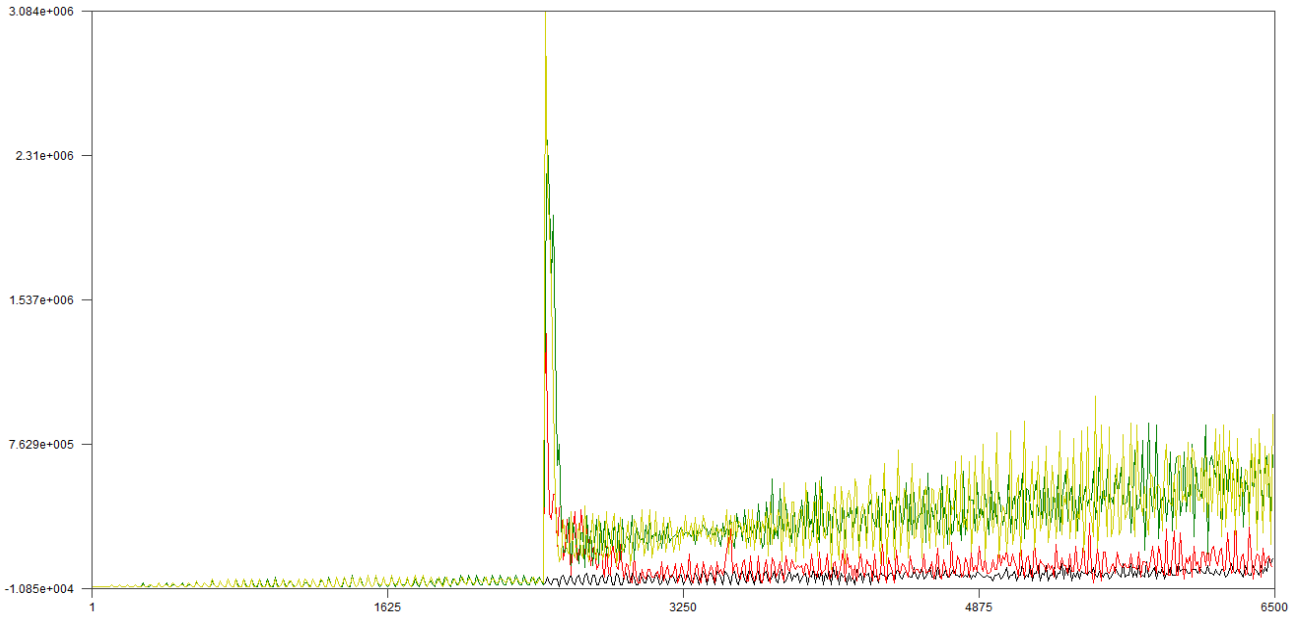

Figure 4: Workers Aggregate Wealth in the baseline model (black), test i (yellow), test ii (red) and test iii (green) – Pessimism Shock

The message of the model is clear: although short-lived pessimism shocks restricted to a few firms are not able to permanently contaminate all competitors – as even the few pessimists are brought back to their normal mood after a few periods-, when pessimism waves are persistent, even if localized in a few firms, they spread very quickly through the system. Once the economy reaches the minimum level of optimism, either through the contagion of case (iii), or through a generalized one-period shock as in (i), the system seems to have no endogenous mechanisms to recover from this bad mood. Only exogenous changes, as positive confidence shocks, would be able to play such a recovering role. Nevertheless, even shocks as (ii), which seems to have only

transitory short-run consequences, are capable of bringing hysteresis effects to some macroeconomic variables.

Now that we understand the main effects and transmission mechanisms of the confidence level in our model, it is worth returning to our main concern in this paper: the expansionary fiscal austerity hypothesis. This hypothesis can be divided in two parts: an action and a reaction. The action would be a cut of government expenditures, and the reaction would be an increase in the confidence level of the firms. Therefore, the relevant theoretical question is whether the contractionary effects of the action can be avoided by the alleged expansionary effect of the reaction.

We have already observed the independent repercussions of this kind of reaction by the firms, as the effects of pessimism shocks have been studied above isolated from any other shocks[9]. Accordingly, it is now relevant to present the independent results of that kind of action by the government, when isolated from any other shocks. For that, we simulate the effects of exogenous policy changes in periods 2,500 and 5,000 in two ways.

In the first test, the model starts under the specifications of the baseline version, but in period 2,500 the value of the unemployment benefit is changed from the original 70% of the average wage requested by workers, to 40% of that value. Then, in period 5,000, the unemployment dole payed by the government returns to its original value. As a second test, we already start the simulation implementing the reduced value of 40% of the average wage for the unemployment benefit, and we increase this value to the standard 70% in period 2,500, only to return to 40% again in the period 5,000.

When we observe jointly the results for the number of unemployed in each of these simulated economies, a general conclusion is straightforward: the dynamism of the economy is greatly improved when the average unemployment dole is higher. While the total number of unemployed jumps from around 750 with 70% of the average wage to 1,100 with the benefit of just 40% (Figure 5), the real GDP and the total number of machines fall by almost 20%. The share of the government expenditures in GDP, in fact, is diminished when the unemployment dole is reduced, but that is not reflected in any relevant improvement in the debt-to-GDP ratio of the government. Moreover, the reserves of the consumption goods firms appear to increase faster under higher levels of unemployment insurance.

[9] We also simulate the effects of positive independent shocks in the optimism level of the firms. In this case, the economy really manages to grow faster (and with more volatility) than the baseline version for some time, but this growth does not prove sustainable and after 500 periods the real GDP level is already smaller than in the baseline version. The persistency of high levels of confidence brings a jump in demand expectations and raises the total number of machines in this economy. However, this euphoria quickly brings very low levels of capacity utilization, and the great increase in the volatility of the system brings, in the long run, a collapse to some of the simulated economies.

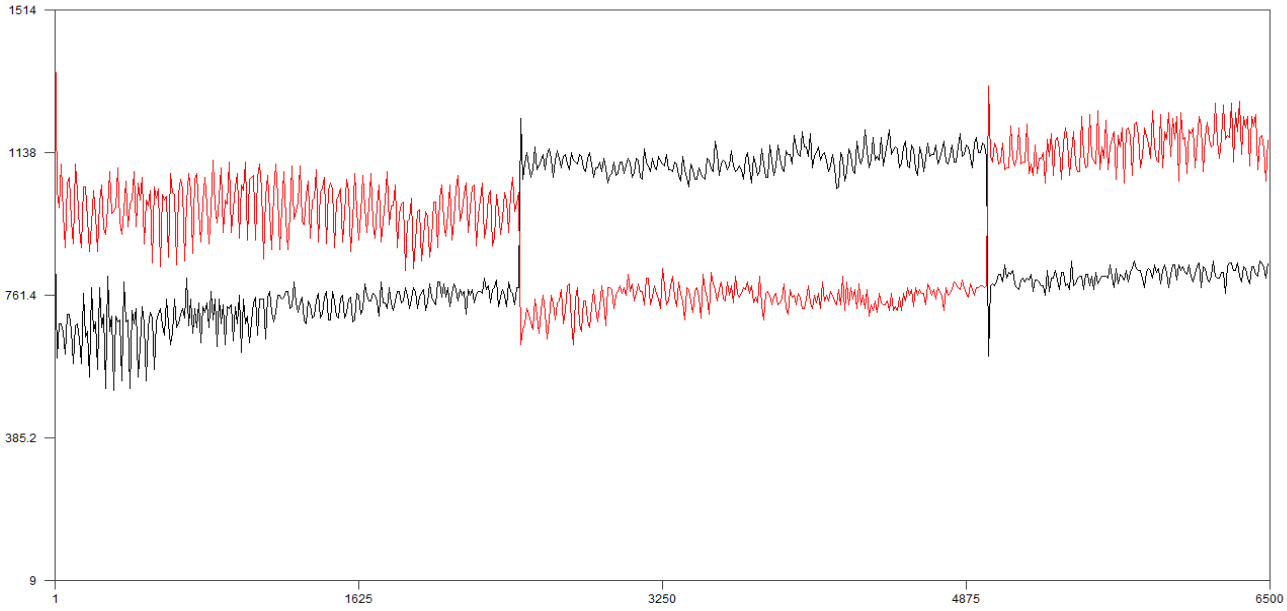

Figure 5: Total unemployment level under low initial unemployment dole (red) and low unemployment dole between periods 2,500-5,000 (black) – Government policy shock

Having studied the results of both the action and the reaction of the expansionary fiscal contraction hypothesis independently, we can now analyze their combined results. The aim of this final experiment is to evaluate whether, under the specific set of conditions exposed above, it will emerge a result in any way similar to the expansionary fiscal contraction hypothesis. To do so, we run 10 simulations under the baseline model specifications, but in period 2,500 we reduce the value of the unemployment benefit paid by the government, from 70% of the average wage to 40%. And, in response to that, the model's entrepreneurs get enthusiastic and the optimism of all consumption goods firms suffers a shock, which brings it to its maximum level of confidence (2) – recall that we have seen that these shocks have persistent effects on the optimism level of the firms.

As shown in Figure (6), the "double shock" represented by the government action and the simultaneous reaction by the consumption goods firms lead the economy to become much more unstable and the average level of unemployment to be substantially higher. Moreover, as pointed out in footnote 10, the excessive enthusiasm of the firms ends up leading to a very low (and decreasing) level of capacity utilization in the economy. As a result, around period 3,900, some of the simulated economies start to crash, and the instability brought by the double shock brings our model to a collapse (the model loses resiliency).

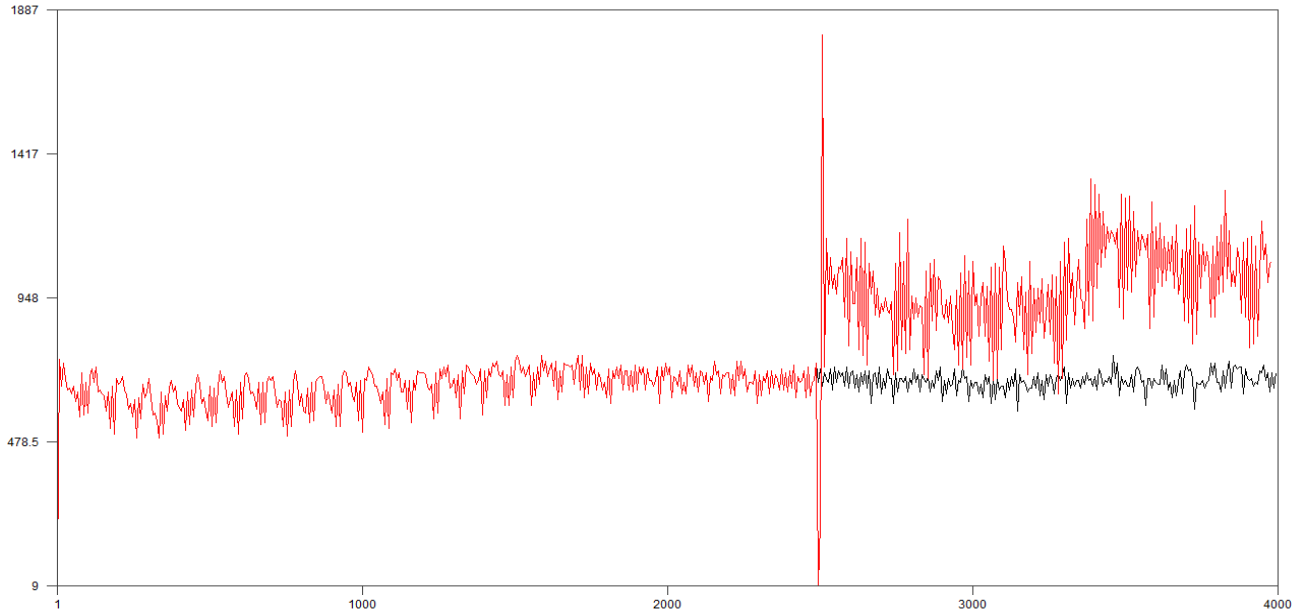

Figure 6: Unemployment Level – Expansionary Fiscal Austerity Hypothesis

Furthermore, as it is clear in Figure 7, despite a high number of machines being purchased at first (which causes a brief jump in the productivity level of the economy), this peak of growth is not persistent in the medium term. As a result, the real GDP after the double shock is permanently lower, and much more volatile than in the baseline simulation. Also, even if the total government expenditure as a proportion of GDP falls in around 1.5%[10] under the expansionary fiscal austerity hypothesis, the government reserves/GDP ratio depicted in Figure 8 is much more volatile, has similar levels to the baseline version in the short run, and shows higher levels of debt in the long run.

[10] It is interesting to note that the lack of evidence for the expansionary austerity hypothesis in these simulations is a result that emerges even in a very favorable experiment. While in Alesina et al. (2017) a fiscal contraction of one percentage point of the GDP brings less than a 1% increase in the confidence level, here we are doubling the level of optimism, for a fiscal contraction of almost 4% of the GDP.

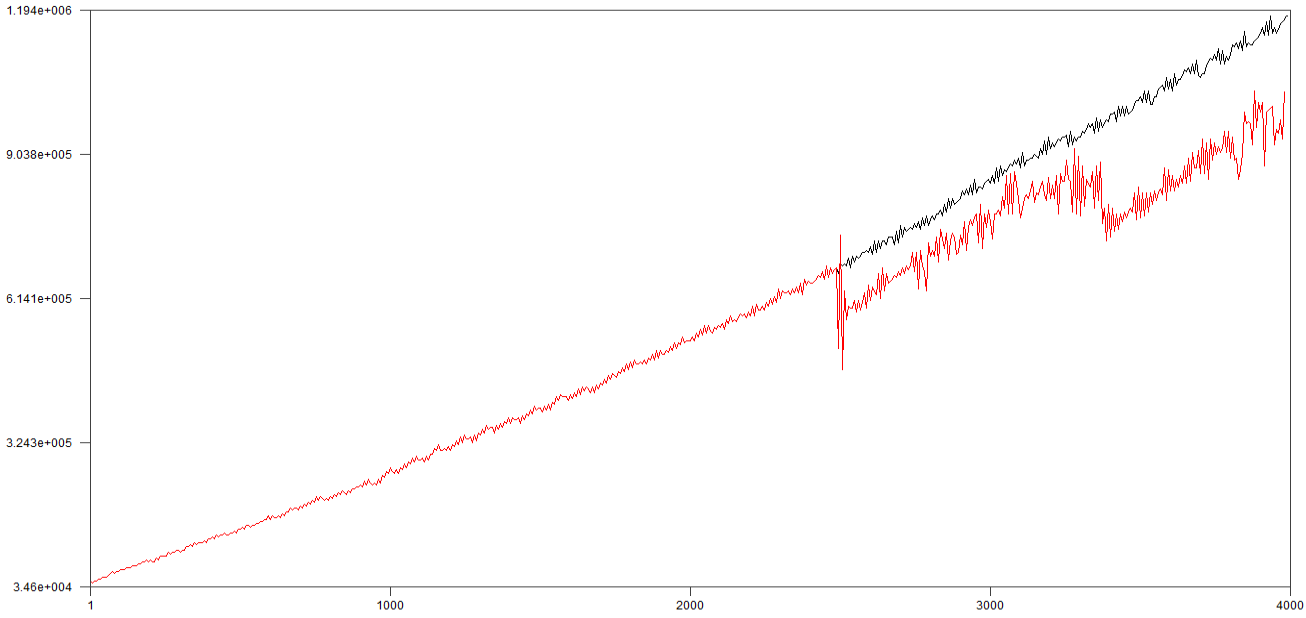

Figure 7: Real GDP in the Baseline version (black) and under the Expansionary Fiscal Austerity Hypothesis (red)

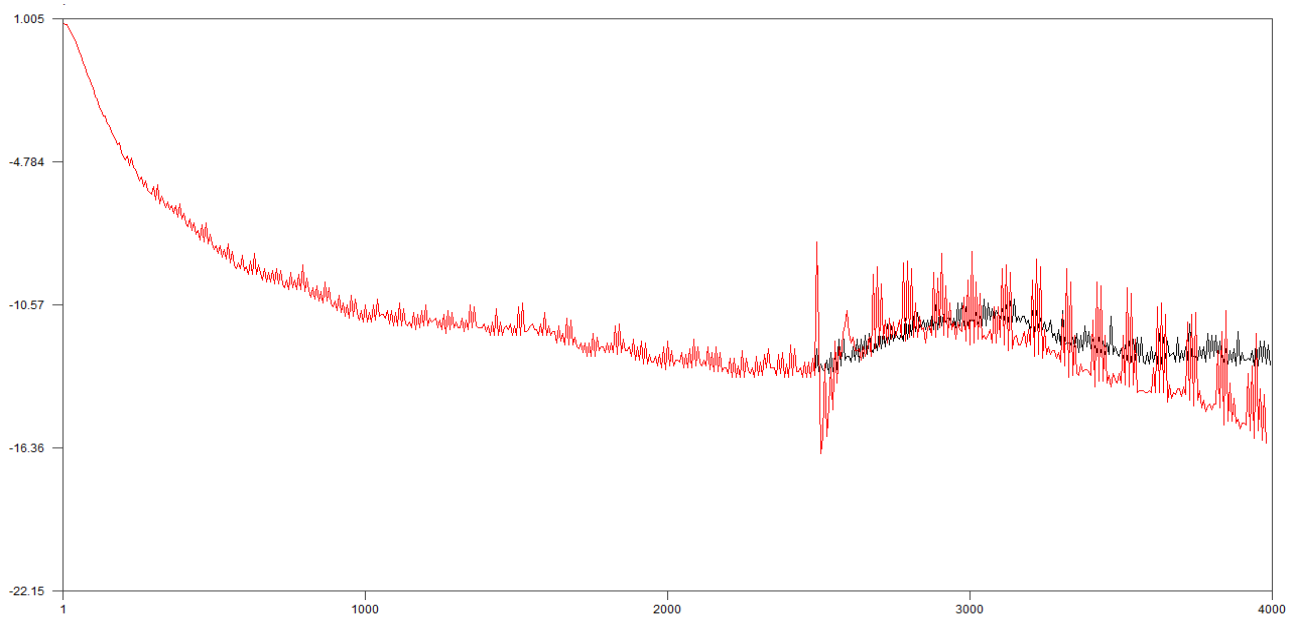

Figure 8: Assets of the Government / GDP in the Baseline version (black) and under the Expansionary Fiscal Austerity Hypothesis (red)

In light of these results, the evidence is significantly against the possibility of an expansionary fiscal contraction – especially in the short-run – in our model. After all, not even the rise of optimism by itself seems to be a sustainable source of higher growth in this simulated economy. Also, the decrease in the government spending/GDP ratio does not seem to bring a more favorable trend for the government debt/GDP ratio, quite the opposite.

Conclusion

Starting from a demand-driven ABM model in which contagion plays an important role for expectation formation and investment decisions, the aim of this paper was to study under which conditions a wave of pessimism as generated, for instance, by a public discourse, could lead to large permanent macroeconomic effects. In particular, could the negative effects of a fiscal contraction on aggregate demand be compensated by a positive effect on the confidence level of investors who come to believe in the need for fiscal austerity? In other words, could the expansionary austerity hypothesis be confirmed in a demand-driven Keynesian framework with a strong role for expectations and contagion in investment decisions?

The answer provided by our set of simulations is no. While it is possible that a shock of optimism restricted to a small proportion of firms may lead to short-run positive effects on output, a cut in government expenditures combined with even a significant increase in confidence raises the unemployment level and brings more instability to the system. The initial increase in investment and productivity brought about by higher confidence vanishes in the medium run, giving rise to a permanent reduction in output levels and capacity utilization.

Our findings are in keeping with the weak existing empirical evidence in favor of expansionary fiscal consolidations. Even a rise in investor's confidence resulting from a fiscal consolidation based on spending cuts (as found in the econometric study by Alesina et al (2017), for instance), seems to be incapable of neutralizing the negative effect of the operation of the fiscal multipliers. Once interactions across heterogeneous and boundedly rational agents who form expectations about an uncertain future are duly taken into account, several microdynamic mechanisms explaining why the expansionary austerity hypothesis is not confirmed become visible.

References

Alesina, A., & Ardagna, S. (2010). Large Changes in Fiscal Policy: Taxes versus Spending. In J. R. Brown, *Tax Policy and the Economy* (Vol. 24, pp. 35-68).

Alesina, A., Barbiero, O.,Favero, C.; Giavazzi, F.; Paradisi, M. (2017). The Effects of Fiscal Consolidations: Theory and Evidence, *NBER Working Paper No. 23385.*

Alesina, A., Favero,C. & Giavazzi (2012). The Output Effect of Fiscal Consolidations. NBER Working Paper Series n 18336.

Alesina, A., & Perotti, R. (1995, August). Fiscal Expansions and Fiscal Adjustments in OECD Countries. *NBER Working Paper Series*, 5214.

Alexander, R. (2013, April 20). *Reinhart, Rogoff... and Herndon: The student who caught out the profs.* Retrieved June 08, 2018, from BBC News: https://www.bbc.com/news/magazine-22223190.

Axtell, R. L. (2001, September 7). Zipf Distribution of U.S. Firm Sizes. *Science*, pp. 1818-1820.

Backus, D. K., & Kehoe, P. J. (1992, September). International Evidence on the Historical Properties of Business Cycles. *American Economic Review, 82*(4), 864-888.

Blanchard, O., & Perotti, R. (1999, July). An Empirical Characterization of the Dynamic Effects of Changes in Government Spending and Taxes on Output. *NBER Working Paper Series*, p. Working Paper 7269.

Bromiley, P. (1986, June). Corporate Planning and capital Investment. *Journal of Economic Behavior & Organization, 7*(n.2), pp. 147-170.

Caballero, R. J. (1999). Aggregate Investment. In *Handbook of Macroeconomics* (Vols. 1 - part B, pp. 813-862). Elsevier.

Caiani, A., Godin, A., Caverzasi, E., Gallegati, M., Kinsella, S., & Stiglitz, J. (2016, August). Agent based-stock flow consistent macroeconomics: Towards a benchmark model. *Journal of Economic Dynamics and Control, 69*, pp. 375-408.

Carvalho, L. B. (2012, April). Economic Growth after the Great Recession: Essays on Structuralist Macroeconomics. *Tese de Doutorado - The New School for Social Research*, pp. 30-38.

Chamley, C., & Gale, D. (1994, September). Information Revelation and Strategic Delay in a Model of Investment. *Econometrica, 62*(5), pp. 1065-1085.

Davar, Y. P., & Gill, S. (2007, June). Investment Decision Making: An empirical Study of Perceptual View of Investor. *Methamorphosis: A Journal of management Research, 6*, pp. 115-135.

Davis, J. B. (2016, December). The Continuing Relevance of Keynes's Philosophical Thinking: Reflexivity, Complexity and Uncertainty. *). Forthcoming in Annals of the Fondazione Luigi Einaudi: An Interdisciplinary Journal of Economics, History and Political Science*.

Dosi, G., Fagiolo, G., & Roventini, A. (2010, June 23). A Schumpeter meeting Keynes: A policy-friendly model of endogenous growth and business cycles. *Journal of Economic Dynamics and Control, n.9*, pp. 1748-1767.

Dreman, D., Johnson, S., Macgregor, D., & Slovic, P. (2001, June). A report on the March 2001 Investor Sentiment Survey. *The Journal of Psychology and Financial Markets, 2*(n.3), pp. 126-134.

Fabiani, S., Druant, M., Hernando, I., Kwapil, C., Landau, B., Loupias, C., et al. (2006). What Firms' Surveys Tell Us About Price-Setting Behavior in the Euro Area. *International Journal of Central Banking*(n.3), pp. 3-47.

Fatas, A., & Mihov, I. (2001). The effects of Fiscal Policy on Consumption and Employment: theory and evidence. *Working Paper, INSEAD*.

Fazzari, S. M., Hubbard, R. G., Petersen, B. C., Blinder, A. S., & Poterba, J. M. (1988). Financing Constraints and Corporate Investment. *Brookings Papers on Economic Activity*(n.1), pp. 141-148.

Gennaioli, N., Ma, Y., & Shleifer, A. (2016). Expectations and Investment. *NBER Macroeconomics Annual, 30*, pp. 379-431.

Giavazzi, F., & Pagano, M. (1990, May). Can Severe Fiscal Contractions be Expansionary? Tales of Two Small European Countries. *NBER Working Paper No. 3372*.

Hermalin, B. E., & Isen, A. M. (2000, July 28). *The Effect of Affect on Economic and Strategic Decision Making*. Retrieved March 21, 2017, from SSRN: https://ssrn.com/abstract=200295

Herndon, T., Ash, M., & Pollin, R. (2013, March). Does High Public Debt Consistently Stifle Economic Growth? A Critique of Reinhart and Rogoff. *Cambridge Journal of Economics, 38*(2), 257-279.

IMF. (2010, October). Will it hurt? Macroeconomic effects of fiscal consolidation. *World Economic Outlook*, 93-124.

Jayadev, A., & Konczal, M. (2010). The Boom not the Slump: the Right Time for Austerity. *The Roosevelt Institute, Working Paper*.

Kahneman, D., & Tversky, A. (1979, March). Prospect Theory: An Analysis of Decision under Risk. *Econometrica, 47*(n.2), pp. 263-273.

Kalecki, M. (1968). *Theory of Economic Dynamics - An essay on cyclical and long-run changes in Capitalist Economy* (2nd ed.). Modern Reader Paperbacks.

Kalecki, M. (1971). *Selected Essays on the Dynamics of the Capitalist Economy 1933-1970.* Cambridge University Press.

Keynes, J. M. (1937, February 1). The General Theory of Employment. *The Quarterly Journal of Economics, 51*(2), pp. 209–223.

Keynes, J. M. (1996 [1936]). *A teoria geral do emprego, do juro e da moeda.* Nova Cultural.

Krugman, P. (2009, August 30). *Keynes: The Return of the Master by Robert Skidelsky.* Retrieved June 06, 2018, from The Guardian: https://www.theguardian.com/books/2009/aug/30/keynes-return-master-robert-skidelsky

Krugman, P. (2012, April 26). *Death of a Fairy Tale.* Retrieved June 06, 2018, from New York Times: https://www.nytimes.com/2012/04/27/opinion/krugman-death-of-a-fairy-tale.html?_r=0

Krugman, P. (2015, April 29). *The case for cuts was a lie. Why does Britain still believe it? - The austerity delusion*. Retrieved August 25, 2016, from The Guardian: www.theguardian.com/business/ng-interactive/2015/apr/29/the-austerity-delusion

Krugman, P., Friedman, B., Fleming, K., & Skidelsky, L. (2015, March 29). *What's Wrong with the Economy—and with Economics?* Retrieved June 2018, 06, from The New York Review of Books: http://www.nybooks.com/daily/2015/03/29/whats-wrong-with-the-economy/

Lima, G. T., & Cardoso, F. G. (2008). A concepção de Keynes do sistema econômico como um todo orgânico complexo. *Economia e Sociedade, 17*, pp. 359-381.

Lima, G. T., & Freitas, G. G. (2007). Debt financing and emergent dynamics of a financial fitness landscape. *Anpec: Anais do XXXV Encontro Nacional de Economia, 35*.

Nelson, R., & Winter, S. (1982). *An evolutionary theory of economic change.* Harvard, Mass: Harvard University Press.

Oliveira, A. d. (2018). Complexidade aplicada ao estudo da dinâmica do investimento: um modelo baseado em agentes (ABM) de inspiração Kaleckiana. Master's Dissertation - University of São Paulo.

Possas, M. L., Koblitz, A., Licha, A., Oreiro, J. L., & Dweck, E. (2001, July/September). Um modelo Evolucionário Setorial. *Revista Brasileira de Economia, 55*(3), pp. 333-377.

Rabin, M. (1998, March). Psychology and Economics. *Journal of Economic Literature, 36*(n.1), pp. 11-46.

Reinhart, C., & Rogoff, K. (2010). Growth in a Time of Debt. *American Economic Review, 100*(2), 573–578.

Romer, C. D. and D. H. Romer (2010). The macroeconomic effects of tax changes: Estimates based on a new measure of fiscal shocks.*The American Economic Review* 100(3), 763–801.

Schauble, W. (2010). Maligned Germany is right to cut spending. *Financial Times*.

Skidelsky, R. (2009). *Keynes: The Return of the Master.* Public Affairs.

Skidelsky, R. (2015a, March 24). *Messed-Up Macro.* Retrieved June 06, 2018, from Project Syndicate: https://www.project-syndicate.org/commentary/economic-policies-public-expectations-by-robert-skidelsky-2015-03?barrier=accesspaylog

Skidelsky, R. (2015b, April 22). *Debating the Confidence Fairy.* Retrieved June 06, 2018, from Project Syndicate: https://www.project-syndicate.org/commentary/consumer-confidence-policy-success-by-robert-skidelsky-2015-04?barrier=accesspaylog

Appendix

Table A: Initial Values

Initial Values			
Number of Consumption goods Firms	Number of Workers	Number of Machines	Market Share
32	3000	150-10	0.2 – 0.012
Markup: Consumption goods firms	Markup: Capital goods firm	Lifetime: Machines	Price: Consumption goods firms
1.2	1.4	2-14	2 - 4
Reserves: Consumption goods firms	Reserves: Capital goods firm	Reserves: Bank	Revenue in period t-1
200,000 – 12,500	50,000	15,000,000	3,000 - 185
Demand for goods in period t-1	Optimism Level	Productivity: Machines	
1,500 - 90	1	4.8	
Demanded Wage: Workers		Aggregate Reserves: Workers	
15 - 18		100	

Table B: Parameters

Parameters				
μ	σ	τ	ϑ	Extra Optimism
0.25	0.25	50	0.5	0.05
β1	β2	β3	β4	β5
1.5	1	0.5	20	20
ρ1	ρ2	ρ3	ρ4	ρ5
0.35	0.225	0.175	0.15	0.1
α1	α2	α3	Maximum Workers per Machine	
-0.01	0.15	0.0005	5	
Tax rate on Profits: Capital goods firm	Tax rate on Wealth: Capital goods firm		Number of Workers to Produce Machines	
30%	1%		1	
Tax rate on Profits: Consumption goods firms	Tax rate on Wealth: Consumption goods firms		Proportion of Unemployment Benefit	
30%	1%		70%	
Tax Rate on Profits: Bank	Tax Rate on Wealth: Bank		Share of Profits to Innovation	
30%	0%		50%	
Maximum Level of Indebtedness: Firms	Lifetime: Machines		Proportion of Inventories	
1	14		30%	
Maximum Level of Indebtedness: Bank	Extra Wage: Capital goods firm		Extra Wage: R&D	
0.9	10%		10%	