Leonardo Dutra

MAKING STABILIZERS INTENTIONAL: ASSESSING FISCAL POLICY PROPOSALS IN AN AGENT-BASED MODEL

Rio de Janeiro, Brasil

2025

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Dissertação de mestrado apresentada ao Programa de Pós-Graduação em Economia, do Instituto de Economia da Universidade Federal do Rio de Janeiro como requisito para a obtenção do título de mestre em Economia.

Universidade Federal do Rio de Janeiro – UFRJ

Instituto de Economia

Programa de Pós-Graduação em Economia

Prof. Doutor Ítalo Pedrosa

Prof. Doutor Marcelo Pereira

Rio de Janeiro, Brasil

2025

CIP - Catalogação na Publicação

D97897 8m

Dutra, Leonardo
MAKING STABILIZERS INTENTIONAL: ASSESSING FISCAL POLICY PROPOSALS IN AN AGENT-BASED MODEL / Leonardo Dutra. -- Rio de Janeiro, 2025.
92 f.

Orientador: Ítalo Pedrosa Gomes Martins.
Coorientador: Marcelo de Carvalho Pereira.
Dissertação (mestrado) - Universidade Federal do Rio de Janeiro, Instituto de Economia, Programa de Pós-Graduação em Economia, 2025.

1. Fiscal policy. 2. Agent-based model. 3. Automatic stabilizers. 4. Semiautomatic stabilizers. I. Pedrosa Gomes Martins, Ítalo, orient. II. de Carvalho Pereira, Marcelo, coorient. III. Título.

Elaborado pelo Sistema de Geração Automática da UFRJ com os dados fornecidos pelo(a) autor(a), sob a responsabilidade de Miguel Romeu Amorim Neto - CRB-7/6283.

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Rio de Janeiro, Brasil, 11 de julho de 2025:

Prof. Doutor Ítalo Pedrosa
Universidade Federal do Rio de Janeiro (UFRJ) - Presidente

Prof. Doutor Marcelo Pereira
Universidade de Campinas (Unicamp) - Coorientador

Profª. Doutora Lílian Nogueira Rolim
Universidade de Campinas (Unicamp) - Membro externo

Prof. Doutor Matheus Trotta Vianna
Universidade de Manchester - Membro externo

Rio de Janeiro, Brasil
2025

AGRADECIMENTOS

Os últimos dois anos e alguns meses foram um período de altos muito altos e baixos muito baixos. Com isso, tenho uma longa lista de pessoas a agradecer. Em primeiro lugar, devo agradecer à minha família. Agradeço às minhas avós, Etelvina e Irene, que sempre me apoiaram em tudo que decidi fazer nessa vida, e aos meus pais, Alexandre e Andréa, que enxergam nesse mestrado mais do que eu mesmo.

Agradeço a um grande número de amigos, como aqueles com que vivi as angústias do período do Exame Anpec e foram para outros centros - dentre esses, destaco minha amiga Luiza Bellon –, aqueles com que dividi a turma de mestrado, – apesar de não ter sido próximo de todos, tenho uma boa lembrança de todos, inclusive dos que ficaram pelo caminho por motivos infortúnios ou injustos – e aqueles de outras universidades que conheci durante esse período. Devo mencionar meus amigos mais próximos: Emmanuel Tsallis – que me lembrou no último dia sobre a inscrição para a escola de verão de Sant'Anna, evento que mudou a trajetória do meu mestrado, e infelizmente acabou não podendo ir comigo –, Letícia Inácio - fã número um de Kalecki que adora tentar me convencer de que ele foi mais importante que Keynes –, Lucas Foffano - que nos levou para dar uma volta de Fusca no que acabou sendo um dos melhores dias desses anos –, (Lucas) Helder Barreto – que é meu companheiro de zona oeste e me deu carona um número incontável de vezes, ajudando enormemente a diminuir o estresse de gastar mais de quatro horas por dia em transporte público para frequentar a Universidade –, Luiza Wermelinger - que teve coragem de ir de Copacabana até a Prainha em um fusca com motor e freio não tão confiáveis sendo dirigido por mim –, Maria Clara Soares – que dividiu comigo a alegria de ver o Wooldridge no encontro da SBE –, Nathalia Haynes – que infelizmente não fui capaz de convencer que psicanálise é uma pseudociência –, e Thomaz Leite – responsável por eu ter tirado 10 na minha primeira prova no mestrado. Agradeço também ao Henrique Moura, que salvou minha pele em uma disciplina, ao Marcos Tigre, com quem dividi o quarto durante o encontro da AKB 2024 e tivemos momentos engraçados, e ao Igor Calvelli que, junto do Marcos e do Helder integrou a breve banda da turma de 2023.

Agradeço também aos funcionários da UFRJ, sem os quais a Universidade não pode funcionar, e aos professores que exercem bem a profissão e são inspiração para nós alunos. Agradeço aos professores que participaram da escola de verão de modelos ABM em Sant'Anna, em especial a professora Maria Enrica Virgilito (aka Márica) que sempre se mostrou muito solícita, e à coordenação do PPGE pelo auxílio financeiro que facilitou minha ida para Pisa. Esse evento foi o que me deu ânimo novamente para terminar esse mestrado quando estava afundado em frustração e desânimo. Agradeço aos professores Ítalo Pedrosa e Marcelo Pereira pela orientação, principalmente ao primeiro pela agilidade

quando eu precisei. Agradeço aos membros da banca, Matheus Vianna, Lilian Rolim – que também toparam participar da qualificação –, Ana Reif e Carlos Pinkusfeld, em especial ao primeiro por ter me ajudado desde quando essa dissertação era apenas um trabalho de conclusão de disciplina e uma fração do que é hoje, sempre se mostrando muito solícito. Além disso, agradeço a alguns professores que me ajudaram de uma forma ou de outra na elaboração dessa dissertação. Entre eles, Marília Bassetti, Eduardo Pontual, Ricardo Summa, Lídia Brochier, Gustavo Gonzaga, Andrea Roventini, e (novamente) Márica.

Obviamente, devo um agradecimento especial à minha namorada – que também é minha melhor amiga – Larissa, que me acompanha desde antes de ingressar na graduação e esteve comigo nos piores momentos desses últimos anos. Também não posso deixar de fora meu querido filho felino, o Sussa, que me deu um susto danado e quase nos deixou durante o segundo semestre do mestrado mas segue sendo um companheiro muito amoroso e carinhoso.

"Economics consists of theoretical laws which nobody has verified
and empirical laws which nobody can explain"
(Michał Kalecki)

"The greatest enemy of knowledge is not ignorance;
it is the illusion of knowledge."
(Stephen Hawking, allegedly)

"One day our generation is gonna rule the population
So we keep on waiting (waiting)
Waiting on the world to change"
(John Mayer - Waiting on the world to change)

"Burn like a slave
Churn like a cog
We are caged in simulations
Algorithms evolve
Push us aside
Render us obsolete"
(Muse - Algorithm)

RESUMO

O interesse em política fiscal como uma ferramenta de estabilização macroeconômica tem passado por crescimentos esporádicos e temporários nas últimas décadas. Em meio a um reconhecimento de que a política monetária pode não ser suficiente para lidar com crises econômicas e a desconfiança em medidas discricionárias, surgiu a ideia de estabilizadores assimétricos e semiautomáticos. Tais mecanismos garantiriam uma melhor resposta diante de recessões sem abandonar o paradigma de seguir regras pré-estabelecidas. Nessa dissertação, busca-se contextualizar esse debate e mostrar, através de simulações, como esses mecanismos poderiam funcionar. Para isso, algumas políticas foram examinadas com base em propostas encontradas no debate econômico – um programa de estímulo direto a indivíduos, um esquema de seguro desemprego dinâmico, e um programa de compras públicas. Também foi analisado um desenho de política fiscal discricionária, como um parâmetro de comparação para as outras políticas. Para análise, foi utilizada uma versão modificada do modelo K+S labor, um modelo agent-based que permite explorar dinâmicas macroeconômicas, industriais e principalmente de mercado de trabalho. Foi encontrado que algumas destas políticas possuem potencial de estabilizar a macroeconomia, bem como o mercado de trabalho, sem efeitos colaterais relevantes além de um aumento da inflação. Em especial, se destacaram as políticas de seguro desemprego dinâmico e de compras públicas. A política fiscal discricionária se mostrou eficiente para estabilizar o mercado de trabalho, mas não o crescimento do produto, enquanto o programa de estímulo direto a indivíduos se mostrou ineficaz no modelo.

Palavras-chave: política fiscal, modelo agent-based, estabilizadores automáticos, estabilizadores semiautomáticos.

ABSTRACT

Interest in fiscal policy as a tool for macroeconomic stabilization has experienced sporadic and temporary increases over the past decades. Amid growing recognition that monetary policy may not be sufficient to address economic crises, and skepticism toward discretionary measures, the idea of asymmetric and semiautomatic stabilizers has emerged. These mechanisms would ensure a better response during recessions without abandoning the paradigm of rules. In this thesis, we aim to contextualize this debate and demonstrate, through simulations, how such mechanisms could function. For this purpose, we examine some policies based on proposals found in the economic debate – a direct stimulus payment, a dynamic unemployment scheme, and a government purchases program. We also analyzed a discretionary fiscal policy setting, as a benchmark to other policies. For this analysis, we use a modified version of the K+S labor model, an agent-based model that allows for the exploration of macroeconomic, industrial, and especially labor market dynamics. we found that some of these policies have the potential to stabilize the macroeconomy as well as the labor market, with no significant side effects other than an increase in inflation. The dynamic unemployment benefit and the government purchases program stood out. Discretionary fiscal policy turned out to be very powerful to stabilize the labor market, but not GDP growth, while direct stimulus payment program turned out ineffective in the model.

Keywords: fiscal policy, agent-based model, automatic stabilizers, semiautomatic stabilizers.

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1 INTRODUCTION

The Keynesian revolution changed the idea that governments were unable to affect economic activity. At that time, governments were allowed to conduct fiscal policy as they desired, despite the existence of some critics (Blinder & Solow, 1973). However, throughout the second half of the twentieth century this view was overshadowed first by monetarist critics and then by neoclassical critics. They led fiscal policy to be relegated as a policy tool and as an object of academic research.

Fiscal policy would not be desirable because of its discretionary characteristics. Lags and calibration issues would render it ineffective at stabilizing economic activity. This led fiscal policy to be restricted to automatic stabilizers, since they are rule-based mechanisms.

However, the events of beginning of the twenty-first century would bring interest back to fiscal policy, namely the great financial crisis and its aftermath, and the Covid-19 pandemic. From the late 2000s to the early 2020s, more research on the topic has taken place, although it is still overlooked and neglected to the detriment of monetary policy.

Therefore, our motivation comes from two main reasons: the desirability of macroeconomic stabilization and the ongoing debate of how it should take form. While the first reason for motivation is not a subject of dissent, the second has led to long-lasting discussions. This section aims to briefly introduce these two topics as they —- beyond motivating this research —- also explain how economic thought got to the place where it is right now.

The desirability of macroeconomic stabilization is somewhat obvious and straightforward. As economic activity contracts, unemployment rises and household incomes fall, many might suffer from financial insecurity. This affects some parts of the population more profoundly, according to many factors such as income level, race, and gender (Kochhar et al., 2011; Thompson & Smeeding, 2015; Addo & Darity, 2021). The effects of economic downturns are not restricted to material aspects, extending to social and psychological scope (Frasquilho et al., 2016; Gunnell & Chang, 2016; Margerison-Zilko et al., 2016; Mathieu, 2022). Thus, recessions have an immediate and direct impact on people's welfare as they are pushed into economic hardship (Bitler & Hoynes, 2013).

Moreover, economic research has documented how recessions can cause structural, permanent changes to an economy. These immediate, conjunctural effects can translate into the long-run as smaller economic growth as well as higher unemployment, inequality, and poverty (Blanchard & Summers, 1987; Ball, 2014; Blanchard et al., 2015).

Therefore, the need for macroeconomic stabilization goes beyond the temporary effects of recessions. Mitigating downturns plays an important role in the way many socioeconomic variables will unfold in the long-run.

Regarding the ongoing debate, to better situate it, it is worth tracing back to the late 1990s or early 2000s. Shortly before the global financial crisis, it was believed that macroeconomics had been mostly figured out. Developed economies had been experiencing stability and no depressions for a relatively long period of time. For this reason, this period is often labeled as "the Great Moderation".

However, as the Great Financial Crisis hit the world, this belief started to be questioned, especially after economies seemed to take too long to recover. At that time, the mainstream thought agreed that monetary policy was the best tool for macroeconomic stabilization and fiscal policy was not needed– being for the fact that it was ineffective or simply because monetary policy was capable of doing all the work by itself (Blanchard et al., 2010).

The immediate impact of the 2008 crisis managed to shake this belief, with many mainstream economists calling for fiscal stimulus, but this was a matter of pragmatism and did not change the core of the macroeconomic thought, as governments adopted fiscal tightening as soon as the first signs of stabilization had appeared (Fiebiger & Lavoie, 2017). It was only after 2013, when it seemed clearer that recovery was behind the expected, that deeper questioning happened (Summers, 2015, DeLong & Tyson, 2013).

This is the background that motivates the analysis of potential new fiscal stabilizing schemes. The policies implemented during the pandemic served as experiments that can help us understand how some of these policies work and how they could be transformed into a definitive, rule-based policy. This is important to avoid pilot-program problems. It is interesting to understand how successful this kind of policy could be if well thought out and prepared.

In this context, enhancing automatic stabilizers and implementing semiautomatic stabilizers were an alternative to promote a more active fiscal policy while still following predetermined rules. Indeed, this has been suggested by some mainstream economists (Eicheinbaum, 2019; Blanchard & Summers, 2020) and some policy proposals for that have surged (Sahm, 2019; Haughwout, 2019; Chodorow-Reich & Coglianese, 2019).

This thesis aims to advance this discussion by assessing some of these policies in a theoretical model, since to our knowledge this has not been done yet. We also intend to evaluate how a number of variables would be affected by different fiscal policy designs. These are two gaps in this literature. We address three policy proposals as well as a discretionary policy setting as benchmark and make use of an agent-based model which comprises a detailed labor market and allows a thorough exploration of heterogeneity and

path dependency dynamics. We aim to show that fiscal policy designs can be a strong tool to stabilize the economic activity and that some of the proposed fiscal stabilization schemes point towards the right direction.

Besides this introduction, the remainder of the thesis is structured as follows. Chapter 2 presents fiscal stabilization policies as an object of research. It introduces the topic by briefly explaining why stabilization policy is desirable and tracing back the historical developments of the economic thought regarding this subject. After that, we lay out some of the latest advancements and discussions in fiscal stabilization policy, which include empirical investigations of how these devices operate and some policy proposals. Perhaps most importantly, we present the novel idea of asymmetrical semiautomatic stabilizers. we argue that fiscal tools which act solely to boost demand during downturns could be a step forward in stabilization from the existing symmetrical automatic stabilizers, and present some designs for such a mechanism.

Chapter 3 introduces the reader to the complexity economics paradigm and present the model and the methodology used for the analysis. We build upon a well-established agent-based model, adding policy designs. These models are composed of heterogeneous interacting agents that follow simple behavior rules that lead to emergent properties and the reproduction of many stylized facts. The results of the model are extracted using Monte Carlo replications. The policy designs are expected to work, perhaps in different levels of effectiveness.

Chapter 4 presents and discusses the results. We investigate the findings in light of economic theory and of the model design. We also compare the effectiveness of some policy among themselves, discuss some of the design schemes, and present some links to empirical studies.

At last, Chapter 5 sums up the contents of this thesis and presents its conclusions.

2 MACROECONOMIC STABILIZATION POLICY: AN OVERVIEW

2.1 Introduction

This chapter presents fiscal stabilization policies as an object of research. We aim to introduce the reader to the topic of stabilization policy through a historical lens, showing how it was born and the historical developments of the economic thought regarding this subject in order to connect motivation to the object of research. The connection lies in the fact that the current thought is not as consensual as it has been in previous moments of time. We connect the object to theory by reviewing what is most accepted and discussed currently, as well as presenting some policy proposals.

Macroeconomic stabilization is desired because economic downturns lead to losses in the short- and long-run. Beyond job losses and drops in income — which were for some time believed to be only temporary —, these macroeconomic movements might not be neutral in the long-run (Blanchard & Summers, 1987; Ball, 2014; Blanchard et al., 2015).

Although there is no dispute on the fact that economic downturns are a bad thing, it is not unanimous that the government should have an active policy of stabilization. Some believe that such actions would end up having destabilizing effects on economic activity (Friedman, 1948). This pendulum has swung to both sides over the last century.

Before Keynes, it was believed that the government was unable to affect economic activity, as government action would only shift resources from one sector to another. One of the cores of the Keynesian revolution relates to a change in this thought. Under the neoclassical synthesis thought, when prices are sticky, the economy is unable to return to full-employment by itself -– that is, (the neoclassical version of) Say's Law is not applicable — and government spending is able to raise aggregate output. This allowed for governments to conduct fiscal policy as they desired (Blinder & Solow, 1973).

Some decades later, this view was overshadowed by the monetarist view. They believed that not only was discretionary fiscal policy not desired, it was also powerless. It would be ineffective because a total crowding-out effect would take place in a moment after the initial fiscal impulse, and also undesired because implementation lags would end up making it actually destabilizing. During the late 1970s, fiscal policy was pushed further aside with the rise in new classical thought (Friedman, 1948; Blinder & Solow, 1973). Due to the fact that the macroeconomy would be a subproduct of micro-level behavior and that agents would have rational expectations, the belief that fiscal policy was ineffective and destabilizing remained (Kydland & Prescott, 1977).

The slow recovery from the Great Financial Crisis and the Covid-19 pandemic led to a reappraisal of fiscal policy to some degree. While it is still mostly disregarded by mainstream economists, discussion over the possibilities of fiscal policy as a stabilization tool has arisen once again, and there is debate over the subject. This is the historical background to this work.

Among the topics of the recent discussions in the theme of fiscal policy, what matters the most for this thesis is the concept of semiautomatic stabilizers and some possible stabilizer designs. Semiautomatic stabilizers, as named by Blanchard & Summers (2020), are fiscal policy designs that are activated by triggers. They differ from automatic stabilizers due to the fact that they are intentionally designed to achieve macroeconomic stabilization and can be thought of as a middle ground between automatic stabilizers and discretionary policy, since they are an active policy and yet rule-based.

Indeed, this novel concept is featured in some recent policy proposals, most notably the one by Claudia Sahm (2019), which consists of sending checks whenever a recession trigger is activated. But that is not the only one, other notable proposals are the ones by Haughwout (2019) and Eichenbaum (2019).

The policy designs addressed in this thesis reflect the recent debate on fiscal stabilization policy and have been chosen according to two dimensions: institutional recipient (firms or households) and the way the size of the stimulus is defined (fixed or contingent). They are a direct stimulus payments program, a dynamic unemployment program, reflecting some of the actions taken during the pandemic and discussions of reforming the social security system, a government purchases program, and a conventional discretionary setting.

The rest of this chapter is structured as follows. Section 2.2 explains why macroeconomic stabilization is desirable, mentioning individual, collective, short- and long-term justification. It also details the debate on the form of stabilization policy throughout the decades. Section 2.3 deals with the theory. It presents the definition of semiautomatic stabilizers, lays out the transmission channels of fiscal policy, and introduces the policy proposals that are evaluated in the model. At last, it also displays an overview of them. Section 2.4 presents the final remarks of this chapter.

2.2 Stabilization policies as an object of research

2.2.1 Why macroeconomic stabilization is desirable

Recessions happen for a variety of reasons. The role of aggregate demand fluctuations in determining the business cycle and, as a consequence, recessions is recognized in most of the macroeconomics schools of thought.

According to the Keynesian view, if effective demand at some point in time starts to fall, unemployment is expected to rise and the economy is likely to go into recession. As income is generated by someone else's spending, if, for any reason, firms expect to sell less, they will spend less (in investing, ordering inputs, paying employees). This will generate unemployment, accumulation of unwanted inventories, and increase unemployment. As spending decreases, so does income and production. Agents' decisions to spend less might depress aggregate demand, causing the economy to go into recession. One of the main contributions from Keynes was pointing out that governments could act to limit income/demand shortfalls by spending (Blinder & Solow, 1973; Boushey et al., 2019).

But why do we want macroeconomic stabilization? There are many reasons why governments should intervene to mitigate recessions instead of letting markets clear by themselves.

Recessions often bring economic hardship to most citizens individually or collectively. As individuals, people might suffer from job dispels and income losses. Even if an individual keeps their job, they might still be affected collectively since one person's spending is someone else's income, and pessimistic expectations can influence many relevant decisions to the economy as a whole.

Economic downturns also lead to an increase in inequality and poverty. Research shows that these present cyclical factors. Thompson & Smeeding (2015) document how different age groups were affected unevenly by the 2007 Great Recession. They find increases in poverty across all ages, especially among people from 18 to 44 years old. Moreover, despite inequality falling during the recession, it bounced back to higher levels as the economy recovered.

Also studying the Great Recession, Bitler & Hoynes (2013) found that extreme poverty showed a more cyclical component than in previous downturns and related this behavior to welfare reforms that generated losses in social protection. This emphasizes the inequality aspect of such events.

Racial disparities are also further expanded during declines. The Great Recession affected Latino and Black households more profoundly than White ones in aspects such as wealth and unemployment (Kochhar et al., 2011). Addo & Darity (2021) show that after the Great Recession, Black and Latino households recovered slower and experienced smaller relative gains, which led to an increase in wealth inequality – a result in line with the findings from Thompson & Smeeding (2015).

As Danziger et al. (2012) show, recessions are associated with the rise of the number of people in poverty, and this rising trend usually continues going some time after the downturn is done. They also find that the Great Recession brought an increase in poverty compatible with prior more moderate downturns precisely because of the federal stimulus

spending, pointing out that stabilization policy is indeed capable of refraining the rise in poverty.

Also on the micro-level, there is some evidence that relates economic downturns and unemployment to many social ill. There is a broad literature relating economic hardship to deteriorating mental health and higher suicide rates, and to domestic violence and crime, for example.

Mathieu (2022) finds increases in suicidal behavior to be present at the individual and population level during recessions and that unemployment benefits and other forms of social protection may reduce suicides at the population level. Very similar results and conclusions are found by Gunnell & Chang (2016), who also identify austerity as a contributor. They also suggest more generous unemployment benefits and forms of protection as a mitigation measure. Margerison-Zilko et al. (2016) report not only mental but also physical health impacts and point that stronger social safety nets in some European countries might have reduced these negative effects. At last, Frasquilho et al. (2016) make a systematic literature review with 101 papers and concludes that economic recessions are possibly associated with negative mental health outcomes, especially for psychological wellbeing and that groups such as the unemployed, those in debt or facing financial difficulties, people with pre-existing mental health problems, and families with children are more vulnerable.

Links from economic downturns to domestic violence and crime in general are also found in the literature, though there is not so much high-quality evidence. For example, Bhalotra et al. (2021) find that job loss leads to an escalation of domestic violence in man and woman in Brazil. Also studying Brazil, Britto et al. (2022) report that the probability of committing crimes increases by up to 23% when a worker is fired and that this potential crime increase is completely offset by unemployment benefit eligibility.

On the macro-level, the idea that short-run fluctuations can affect the long-run has been widely recognized and studied under the name of hysteresis. Studies show how recessions permanently affect output and unemployment Blanchard & Summers, 1987; Ball, 2014; Blanchard et al., 2015) and, therefore, long-run trajectories are likely to be path-dependent.

During recessions, as investment shrinks, capital formation and technological advances can be diminished, leading to a decrease in the output trend. On the labor market, higher unemployment can lead to worse job matching, smaller accumulation of skills and, premature exiting. In fact, Kahn (2010) shows that graduating from college in a bad economy has long-run, persistent effects on wages, tenure, as well as educational and occupational attainment.

Rising inequality also translates into the long-run. Beyond the cyclical component

mentioned above, structural unemployment growth generates substantial impacts on income inequality (Naci Mocan, 1999).

In conclusion, the importance of stabilizing the economy is not restricted to merely generating a smoother business cycle. Not only do economic downturns have a significant impact on the welfare of people while they are happening, but they might also cause permanent negative outcomes. And this happens on an individual- and collective-level.

2.2.2 How should stabilization policy take form? The debate throughout the years

After the Keynesian revolution, the mainstream thought on macroeconomics was that fiscal policy was effective and governments were allowed to conduct fiscal policy as they desired, meaning discretionary policy was an accepted option in the government's toolbox. But although this was the most welcomed view, that does not mean there were no critics. The debate of discretionary fiscal policy versus automatic stabilizers dates back to the early years of monetarism (Simons, 1936) and is mostly associated with Milton Friedman (1948).

Discretionary fiscal policy suffers from implementation lags and design issues, monetarists argued. The latter regards calibration errors such as delivering too big or too small of a response, chasing unrelated objectives, and problems in design generally — e.g., targeting the wrong institutional sector (Mohl, Mourre, Stovicek, 2019). The former relates to the time elapsed between the acknowledgment of the necessity to act and the implementation of such a stimulus — called inside lags -– and the time it takes to have an effect on the economy — called outside lags (Blinder, 2004; Blanchard et al, 2010). These were the main arguments against such action.

Moreover, some critics also pointed out that a crowding-out effect would take place after any fiscal impulse. This would cause the stimulus to be partially or even completely offset, depending on how the fiscal impulse is financed[1].

The academic skepticism about fiscal policy as a stabilization tool grew even higher in the 1980s with the rational expectations hypothesis. An important landmark in this topic is the "Rules Rather than Discretion" paper by Kydland & Prescott (1977). Fiscal policy would be ineffective due to Ricardian equivalence or some other intertemporal trade-off, not simply because of timing, magnitude, and financing issues as was argued by Friedman (1948).

Other than that, a widespread belief that monetary policy was capable of doing the job by itself emerged. Therefore, fiscal policy would be limited to (rule-based) automatic stabilizers — i.e., tax system and unemployment insurance (Blanchard et al., 2010).

[1] See (Tobin & Solow, 1972) for a detailed discussion on this topic.

In the aftermath of the Global Financial Crisis, macroeconomists called for a rethinking of macroeconomic policy (Blanchard et al., 2010; Blanchard & Summers, 2017). Still in the late 2010s, a series of IMF papers recommended strengthening automatic stabilizers (Spilimbergo et al., 2008; Baunsgaard & Symansky, 2009; Blanchard et al., 2010). However, they seemed not to have received the attention they deserved. In fact, back in 2000 Blanchard claimed that automatic stabilizers had not been discussed much by academics in the prior ten years and asked "if automatic stabilizers play a useful role, why should we be satisfied with the degree of stabilization implied by existing tax and transfer rules?" (Blanchard, 2000, p. 73).

Some years later, in the midst of a slow recovery, discussions of secular stagnation arose and fiscal policy started to become a topic of interest to mainstream macroeconomists again mainly due to monetary policy reaching the zero-lower bound (Krugman, Eggertsson, 2012; Koo, 2012; Eggertsson et al., 2016; Summers, 2015; Summers, 2016; Summers, 2016b). For instance, Blanchard & Summers (2017, p. 28) claimed that it was surprising that almost ten years after the crisis, little academic work and no policy progress had been done on fiscal policy as a stabilization tool. They also held that it would be desirable to go beyond just stabilizers. Later, they argued in favor of enhancing stabilizers especially -– but not only — in the face of constrained monetary policy (Blanchard & Summers, 2020).

However, and perhaps explaining why no academic work had been done on this front, this new interest in fiscal policy was short-lived and more of a matter of pragmatism, as Fiebiger & Lavoie (2017) point out by analyzing IMF documents and communications. The fiscal policy agenda fell short of leaving the realm of the abstract and affecting the core of mainstream thought.

Therefore, there seems to be a recent agreement that monetary policy cannot do the job by itself (in contrast to what was thought prior to the Global Financial Crisis), but there is still a distrust in discretion, leaving rule-based fiscal policy as an alternative. Indeed, discussing the advantages and disadvantages of discretionary policy, Blinder (2004, p. 28) said that "if what we now think of as discretionary policy changes for stabilization purposes could somehow be made automatic, then the lengthy inside lags in fiscal policy could be reduced dramatically". Similarly, Fatás & Mihov (2012, p. 35) reflecting on the fact that discretionary policy is still widely used even though it might not be optimal, stated that "the question is if we can design automatic stabilizers that rely less on the size of government but are still automatic and therefore not subject to political debate and interference".

The drawbacks of discretionary fiscal policy are not present in automatic stabilizers, which by nature tend to have faster and more proportional responses to fluctuations, minimizing lags and calibration errors. Moreover, the mechanisms are usually part of the government budget, making government spending shocks a little more predictable

(Maravelle & Rawdanowicz, 2020).

After 2019, more attention has been given to the topic of creating or enhancing existing stabilizers, especially after the pandemic hit the global economy. Perhaps the most known paper on this topic was the one by Sahm (2019), but mainly due to its historically accurate recession indicator, not its stabilizers proposal. The pandemic would then lead fiscal policy back into the public policy agenda and, as a consequence, amplify its presence in academic work.

Many countries created a wide variety of relief programs to sustain aggregate demand during the years of 2020 and 2021, such as checks and unemployment insurance modifications[2]. But these were temporary (and discretionary) actions (Dube, 2021; Marinescu et al., 2021; Petrovsky-Nadeau & Valletta, 2024), and their effectiveness was likely reduced due to the rush to implement them. As Eichenbaum (2019) points out, policies that are designed outside of a crisis are more likely to be better thought out and communicated, and would also help all kinds of economic agents to better formulate their expectations.

But what about discretionary fiscal policy? What if it could be trusted? As mentioned before, this once-disbelieved tool briefly reemerged in the early 2010s. Discussing where the division of tasks between discretionary and rule-based fiscal policy should be, Blanchard & Summers (2020) argue that the answer lies in how much the designing of a discretionary response can be trusted. In a similar manner, Orszag et al. (2022) propose a "semiautonomous discretion" paradigm. In an older publication, Blinder (2004) proposed "the case against the case against discretionary fiscal policy", listing that an active fiscal policy can in fact be used as a policy tool, although it has drawbacks and some forms are, at first, preferred to others. Moreover, based on historical experience, it is likely that discretionary fiscal policy will still have a central role in mitigating large shocks (Blinder, 2004; Fatás & Mihov, 2012; Blanchard & Summers, 2020). Therefore, it should not be neglected as a research object.

2.3 Theory

2.3.1 A step forward: semiautomatic stabilizers

Many definitions for an automatic stabilizer can be found in literature, most of which focus on the fact that they are policies that mitigate the impacts of the economic cycle with no government active intervention. But for the purpose of our research, it is useful to make a distinction between automatic and semiautomatic stabilizers (Blanchard & Summers, 2020; McLiesh, 2021).

[2] Such as the Pandemic Unemployment Compensation.

We can define automatic stabilizers as "the rules in law that make fiscal revenues and outlays relative to total income change with the business cycle" (McKay & Reis, 2016). This means that they are an incidental consequence of social safety, namely of tax, labor, and social policies (Andersen, 2016; Blanchard & Summers, 2020). Also, they "reduce output fluctuations because some components of fiscal accounts react automatically to the cycle" (Di Bella, 2002, p. 4), no matter the magnitude of the fluctuation, that is, they work continuously as the cycle goes through them.

On the other hand, semiautomatic stabilizers are part of an intentional macroeconomic design and are activated by triggers, only activated at a certain degree of fluctuation. This means that they are not strictly passive as automatic stabilizers but cannot be considered discretionary action, as they are also rule-based and are also written in law (Blanchard & Summers, 2020). This kind of setting contributes to avoiding possible problems related to fiscal impulses planned hastily during a crisis. As we will see, semiautomatic stabilizers are often labeled as automatic. Even though this distinction might not be so important and common in the literature, we present it for clarification purposes.

Such a policy design consists of selecting one (or more) macro variable and defining a threshold from which the policy should be deployed. Common variables chosen to be the trigger are unemployment and output growth (Sahm, 2019; Haughwout, 2019; Blanchard & Summers, 2020), but many different settings are possible. For example, Eichenbaum (2019) suggests the short-term monetary policy rate could be a trigger to change the operation of many fiscal tools. The choice of trigger and threshold is up to the policymaker and, naturally, should consider the country/region's characteristics.

Discussing what triggers should be, Blanchard & Summers (2020) conclude that the unemployment rate is preferable to output variation. This would be because shocks with transitory effects are more likely to be shocks to unemployment than to potential output, and stabilizers should react only to deviations from potential output, not to movements in its curve. According to this, unemployment slumps should be used rather than output recessions. In fact, one can think of the Sahm Rule, which is based on unemployment slumps, though it is used as an output recession indicator (Sahm, 2019).

Moreover, a common feature in semiautomatic stabilizers is an asymmetric design (Eichenbaum, 2019) in the sense that they are biased towards growth. As a matter of fact, all the stabilizers assessed in this thesis are asymmetrical. Eichenbaum (2019) calls for this asymmetry due to binding constraints in monetary policy, while Blanchard & Summers (2020) call for a larger role for fiscal policy in the form of semiautomatic stabilizers for the same reason.

In a more general manner, Maravelle & Rawdanowicz (2020) argue that such policy devices are desirable whenever prevailing uncertainty is preventing private consumption and investments. There is evidence that, beyond decreasing the variance of output growth,

automatic stabilizers have helped to turn periods of recession into periods of normal growth as well as have boosted growth following recessions (Romer, 1999). Thus, one can argue that periods of low, sluggish growth, such as the 2010s decade could be avoided with the help of asymmetric stabilizers (Eichenbaum, 2019).

	Automatic Stabilizer	**Semiautomatic Stabilizer**	**Discretionary Policy**
Precarious or linked	Linked	Linked	Precarious
Predetermined rates or size	Yes	Yes	No
Is it always working?	Yes	No	No
Works both ways or is biased toward growth?	Both ways	Biased towards growth	Biased towards growth

Table 1 – Comparison of fiscal stabilization tools

Table 1 compares some central characteristics of automatic, semiautomatic stabilizers, and discretionary policy. We argue that semiautomatic stabilizers benefit from the best of automatic stabilizers and discretionary policy, while avoiding the downsides of each. For example, like automatic stabilizers, they do not require the politicians' will to take action — for better or worse -– and their effects can be roughly anticipated so that agents can factor them into their decisions; and like discretionary policy, they represent a more robust response to declines.

2.3.2 Transmission channels of stabilization policies

The government is able to support demand by inducing (public and private) consumption and investment. Literature investigating policies focused on consumers has identified a variety of transmission channels.

As these policies generally consist of some form of transfers to people, perhaps the most obvious is the disposable income channel: by stabilizing disposable income, consumption, and, therefore, aggregate demand is stabilized (Brown, 1955). The role of disposable income in the business cycle is widely studied (Taylor, 2009; Di Bella, 2002), but there is some dispute on whether it is through this channel that the demand-stabilizing effect works. Findings from Dolls et al. (2012) and from McKay & Reis (2016) indicate that disposable income has a negligible effect on aggregate demand, and stabilizing the former does not mean stabilizing the latter.

A second channel is the redistribution channel, which works by leading income towards people with a higher marginal propensity to consume (Blinder, 1975). This

reallocation of income increases spending, boosting demand. This is a common feature in most theories that adopt the principle of effective demand, most notably of Kaleckian models (Lavoie, 2022).

A third one is the insurance channel, which presumes that the existence of some financial aid program reduces the uncertainty of future income, therefore leading to a smaller variance in income in face of stochastic shocks and ultimately a smaller decrease in consumption (Browning & Crossley, 2011; Cohen & Follette, 2010). Having some sort of insurance presumes that households can smooth consumption without the need of accumulating prior precautionary saving.

At last, the liquidity channel relates to the avoidance of possible liquidity constraints that might hinder consumption smoothing, even in high-income households (Cohen & Follette, 2010). As income drops, it is hard for high-income households to keep consumption at a level compatible with the prior income level.

In general, all of these channels are somewhat related to smoothing consumption and precautionary savings. They either discourage people from creating an excessively big emergency fund (disposable income and insurance channels) or provide people who have no emergency fund with some financial aid, making it possible for consumption to be smoothed to a greater extent (redistribution and liquidity channels).

Therefore, all fiscal stabilization policies ultimately boil down to the idea of the paradox of thrift, a central element present in many Keynesian, Post-Keynesian, and Kaleckian models (Lavoie, 2022). This idea relates to the fact that if all agents in an economy decide to increase their saving, there will be a drop in aggregate demand and output, which will end up generating a smaller total saving.

Even though a portion of mainstream research on this topic makes use of neoclassical mechanisms (such as some sort of intertemporal optimization), the principle of effective demand is generally taken into account when dealing with recessions (Boushey et al., 2019). Thus, what interests this thesis are the fluctuations in aggregate demand caused by decisions to spend or to save.

Similarly to consumer behavior, firms might want to fire employees and stop or decrease investments in face of uncertainty. Policies can be aimed at firms to avoid pessimism or to relieve financial constraints by granting them that there will be some demand relative to production. These policies would translate into job vacancy and corporate investment smoothing (Devereux & Fuest, 2009; Haughwout, 2019).

Other than the direct effects of the transmission channels highlighted, these channels interact among themselves so that policies aimed at consumers also benefit firms and vice versa. After all, on the aggregate level, income is generated when someone else spends. Therefore, these policies generate income and help sustain consumer and corporate

sentiment.

2.3.3 Policy proposals

We propose to evaluate and compare the implementation of 4 types of stabilization fiscal policies: a direct stimulus payment program, a dynamic unemployment benefit, a government purchases program, and a discretionary consumption policy. One policy is heavily inspired by what's proposed by Claudia Sahm (2019), another is inspired by Chodorow-Reich & Coglianese, 2019, while others are not particularly inspired by specific proposals. In this subsection, the policies will be laid out, followed by their simplified form established in the model.

2.3.3.1 Direct stimulus payments program

The Sahm Rule became a popular topic during discussions of the U.S. macroeconomic situation after the COVID-19 pandemic, especially in 2023. However, the publication from which the rule originates dates to 2019 and aims to propose a semiautomatic stabilizer[3] in the form of a fiscal stimulus paid directly to individuals as soon as a recession is detected (Sahm, 2019).

Sahm (2019) notes that historically, the growth of consumer spending becomes negative or slows down sharply during recessions in the U.S. Additionally, this type of spending accounts for about 70 percent of the country's aggregate demand. Therefore, avoiding declines and mitigating slowdowns in consumption is a key point for macroeconomic stabilization, alongside existing stabilizers.

The Congressional Budget Office (CBO) estimates that during the American Recovery and Reinvestment Act of 2009, transfers to individuals had multipliers ranging from 0.4 to 2.1, being one of the best policy designs (CBO, 2012). Sahm (2019) presents a thorough review of the evidence regarding stimulus payments during the 2001 and 2007 recessions.

However, it is likely that such a policy would generate higher multipliers than what was observed in these previous events. The reasons for that are the existence of a psychological phenomenon that indicates that a stimulus transfer perceived as a bonus is generally more likely to be spent than when the same amount of transfer is a rebate (Shefrin & Thaler, 1988; Murphy, 2021), and the fact that due to the nature of the 2008 crisis led individuals to pay off debt with the received stimulus instead of using it to pay for expenses (Garner et al., 2020). In a meta-analysis, Gechert & Rannenberg (2018) find transfers to be the only method of fiscal impulse to never show negative multipliers.

[3] Semiautomatic by the aforementioned definition, since she describes it as an "automatic stabilizer" (Sahm, 2019).

According to Sahm (2019), the choice of a single, large payment would be justified by a series of studies that point to a more pronounced response to this type of benefit compared to consecutive smaller payments (Sahm et al., 2012; Parker et al., 2013; Misra & Surico, 2014, as cited in Sahm, 2019). In particular, the author highlights the perceptual impact that a fiscal stimulus program has on the public. Dispelling pessimism or uncertainty about the near future is important for economic stabilization because it may prevent a decrease in current consumption and/or an increase in saving as a precaution. Even if the fiscal benefit is not enough to compensate for the entire income loss caused by unemployment, it is argued that the received amount can still reduce the need to cut consumption to save up for an emergency reserve. Thus, the adoption of gradual benefits (with small monthly payments, for example) may not have the same effect on consumer confidence as a single, larger stimulus payment (Sahm, 2019).

The Economic Impact Payments (EIP) implemented in the U.S. during the Covid-19 pandemic is, perhaps, the closest real-world experience to Sahm's proposal since it was not a tax rebate and also not linked to employment status, even though it was restricted to some income levels. Data from week 7 of the Household Pulse Survey[4] show that around 70% of respondents who received or expected to receive the stimulus payment would use it mostly to pay for expenses (Garner et al., 2020). An interesting finding is that individuals who did not use their regular income sources to meet previous spending needs were more likely to use the stimulus payment for expenses (Garner et al., 2020). This possibly indicates a crowding-in effect.

The EIP, however, was somewhat discretionary and designed in a hurry, leading to problems that would be avoided or solved by a proper stabilizer design (Murphy, 2021), such as proposed by Sahm (2019). Her proposal consists of a lump-sum, one-time direct payment sent to individuals automatically as soon as the three-month moving average of the unemployment rate rises 0.5 percentage points above the lowest value of the past 12 months. This threshold is set according to the recent history of the U.S. economy, as it indicates the beginning of a recession in the country since 1970 (Sahm, 2019).

Overall, the triggering rule could be something else than that and should reflect the country/region's idiosyncrasy. This is a big challenge to real-world implementation of such a policy (at least outside the U.S.), as we will discuss further below. The effects of a recession on employment are felt with some delay, so unemployment insurance only starts to act as a stabilizer after a certain period of time. The existence of a recession indicator such as the Sahm Rule is itself a major edge since the timely detection of a recession allows stabilizers to begin acting immediately. One can think of different efficacy levels for the direct stimulus payments with the Sahm Rule and with some not so timely trigger.

[4] The Household Pulse Survey was a survey that measured how emergent social and economic issues impacted households across the U.S during the Covid-19 pandemic.

The total value of the proposed stimulus is 1 percent of real personal consumption expenditures, which equates to half of the consumption slowdown in a "typical recession" in the U.S. In other words, this amount would be about 0.7 percent of GDP. Twelve months after the stimulus payment, a new payment of the same amount could be sent if the unemployment rate is still 2 percentage points or more above the initial value. After another 12 months – i.e., 24 months from the initial point – if the unemployment rate is still 2 percentage points above the initial value, the stimulus will be reduced to a fraction of the initial amount, calculated according to the following formula:

$$\frac{(u_t - u_n - 2)}{(u_p - u_n - 2)} \tag{2.1}$$

Where u_n, u_p, u_t are, respectively, the unemployment rate before the recession, the highest rate during the period (the peak), and the current rate. For instance, if after two years these values are 5%, 10%, and 11%, respectively, the amount paid in the third year would be 3/4 of the initial amount or 0.75% of real personal consumption expenditures.

Eligibility criteria would not be restrictive. Sahm (2019) only mentions the need for beneficiaries to be residents of the country, to not have unpaid taxes, and to ensure that no individual receives the stimulus more than once within a single round. Thus, there are no income criteria for receiving this payment.

The absence of income restrictions is justified by the fact that there are high-income and wealthy families with low liquidity – real estate or retirement funds, for example, are examples of illiquid assets – resulting in a high marginal propensity to consume, which would lead to the stimulus amount being spent. There is solid of evidence regarding higher multipliers in liquidity-constrained households (Cohen, Follette, 2000; Kaplan & Violante, 2011; Dolls, Fuest & Peichl, 2012; 2012b; McKay Reis, 2016; Ganong, Noel & Vavra, 2020; Dube, 2021). Therefore, the payment would be broadly allocated to all adults, who would receive a base amount. Those with minor dependents would also receive an additional half of the base amount for each dependent.

2.3.3.2 Dynamic unemployment benefit

The second type of policy to be evaluated in this thesis is the implementation of a dynamic unemployment benefit. Unemployment benefits could be made dynamic by introducing a bonus on the amount paid whenever the country is going through a recession.

Gruber (1997) states that in the U.S., the fall in consumption for people who become unemployed would be three times greater if unemployment insurance did not exist. Along this line, Dolls, Fuest & Peichl (2012) associate higher unemployment benefit receipts to a better degree of stabilization, and claim that this is the reason why Europe has better demand stability comparated to the U.S.

Some temporary extensions of unemployment benefits can be found in countries that were going through severe or long-lasting recessions, but most of these are restricted to expanding the maximum duration of the benefit[5] [6]. Unemployment insurance, alongside progressive taxation, is usually one of the devices mentioned as examples of automatic fiscal stabilizers. With an increase in layoffs during a recession, the number of unemployed rises, leading to a higher aggregate amount of unemployment insurance paid. However, the benefit rate remains the same whether the economy is experiencing a boom or a recession.

Especially after the pandemic, some have suggested reforming the current social security system towards a more stabilizing scheme (Chodorow-Reich & Coglianese, 2019; Murphy, 2021; Dube, 2021; McLiesh, 2021). For instance, McKay & Reis (2021) conclude that the level of generosity in the social security system depends on how strong the stabilizers are desired to be, one can propose more generous unemployment benefits in order to reach higher stability. In fact, they find that a greater focus on macroeconomic stabilization in the U.S. would lead to a substantial increase in the amount paid in unemployment insurance (McKay & Reis, 2021).

Thus, given the need for stronger rule-based macroeconomic stabilization tools, it is worth proposing an increase in the monthly unemployment insurance benefit during periods of recession. This turns an automatic, incidental stabilization device into a semiautomatic, intentional stabilizer.

Indeed, higher generosity in unemployment insurance generating higher stability against negative shocks was found by Di Maggio & Kermani (2016), investigating at the local level. They found that an increase in 4-7 percent in unemployment insurance generosity leads to a decrease of about 9 percent in adverse shocks.

This seems like an easier alternative with fewer implementation barriers. The advantage of this proposal is the absence of significant technical restrictions –there is no need to create an account for each beneficiary at a specific bank, as would be the case with checks; a smaller number of people filing up to the benefit. It simply requires applying a multiplier to the amounts to be paid to those who have applied for and are eligible to receive unemployment insurance.

[5] Recently, the U.S. deployed a one-sized U$600 boost to unemployment benefits during the first months of the Covid-19 pandemic. See https://www.dol.gov/newsroom/releases/eta/eta20210105 and https://oui.doleta.gov/unemploy/extenben.asp.

[6] Canada has a program called Supplemental Unemployment Benefit (SUB) that grants higher benefits but is restricted to temporary stoppage of work, and is optional and conditional on employer adherence. See https://www.canada.ca/en/employment-social-development/programs/ei/ei-list/ei-employers-supplemental-unemployment-benefit.html.

2.3.3.3 Government purchases program

Another way for the government to inject demand into the economy is to increase public consumption. Instead of relying on transfers to stimulate private consumption, governments can execute direct purchases.

Such a policy should have the advantage of avoiding demand leakages from savings that could take place if the same resources were sent to consumers. This would ensure that the whole of the planned stimulus is implemented. Indeed, there is evidence that spending multipliers are higher than tax multipliers due to the fact that tax cuts can be saved (Whalen & Reichling, 2015).

The aftermath of the Great Financial Crisis led to an upsurge of interest in government expenditures multiplier, with many studies being conducted on the topic, comprising different time periods but mostly restricted to Europe and the U.S. Despite this upsurge, there appears to be little consensus on the topic as there is a lot of divergence over the results. Disagreements vary from whether the multiplier is smaller or greater than unity, state-dependent, and different for investments or purchases.

Literature on this topic is broad and approaches many aspects, such as the values of the multipliers themselves under different estimation methods, state-dependent effects (Auerbach & Gorodnichenko, 2012; Ramey & Zubairy 2018; Christiano et al., 2011), and the kind of spending (CBO, 2012; Boehm, 2020). As this is a subject of broad research and conflicting results, it makes sense to resort to a meta-analysis, such as the one by Gechert & Rannenberg (2018).

Using a meta-regression analysis including 98 empirical studies over more than 1800 observations, Gechert & Rannenberg (2018) find that the unspecified spending multiplier is on average significantly positive and higher during declines. When it comes to consumption spending specifically, the average multiplier is slightly lower, but more sensitive to the business cycle. In such a disputed topic, it is important to mention that this analysis controls for publication bias.

The theory behind the effectiveness (or the lack thereof) of such a policy is as follows. Government spending can crowd in or out private consumption and investment. When aggregate demand is weak, at first, it is reasonable to expect that increased spending raises aggregate income and lowers unemployment, crowding in consumption, as found by Blanchard & Perotti (1999). Also, Keynesian theory suggests that a high aggregate marginal propensity to consume tends to generate higher multipliers (Ramey & Zubairy, 2018).

However, some obstacles may prevent this from happening. As mentioned, a nominal interest rate that follows the Taylor Rule likely hinders a fiscal expansion since real interest rates will rise after the effects of the stimulus start to take place (Christiano et al., 2011;

Ramey & Zubairy, 2018). Similarly, neoclassical theory suggests that the presence of distortionary taxes to offset the increase in spending also tends to lower the multiplier because of a wealth effect (Ramey & Zubairy, 2018).

2.3.3.4 Discretionary policy

As a benchmark, we propose to assess the effectiveness of discretionary policy, specifically in the form of public purchases. The main motivation for the inclusion of a discretionary policy in this analysis is the possibility that automatic stabilizers and discretionary policy are in some way substitutes, as suggested by Fatás & Mihov (2012) when looking at OECD countries. They also observe that from the 1990s to the early 2010s, these countries started to make more use of this kind of policy. The same is found by Auerbach (2002) regarding the U.S. This indicates that governments might not be willing to give up on this device, irrespective of what economic theory says, making it a relevant object of study.

Regarding historical evidence, Romer and Romer (1994) argue that discretionary fiscal policy has played a moderate role in economic recoveries in the U.S., partially because of delayed action in some recessions, but Auerbach (2002) disputes this. Hebous (2011) surveys empirical VAR evidence and concludes that generally output increases following expansionary shocks, but there are some exceptions and that there is no conclusive evidence in favor or against the effectiveness of discretionary policy. In the experience of Greece, Tagkalakis (2013) finds discretionary policy to have behaved as predicted by typical Keynesian theories – boosting output growth, private consumption, and nonresidential investments. On the other hand, Carnot & De Castro (2015), studying the EU countries, find that discretionary fiscal effort has been conducted in a more stop-and-go and procyclical fashion over the previous ten years.

Again, this shows that this is a topic of dispute and it is relevant to resort to a meta-analysis. The results presented by Heimberger (2023), based on 154 studies comprising more than 3500 estimates, are that discretionary fiscal policy tends to be slightly procyclical in developing countries and generally acyclical in advanced economies.

On theoretical grounds, Fazzari et al. (2021) show that discretionary policy effectiveness depends on the form (tax cuts or spending increases) and the state of the economy. Discretionary fiscal policy presents high multipliers in periods of slackness and works primarily through the consumption channel. This suggests that the problem with discretionary policy found in empirical studies might be a misuse of this kind of policy.

This finding by Fazzari et al. (2021) reinforces the motivation to study this policy tool, which originally comes from the brief revival of interest in discretionary policy during the 2010s. As mentioned before, Blanchard & Summers (2020) state that the division of tasks between automatic (and semiautomatic) stabilizers and discretionary policy lies

in how much discretionary policy can be trusted to do the right thing. They also recall that discretionary policy eventually comes into play during recessions. This suggests that although stabilizers and discretionary policy might be substitutes from an inter-country point of view, they are also complementary from an intra-country point of view.

This is, indeed, the idea behind semiautonomous discretion (Orszag et al., 2022), which emphasizes residual fiscal discretion. Even though this is a different role than the one under analysis — being the main vs. residual stabilization tool —, if it is found, for instance, that discretionary policy is more destabilizing than stabilizing on its own, then it is likely that it will not be helpful even as a residual tool.

The rationale behind government purchases promoting stabilization has been laid out in the previous subsection. The objective of this policy experiment is, therefore, to concentrate on the absence of predetermined rules.

2.3.4 Overview of policies

To sum up this section, we recall the four policies to be assessed in this thesis: a direct stimulus payment program, a dynamic unemployment benefit, a government purchases program, and a discretionary consumption policy. These four policies can be divided into two dimensions: whether they are aimed at consumers or firms, and whether they are contingent or fixed amounts.

Both the direct stimulus payment program and the dynamic unemployment benefit are aimed at consumers, but the amount transferred is fixed in the former, while in the latter, it is contingent on how much the unemployment rate has increased in a given period of the business cycle. Similarly, irrespective of the proportion of the economic slowdown, in the public consumption program, the government will contribute with a predetermined amount of purchase expenditures, while in discretionary policy, it can better calibrate the amount of expenditures according to the slump in capacity utilization.

2.4 Final remarks

This chapter aimed to show that even though stabilization policy is seen as desirable, it seems like current schemes are suboptimal. While monetary policy might not be able to do all the job by itself, automatic stabilizers are generally weak in comparison to what fiscal policy is capable of. It's not surprising that these stabilizers are insufficient, though, since they are an incidental consequence of social safety. In this context, the idea of semiautomatic stabilizers, that is, of rule-based yet strong and intentional policy designs, seems attractive and, in fact, has been called for by academics. Most of these devices, however, have barely been tested in the real-world or researched at all.

Having this in mind, we present three of such policies and intend to investigate their effectiveness and compare them to a discretionary policy setting. With policies that can be characterized by two dimensions — a focus on consumers or firms, a fixed or contingent amount — we laid the rationale and some empirical evidence behind the effectiveness (or ineffectiveness) of each to guide the analysis and results to be found in the next chapters.

3 MODEL AND METHODOLOGY

3.1 Introduction

In this chapter, we present the model and other details of the methodology that will be used to analyze the policies. Subsection 3.2 introduces the complexity economics paradigm and agent-based models. In subsections 3.3 and 3.4 the model is presented, giving special attention to the equations ruling the behavior of the labor market, consumers, firms, and the government. Subsection 3.5 lays out the modifications introduced in order to implement the policies into the model, and the general policy settings to be assessed.

3.1.1 Complexity economics and agent-based models

We make use of simulations within a macroeconomic agent-based model (ABM). The use of this type of modeling is justified by its capacity to portray heterogeneity, bounded rationality, local interactions, path-dependency and out-of-equilibrium dynamics (Rosser, 1999; Arthur, 1999). Economies can be thought of as complex adaptive systems (Rosas et al., 2024; Delli Gatti et al., 2010; Dosi & Roventini, 2019) and agent-based computational economics (ACE) deals with the computational study of economies as complex-evolving systems with autonomous agents interacting with each other (Tesfatsion, 2003).

There are many possible ways to define complex systems. For a detailed discussion over the definition of a complex system, refer to Rosser (1999) and Chudziak (2025), but for the practical purpose of presenting this paradigm within economics for the reader of this thesis, we shall mention some well established characteristics/properties of complex systems. In general, such systems are composed of elements that behave in a decentralized way and interact in a micro-level, leading to emergent properties – that is, meso- or macro-level patterns that arise from the micro-level even though they are not present there. This means that the aggregate is not simply the micro-level multiplied by a large number.

As the elements of the micro-level interact, the aggregate changes, and these elements once again react to the changes in the aggregate. This generates a recursive loop (Arthur, 1999; 2021) which prevents some sort of asymptotical equilibrium to be reached. Indeed, some define complex systems as the ones that do not endogenously tend to a asymptotical equilibrium (Rosser, 1999). This happens because at the micro- and meso-level networks are formed and interactions might not be linear, so that positive feedback loops and the presence of auto-catalyticity might take place, while the notion of asymptotical equilibrium requires negative feedback loops.

In economics, complexity is usually presented in the following way. Workers, firms and other micro-level agents interact following simple rules and this generates higher-level structures such as markets, emergent properties such as self-sustained growth, and statistical regularities such as a Phillips or Beveridge curve. (Dosi & Roventini, 2019). All of these happen without being imposed in any matter. Rather, they come from the evolutionary and path-dependent behavior of the lower-level elements. The macro-level exhibits properties that are not present in the micro-level.

The complexity economics approach and agent-based models reverse several neoclassical assumptions and building blocks. Agents are boundedly rational, have limited capabilities, make persistent mistakes, and create inconsistent expectations (at odds with neoclassical individual behavior modeling); populations are heterogeneous in a persistent and relevant way for the aggregate behavior, so that the average behavior and characteristics of the economy are not the same as the behavior and characteristics of the average individual (at odds with neoclassical aggregate heterogeneity modeling); interactions take place in complicated ways inside non-trivial networks which might evolve over time instead of being limited to regimes of interaction between all agents or no interaction at all (at odds with neoclassical interaction modeling); and the system's state evolves endogenously going through metastable equilibria, meaning it does not need to be under equilibrium (at odds with neoclassical dynamics). Beyond these building blocks, ABMs take up a bottom-up approach, generating emergent properties and macro-outcomes from the micro-level behaviors and interactions, instead of imposing top-down assumptions to constrain macro-level dynamics and behaviors in a given way (Delli Gatti et al., 2018).

Therefore, ABMs can be generally summarized as microfounded models composed of heterogeneous agents with bounded rationality that interact and undergo a constant learning process in a way that does not necessarily lead to equilibrium and that generates emergent properties (Rosser, 1999; Delli Gatti et al., 2010; Arthur, 2021; Dosi; Roventini, 2019). Agent-based models in economics date back to as far as the early 2000s (Possas et al., 2001; Tesfatsion, 2003; Possas & Dweck, 2004) and many families of models have formed (Delli Gatti et al., 2010b; Dawid et al., 2014; Caiani et al., 2016; Busato & Possas, 2016; Popoyan, 2017; Pedrosa & Lang, 2021; Rolim et al., 2023). ABMs have also seen an increase in popularity in other fields of science such as biology, ecology and social sciences (Amendola & Pereira, 2025).

3.2 The model

The model used is built upon the K+S labour-augmented model that belongs to the "Schumpeter meeting Keynes" family of models (Dosi et al., 2010) which are able to reproduce an ensemble of macro- and industry-level stylized facts (Dosi et al., 2017,

Haldane; Turrell, 2018, Dosi, 2024).

Specifically, the K+S labor augmented model is able to reproduce hysteresis and at least eight labor market stylized facts such as persistent unemployment, the wage curve, the Beveridge curve, the Okun curve, separation and hiring rates volatility, matching function, productivity, unemployment and vacancy rates volatility, and unemployment and inequality correlation (Dosi et al., 2017) emerging from microfounded economic relationships. It features a wide range of labor market parameters and regimes that provide us with a laboratory for labor market policy and institutional arrangements evaluation (Dosi et al., 2017, 2018, 2018b, 2019, 2020).

As a general characteristic of ABMs, the K+S model does not allow for analytical solutions due to the number of elements and the non-linearities and stochastic factors present in interaction patterns, decisions, and behavior rules. For that reason, computer numerical simulations are used to run the model. Results will refer to Monte Carlo replications over a large number of periods following "warm-up" periods, which will be discarded. Monte Carlo experiments are a method that uses sampling to produce numerical results. In this case, the model is run for 300 periods and replicated 50 times. The results for each variable in each period are aggregated so that the median value and other statistical moments can be calculated.

The model is run on the Laboratory for Simulation Development (LSD) software (Valente & Pereira, 2024) which can be described as "a free, open-source software framework (SF) and integrated development environment (IDE) dedicated to ABM methodology" (Pereira, 2024, p. 618). Some of the advantages of using LSD are relatively low processing and memory requirements, a modular and more friendly way of coding in C++, and a tree-like organization of models.[1]. The data generated in LSD will be analyzed using R (R Core Team, 2022)

3.3 Model specifications

As mentioned, we build upon the K+S labour-augmented model, a general disequilibrium model which comprises a detailed labor market with heterogeneous, interacting agents. In the following subsection, we present the most important behavioral equations to our analysis following conventions from previous publications that use this model (Amendola & Pereira, 2025) and later we present our modifications used to introduce the policies to be evaluated. All contents from subsections 3.4.1 to 3.4.4 are sourced from Amendola & Pereira (2025).

[1] For further details on LSD, refer to Appendix 9.G in Dosi's "The Foundations of Complex Evolving Economies" (Pereira, 2024).

3.3.1 General structure

The model is composed of F_t^1 capital-goods firms that produce capital-goods with heterogeneous productivities; F_t^2 consumption-goods firms that produce single quality-differentiated goods for consumers using these capital-goods (machines) combined with hired labor from L^S consumers/workers; B banks that provide credit for firms. All four of these consist of heterogeneous populations. Finally, there is a central bank that sets the prime interest rate following a Taylor Rule and may require compulsory reserves from banks and a government that levies taxes on firms and workers, pays unemployment benefits and rescues failing banks (Dosi et al., 2019). The relations among these agents are represented in Figure 1.

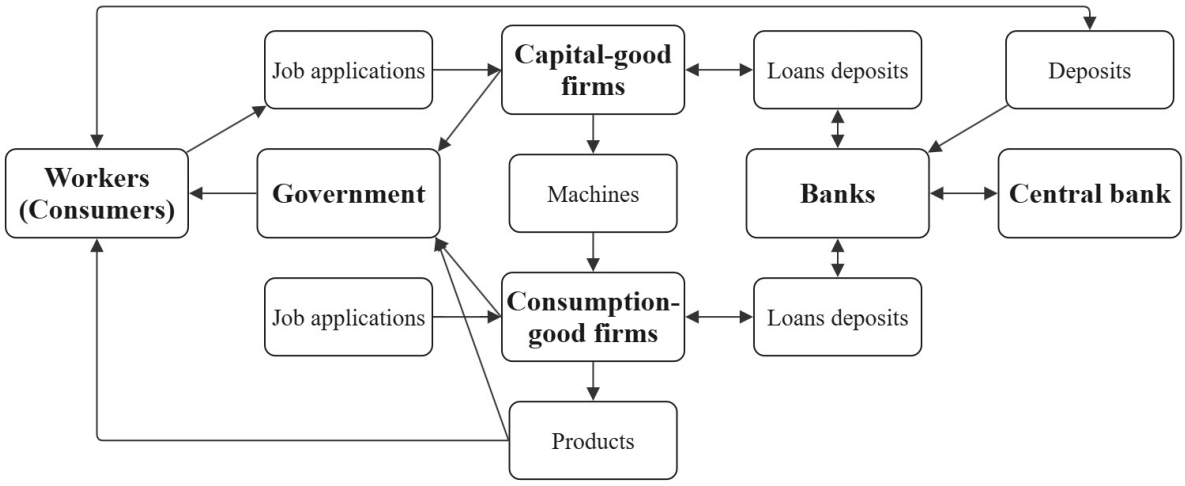


Figure 1 – Model structure (Amendola & Pereira, 2025).

In each simulated period, the timeline of events comprises 16 steps, as follows (Amendola & Pereira, 2025):

1. Policy variables (like unemployment benefits rate and interest rate) are fixed by the government and central bank;

2. Workers update their skills;

3. Machines ordered in the previous period are delivered;

4. Capital-goods firms perform R&D and signal their machines to consumption-good firms;

5. Consumption-good firms determine desired production, investment, workforce size and credit demand;

6. Firms send/receive machine-tool orders for the next period;

7. Firms open job queues and job-seekers send applications to them;

8. The labor market runs and job vacancies are partly or totally filled;

9. Firms produce and pay wages (and bonuses);

10. Government pays unemployment benefits, levies taxes on incomes and makes demand for public consumption;

11. Workers compute their disposable income and decide their consumption demand;

12. Consumption-good market opens and market shares evolve driven by competitiveness;

13. Firms and banks compute their profits, pay taxes on profits and repay their debts;

14. Firms with near-zero market share or negative net assets exit the market;

15. Aggregate variables are computed;

16. New firms enter in the two sectors and the cycle restarts.

3.3.2 Labor market and consumers

The aggregate supply of labor L^S is fixed and divided between consumption-good and capital-goods firms, which will be denoted by j and i subscripts, respectively. In the consumption-good sector, the desired labor demand $L^d_{j,t}$ depends on desired production $Q^d_{j,t}$ and the average productivity of the capital stock owned $A_{j,t}$ by each firm in each time period, while in the capital-goods sector, the desired labor demand $L^d_{i,t}$ depends on effective orders $Q_{j,t}$ and the firms' machine-production productivity $B_{i,t}$:

$$L^d_{j,t} = \frac{Q^d_{j,t}}{A_{j,t}} \tag{3.1}$$

$$L^d_{i,t} = \frac{Q_{i,t}}{B_{i,t}} \tag{3.2}$$

In each period, firms decide whether to fire or hire workers (or keep the same labor force). We present the rules of the so-called Competitive regime.[2] (Dosi et al., 2019) — a specific setting of the labor market in the model —, as it is what will be used in the simulations in the following. If a firm desires to increase production, it will try to hire more workers and will get a fraction of job applications proportional to its market share, from which it will choose workers that would accept its wage offer and it will prioritize applications with higher skills-to-wage ratio. They might be unable to hire a worker since workers can apply to multiple firms at a time.

[2] A Competitive labor market regime is characterized, for instance, by high wage sensitivity to unemployment, no firing restrictions, partial minimum wage indexation. Further details can be found in Dosi et al. (2019).

Conversely, firms fire workers if their profits are negative and there is excess capacity production. Workers with lower skills-to-wage ratio will be fired first. If a firm leaves the market, all workers are fired.

Wages requested by workers $w^r_{l,t}$ follow a simple rule that reflects their employment status, past wages and unemployment insurance:

$$w^r_{l,t} = \begin{cases} \max(w^{un}_t, w^s_{l,t}) & \text{if } l \text{ is unemployed in } t-1, \\ w_{l,t-1}\ (1+\varepsilon)\ , & \text{otherwise.} \end{cases} \tag{3.3}$$

where w^{un}_t is the amount paid as unemployment benefits, $w^s_{l,t}$ is the moving average of the last X salaries, and ε represents an increase in desired wage. The dynamics in equation (3.3) make it so that if a worker is employed, they will request a higher wage in the next period and if they are unemployment they might accept a smaller wage, as long as it is higher than the unemployment benefit. Workers who are already employed can still search for jobs and can quit if they receive a wage offer that is equal to or higher than their required wage.

Beyond wages, workers can receive a bonus $Bon_{l,t}$ that depends on the firm's performance. Bonuses are paid by firms that show a profit above the average on the period. Individuals can also earn income from interest on past saving deposited in banks. Therefore, individuals' gross nominal income is:

$$In_{l,t} = \begin{cases} w^{un}_t + Sav^{acc}_{l,t-1} r^D_{t-1} & \text{if } l \text{ is unemployed in } t, \\ w_{l,t} + Bon_{l,t} + Sav^{acc}_{l,t-1} r^D_{t-1}, & \text{if } l \text{ is employed in } t \end{cases} \tag{3.4}$$

where $Sav^{acc}_{l,t-1}$ represents the accumulated savings and r^D_{t-1} the interest rate paid on deposits. Saving is given by deducting consumption and taxes paid from income:

$$Sav_{l,t} = In_{l,t} - Tax_{l,t} - C_{l,t} \tag{3.5}$$

The desired consumption takes into consideration the expected disposable income, past consumption levels and expected inflation. Using an exponential moving average of the last $T_{exp} \in N$ periods, individuals formulate expectations for inflation in order to calculate their expected real disposable income $\widehat{In}^{exp}_{l,t}$. The same exponential moving average is used to evaluate past consumption levels, in conjunction with a "ratchet effect"[3] that imposes a lower bound to consumption reduction in a single period, in order to reach a reference consumption level $\hat{C}^{ref}_{l,t}$ (Ciarli et al., 2019, apud Amendola & Pereira, 2025):

[3] This aims to reflect the idea that "it is harder for a family to reduce its expenditure from a higher level than for a family to refrain from making high expenditures in the first place" presented in Duesenberry (1948, apud Amendola & Pereira, 2025).

$$\widehat{C}_{l,t}^{ref} = \frac{\sum_{\nu=1}^{T_{exp}} (\omega_c)^{v-1} \widehat{C}_{l,t-\nu}^{d}}{\sum_{\nu=1}^{T_{exp}} (\omega_c)^{\nu-1}} \tag{3.6}$$

where $\omega_c \in]0, 1]$ is a decay parameter.

The expected real disposable income and the reference consumption level are weighted by parameters a_c and b_c to give us the individuals' real desired consumption expenditures:

$$\widehat{C}_{l,t}^{d} = max(a_c \widehat{In}_{l,t}^{exp} + b_c \widehat{C}_{l,t}^{ref}, \gamma_c \widehat{C}_{l,t}^{ref}), \quad a_c + b_c \leq 1; \; b_c < \gamma_c < 1 \tag{3.7}$$

where γ_c is a parameter that governs the stickiness to consumption reduction so that an individual can only accept up to $(1 - \gamma_c)$ percent reduction in consumption in a single period.

This formulation leads to consumption slowly following income (Morley, 2007, apud Amendola & Pereira, 2025) and being rigid downward. It also reflects empirical evidence regarding the relevance of current income (Jappelli and Pistaferri, 2010, apud Amendola & Pereira, 2025), marginal propensity to consume (Carrol et al., 2017, Amendola & Pereira, 2025) and internal habits formation (Pollak, 1970; Morley, 2007; Carrol, 2011, apud Amendola & Pereira, 2025).

If the ratchet effect becomes binding to current income individuals might need to rely on previous saving to smooth consumption. As there is no access to credit, an abrupt decrease in income can lead to the desired consumption being unattainable. Hence, in this case desired consumption is given by:

$$C_{l,t}^{d} = \tilde{In}_{l,t} + Sav_{l,t-1}^{acc} \tag{3.8}$$

At last, if desired consumption is satisfied without fully spending disposable income, the unspent amount is saved in the individuals' bank account.

3.3.3 Firms

There are two firm sectors in the model: capital- and consumption-goods. The capital-goods firms produce machine-tools and compete to produce more productive and/or cheaper machinery by processes of innovation and imitation. They send "brochures" of their machines to existing customers and to a number of potential new ones and produce the machines after receiving buying orders. Prices are set using a variable mark-up over costs according to the market share of the firm in the consumption-good firms, while in the capital-goods mark-ups are fixed (Dosi et al., 2019b):

$$p_{i,t} = (1 + \mu_{i,t})c_{i,t} \tag{3.9}$$

Where $\mu_{i,t}$ is the consumption-good firm's mark-up, which is determined by its market share in the previous two periods, and $c_{i,t}$ is the unit cost of production, given by:

$$c_{i,t} = \frac{w_{i,t}}{A_{i,t}} \tag{3.10}$$

It is within these firms that technical change happens in the model, leading to Schumpeterian-style endogenous growth, as they allocate a part of their revenue to R&D in order to innovate or imitate a competitor's innovation in an imperfect information market. This process is governed by the following. Equation (3.11) represents the monetary investment in RD, equation (3.12) denotes the demand for workers devoted to R&D, and equations (3.13) and (3.14) the division between innovation and imitation:

$$RD_{i,t} = \nu S_{i,t-1} \tag{3.11}$$

$$L_{i,t}^{R\&D} = \frac{RD_{i,t}}{w_{i,t}} \tag{3.12}$$

$$IN_{i,t} = \xi RD_{i,t} \tag{3.13}$$

$$IM_{i,t} = (1 - \xi)RD_{i,t} \tag{3.14}$$

Where $\nu \in]0, 1]$, $S_{i,t-1}$ is the firm's sales in the previous period and $\xi \in [0, 1]$ is a parameter to determine the division between the two R&D activities.

Consumption-good firms behave similarly to the capital-good firms regarding the distribution of "brochures" to clients (in this case consumers), costs and price setting. However, they do not conduct R&D and might have their production constrained according to the capital-goods available. These firms produce a homogeneous consumption good by employing the machines bought from the capital-goods firms, according to their expected demand.

The desired amount of production of a consumption-good firm is given by equation (3.15):

$$Q_{j,t}^{d} = (1 + \iota)D_{j,t}^{e} - N_{j,t-1} \tag{3.15}$$

Where $\iota \in \mathbb{R}^{+}$ is a parameter, $D_{j,t}^{e}$ is the expected demand faced by the firm which is formulated by the moving average of demand effectively faced by the firm in the

previous four periods, and $N_{j,t-1}$ is the stock of inventories in the previous period. The firm can, therefore, use goods accumulated as excess production in previous periods. It also aims to keep a certain amount of inventories $N^d_{j,t} = \iota D^e_{j,t}$.

Firms might buy machines on two occasions. First, they might want to invest if their current capital stock is lower than their desired level. As the desired/target capital stock is a linear function of the desired level of production, firms will invest if they desire to expand their production capacity. Second, they might desire to replace old machines with more productive ones, according to a payback rule that weighs the cost of the older and newer vintages of machines. The payback rule is given by:

$$\frac{p^*_{i,t}}{c^{Ai}_{j,t} - c^*_{j,t}} \leq b \tag{3.16}$$

Where $p^*_{i,t}$ is the price of the new machine and the denominator represents the difference of unit costs of production of an old machine $c^{A_i}_{j,t}$ and a new one $c^*_{j,t}$.

3.3.4 Government

The government's revenue Tax_t consists of taxes levied on individuals and firms from the capital-goods Π^1_t, consumption-goods Π^2_t and banking Π^b_t sectors, while its spending G^{spend}_t consists of unemployment benefits G^{trf}_t, interest rates r^{bonds}_t on bonds $Bonds_t$, central bank net results Π^{cb}_t and failing banks bail-outs G^{bail}_t as well as possible discretionary public consumption expenditure G^c_t:

$$Tax_t = tr(\Pi^1_t + \Pi^2_t + \Pi^b_t) + tr_{in} In_{l,t} \tag{3.17}$$

$$G^{spend}_t = G^{trf}_t + r^{bonds}_t Bonds_t + G^{bail}_t + G^c_t - Tax_t - \Pi^c_t b \tag{3.18}$$

Deficits are financed by issuing new bonds which are bought by banks or the central banking in case commercial banks are unable to buy the total amount issued.

Unemployment benefits are calculated by multiplying the average wage across sectors by a constant value and are part of government transfers.

$$G^{trf} = W^{un}_t = \phi \frac{\sum_{L=1}^{L} w_{L,t}}{L_t} \tag{3.19}$$

When consuming goods, the government simply buys them directly from the consumption-good sector. There is no further transformation of the bought goods. Public consumption may display some crowding-out if demand is high. Desired public consumption $G^{c,d}_t$ is given by:

$$G_t^{c,d} = g_0 \; Y_t^{mt} \tag{3.20}$$

where g_0 is the target public consumption-to-GDP ratio, Y_t^{mt} is a medium-term representation of GDP, calculated by regressing the last T_{mt} periods of GDP. The government buys from consumption-good firms based on their market share. This formulation aims to reproduce empirical evidence that i) the public consumption-to-GDP ratio has no clear long-term trend, ii) fluctuates in the short term, and iii) public consumption tends to be slightly procyclical in most countries, though the public consumption-to-GDP ratio displays countercyclical dynamics (Lane, 2003; Lamo et al., 2013 apud Amendola & Pereira, 2025). The result is that public consumption-to-GDP ratio fluctuates around the target value in a countercyclical manner. Effective public consumption G_t^c might be lower than desired due to fiscal rules or due to a lack of supply capacity by firms.

3.4 Variables of interest

The main variable of interest to be analyzed in the model is the volatility of the GDP, since it ultimately translates how stable the economy is during the business cycle. We adopt the variance of GDP growth as its volatility, following previous publications that use this model (Dosi et al., 2017, 2018, 2018b, 2019, 2020).

Other variables related to GDP are the likelihood of crises, recovery from GDP crises and losses from GDP crises. Crises are defined as GDP drops over 3 percent, so that the likelihood of crises is the number of times this has happened divided by the total number of periods. Recovery and loss reflect the amount of GDP lost in crises and the time it takes to overcome them.

The crises and volatility of the GDP cannot be analyzed in isolation, though. In order to be effective a stabilization mechanism needs to reduce GDP volatility without impairing growth, affecting fiscal balance, or creating too much inflation. Thus, GDP growth, government deficit and debt, as well as inflation are also variables of interest.

Since the policies to be evaluated are related to the labor market, the unemployment rate and its volatility are also of interest. By preventing hysteresis from settling in, these policies are expected to affect the unemployment rate over the long run.

Lastly, considering the growing concern with inequality in macroeconomics and the role of heterogeneity in the complexity economics literature the Gini index can also be analyzed. They can also help to understand whether the redistribution channel is playing a relevant role.

3.5 Implementation of policies

In this subsection, we present the modifications to the K+S labour-augmented model (Amendola & Pereira, 2025) in order to implement the policies to be evaluated. Beyond the policy designs, we need to add their triggers and funds. We shall first spell out the policies and then present them using equations.

3.5.1 Triggers

Before presenting the actual policies, it is necessary to lay out the triggers that will determine when they should be deployed in the economy. Recalling the conclusion from Blanchard & Summers (2020) that the unemployment rate is preferable to output variation because output variation could be subject to structural changes in potential GDP, we propose to evaluate each policy with two triggers: unemployment slumps and GDP growth slumps. This should shed light on this question and help us understand whether the chosen variable to the trigger really makes much difference.

A slump can be thought of as a deviation from a recent trend. Therefore, we set a simple rule: whenever the unemployment rate (GDP growth rate) is more than one standard deviation greater (smaller) from its 16 quarters moving average, then there is a slump and the trigger is activated.

The unemployment slump and GDP slump triggers are given by equations (3.21) and (3.22)

$$Trggr_U = \begin{cases} 1 & \text{if } U_{(t-1)} > \bar{U}_{16} + \sigma^U_{16} \\ 0, & \text{otherwise} \end{cases} \tag{3.21}$$

$$Trggr_{GDP} = \begin{cases} 1 & \text{if } gY_{(t-1)} < \bar{gY}_{16} - \sigma^{gY}_{16} \\ 0, & \text{otherwise} \end{cases} \tag{3.22}$$

Where $\bar{U}_{16}$ is the 16-quarter moving average of the unemployment rate and σ^U_{16} is the standard deviation $\bar{U}_{16}$. Similarly, $\bar{gY}_{16}$ is the 16-quarter moving average of the GDP growth rate and σ^{gY}_{16} is its standard deviation.

3.5.2 Direct stimulus payments

The core of the policy proposed by Sahm (2019) is a transfer of a fixed amount sent to the population whenever a recession is imminent. To implement a direct stimulus payments program on the model, some simplifying assumptions are made from the original proposal presented in the first chapter.

First, the trigger is changed since there is not such a thing as a general Sahm Rule, as it is a historical pattern of the U.S. Instead, we adopt triggers based on unemployment or GDP slumps. Second, the program works on a quarter basis. This means that checks can be sent more than once within what would be a year in the model (4 periods) and also that the amount disbursed is calculated based on the GDP of the previous quarter.

Third, the amount disbursed in case of a second or third consecutive stimulus follows a simpler formula, which consists of a full value check if the trigger is being activated for the first or second time in a row, and a half value check if it is the third time in a row. Fourth, there are no additional checks for households with minors since all consumers are workers. Last, we design a rainy-day fund based on Haughwout (2019), since Sahm (2019) does not specify how it should work.

The rainy-day fund is designed as a fraction of government budget that is reserved to the policies, and it works as follows. At each quarter, the government separates a part of its budget to 'transfer' resources into the fund[4] and its value is limited to 2% of GDP, as in equation (3.23):

$$Fund^{trf} = \begin{cases} \varphi^{trf} Y_{t-1} & \text{if } Fund_{t-1} < 0.02\ Y_{t-1} \\ 0, & \text{otherwise} \end{cases} \tag{3.23}$$

where $\varphi^{trf} \in]0, 1]$ is a parameter that governs the percentage of the last quarter's GDP to be destined to the fund. If the fund has reached its cap of 2% of GDP, nothing is transferred. The savings in the fund yield a rate of return equal to the interest rate on bonds. We do this by assuming, based on the sovereign wealth funds literature [5], that the fund is run by a specialized team that invests its resources in stocks and is able to ensure returns equal to the interest rate on bonds.

The fund value is given by subtracting the effective stimulus disbursements from the sum of all transfers from the government and the earnings yielded by the managing team. In equation form:

$$Fund_t = Fund_{t-1}\left(1 + r_{t-1}^{bonds}\right) + \sum_{0}^{t-1} Fund^{trf} - \sum_{0}^{t-1} Disb \tag{3.24}$$

where $Fund$ is the fund balance and $Disb$ is the amount effectively disbursed. Whenever the trigger is activated, the government checks whether the fund has enough resource to execute a round of stimulus and effectively does it so only if it has the financial resources to do so:

[4] The government does not actually transfer its resources into a fund, it just keeps track of how much it would be allowed to spend at each period, if necessary. This is why $Fund^{trf}$ is not in equation (3.18). Instead, the amount spent is registered at G_t^{trf} when the policy is deployed.

[5] See Corneo (2016, 2022).

$$Disb_t^d = \begin{cases} 0 & \text{if } Trggr_t = 0 \\ 0.5\ \varphi^{disb} C_{t-1} & \text{if } Trggr_t = \ Trggr_{t-1} = Trggr_{t-2} = 1 \\ \varphi^{disb} C_{t-1}, & \text{otherwise} \end{cases} \tag{3.25}$$

Where $\varphi^{disb} \in]0, 1]$ is a parameter that determines the size of the stimulus as a percentage of aggregate consumption and $Disb^d$ is the desired disbursement value.

Equation (3.25) states that if the trigger is not active, then the desired stimulus is zero. If it is active in the current period and has not been active for two periods in a row, the full amount of stimulus is desired by the government. If, on the other hand, the current period has the trigger active for the third time in a row, the desired amount to be disbursed is cut by half.

This is a simplifying assumption since Sahm (2019) does not set a limit to consecutive annual payments and proposes a more complicated formula to determine the subsequent stimulus value. This simpler rule is inspired by Haughwout (2019).

At last, the effective disbursement is given by equation (26) that states the rule mentioned above:

$$Disb_t = \begin{cases} Disb_t^d & \text{if } Disb_t^d \leq Fund_t, \\ 0 & \text{otherwise} \end{cases} \tag{3.26}$$

With this policy active, government transfers become:

$$Gtrf_t = W_t^{un} + Disb_t \tag{3.27}$$

For this policy, two scenarios are simulated. As Sahm (2019) proposes a stimulus of approximately 1 percent of personal consumption expenses financed by a rainy-day fund. We simulate this scenario as well as a second where the program is not financially restricted in any way, in order to understand how binding is the budget restriction to a rainy-day fund.

3.5.3 Dynamic unemployment benefit

Implementing a dynamic unemployment benefit in the model is very straightforward. The standard formulation of unemployment benefits of the model (Amendola & Pereira, 2025) is given by a percentage of the average wage $\bar{w}_{t-1}$:

$$w_t^{un} = \varphi^{ub} \bar{w}_t \tag{3.28}$$

where $\varphi \in]0, 1]$ is a parameter determining the percentage of the average wage to be paid as benefit, and it is set to 0.3. We simply add a parameter φ^{bonus} that is also multiplied by the unemployment benefit formulation above so that the amount disbursed can be increased temporarily. Equation (3.28) therefore becomes:

$$w_t^{un} = (\varphi^{ub} + \varphi^{bonus})\bar{w}_t \tag{3.29}$$

And the policy is given by:

$$w_t^{un} = \begin{cases} \varphi^{ub}\bar{w}_t & \text{if } Trggr_t = 0, \\ (\varphi^{ub} + \varphi^{bonus})\bar{w}_t & \text{if } Trggr_t = 1 \end{cases} \tag{3.30}$$

Simulations for the dynamic unemployment benefit policy feature three scenarios. The bonus rate is set to 0.10, 0.15, and 0.20, in order to understand whether this yields somewhat linear results or not. As the baseline unemployment benefit in the model is 30 percent of the average nominal wage, when the policy is active this level will be raised by one-third, half and two-thirds, respectively.

The practical implementation of these scenarios in the model is straightforward. All is done by changing the value attribute to φ^{bonus} in equation (3.29) to the desired policy bonus rate.

3.5.4 Government purchases program

To design a government purchases program, we draw on Haughwout (2019), where an infrastructure investment program to the U.S. is proposed. The program consists of creating a catalog of construction projects for a 5-years horizon and having an annual budget of $2 billion devoted to them; whenever a trigger is activated — in this case, also by the Sahm Rule -– this amount is raised to $10 billion. If the trigger is no longer active the next year, the next four years will have a baseline budget of half the normal amount, or $1 billion. On the other hand, if it is still active, the stimulus should be repeated with a budget of $5 billion and returned to half the baseline after the trigger is no longer active and remain halved for at least four years after the initial stimulus.

We draw on this set of rules to implement a government purchases program. The main reason why it is a public consumption and not an investment program is due to the way the model works. In the model, there are no public capital goods that could promote an increase in private productivity and welfare so that infrastructure investments could be well represented.

Instead of having an annual budget of $2 billion, we set a baseline level of 0.01% of GDP, since that is roughly $2 billion relative to the U.S. GDP in 2019. Also, for technical

simplicity, we rule out the possibility of a third consecutive row of stimulus, so that the third period after the first stimulus will have a funding of half the baseline irrespective of the trigger being active or not. This is described by equation (3.31):

$$PP_t = \begin{cases} \varphi^{disb} Y_{t-1} & \text{if } Trggr_t = 0, \\ 5\ \varphi^{disb} Y_{t-1} & \text{if } Trggr_t = 1 \wedge Trggr_{t-1} = \ Trggr_{t-2} = 0, \\ 2.5\ \varphi^{disb} Y_{t-1} & \text{if } Trggr_t = 1 = \ Trggr_{t-1} = 1 \wedge Trggr_{t-2} = 0, \\ 0.5\ \varphi^{disb} Y_{t-1} \text{otherwise} & \end{cases} \tag{3.31}$$

Where $\varphi^{disb} \in\ ]0, 1]$ is a parameter that determines the size of the package of purchases as a percentage of GDP and PP is the amount spent in the purchases program.

Equation (3.20) which represents the desired public consumption is changed to include the expenses from this program:

$$G_t^{c,d} = g_0 Y_t^{mt} + PP_t \tag{3.32}$$

For this program, again multiple scenarios are featured. Following Haughwout (2019), we simulate the program with a baseline budget of 0.01 percent of GDP. As this is a considerably smaller stimulus in comparison to what is proposed by Sahm (2019), we also simulate two more scenarios, with baseline budgets of 0.5 and 1.0 percent of GDP. This is done by assigning these values to φ^{disb} in equation (3.31).

3.5.5 Discretionary fiscal policy

To simulate a scenario where stabilization policy is led by the discretionary action of governments, we propose the following setting. At any given period, irrespective of the trigger being active or not, there is a chance of the government executing purchases in a somewhat random amount.

The aim of the government is to close the output gap, but as in the real world it is very difficult to measure it precisely, we introduce a parameter to emulate the government's calculation errors. This behavior is modeled by equation (3.33):

$$DFP_t = \begin{cases} \left(1 + \varphi^{fp}\right)\left(Q_t^{max} - Q_t\right) & \text{if } \theta_t > \delta_r\ \wedge\ Trggr_t = 1, \\ \left(1 + \varphi^{fp}\right)\left(Q_t^{max} - Q_t\ \right) & \text{if } \theta_t >\ \delta_w\ \wedge\ Trggr_t = 0, \\ 0 & \text{otherwise} \end{cases} \tag{3.33}$$

Where $\theta_t \backsim U(0, 1)$ and $\delta_r,\ \delta_w \in [0, 1]$ are "false negative" and "true negative" parameters. The interaction between δ and θ_t relates to how good the government is at "doing the right thing", as suggested by Blanchard & Summers (2017, p. 6). By setting δ_r

and δ_w to, for instance, 0.2 and 0.85, respectively, there will be an 80% chance that the government will correctly realize the trigger has been activated and a 15% chance that the government will incorrectly assume the trigger is active. On the other hand, there is a 20% chance that the trigger will be active but the government does not act and an 85% chance that it rightfully assumes there is no need to act since there is no slump.

Moreover, $\varphi^{fp} \backsim N(0, \sigma)$ is the government calculation error parameter, it ultimately determines, via its variance, how accurate the government is at reaching its target of closing the gap. At last, $Q_t^{max} - Q_t$ is the difference between the effective output of consumption-good firms and its maximum capacity.

The parameter settings for this policy simulations aim to reproduce governments with different levels of trustworthiness and accuracy regarding executing such kind of policy. By tweaking the parameters, we present two archetypes of governments: one that is bad, and one that is good at designing a discretionary stimulus.

These take into account two factors: how good the government is at (i) telling whether the economy needs a stimulus or not and (ii) calculating the adequate size of the stimulus. In equation (3.33), φ^{fp} governs the latter while δ_r and δ_w relate to the former.

In the "bad government" scenario, δ_r and δ_w are set to 0.3 and 0.75, respectively, while $\varphi^{fp} \backsim N(0,\ 0.25)$. This means that it correctly detects a trigger activation with a 70 percent chance and mistakenly believes the trigger was activated when it was not with a 25 percent chance. Moreover, even though this government on average is capable of disbursing the correct amount of stimulus to close de GDP gap, it might overshoot or undershoot the stimulus significantly.

For the "good government" scenario, δ_r and δ_w are set to 0.1 and 0.95, respectively, while $\varphi^{fp} \backsim N(0,\ 0.05)$.

3.5.6 Outline of policies

Table 2 sums up each policy scenario. In appendix A, the values of the introduced parameters are also displayed.

The direct stimulus payment program has two sets, one where the policy is restricted to the rainy-day fund (RDF) and one where it is not. The dynamic unemployment benefit program has three sets, in each of them the replacement rate is increased by one-third, a half and two-thirds, respectively. The government purchases program features two sets, where the policy has a baseline budget of 0.5 percent and 1 percent of GDP. At last, discretionary policy also has two sets, representing two types of government, one which is bad at design fiscal policy and one that is good.

Table 2 – Synthesis of scenarios

	Scenarios		
Policy	Set 1	Set 2	Set 3
Direct stimulus payment	Restricted to RDF	Unrestricted	-
Dynamic unemployment benefit	+1/3 rate	+1/2 rate	+2/3 rate
Government purchases program	0.5% GDP	1.0% GDP	-
Discretionary policy	"Bad"	"Good"	-

3.6 Final remarks

This chapter aims to present the methodology and the model used in this thesis. We briefly introduced complexity economics and how agent-based models deal with its paradigms by taking a bottom-up approach and generating emergent properties. Next, we overviewed the general structure of the model and laid out details of three main institutional sectors for our analysis: the labor market and consumers, the two firm's sector, and the government. After that, we displayed the modifications introduced into the model, namely the triggers and the four policy designs. At last, policy settings for these policies were presented.

4 ANALYSIS OF RESULTS

4.1 Introduction

In this chapter, we present the results of every policy simulation in the model. Section 4.2 shows some information regarding the baseline scenario and exhibits overall results through tables where the ratios of the variables of interest to the baseline scenario in every policy setting. Section 4.3 discusses these results and how the they relate to the operation of the model and to the transmission channels of fiscal policy. We also compare policies according to their institutional sector focus, show some of the drawbacks found in the simulation and discuss some links from the findings to empirical studies. Section 4.4 presents some final remarks.

4.2 Overall results

In this subsection, we present the general findings of each policy by comparing median results of the selected variables. Other variables will be presented in the next subsection, where these overall results are discussed. They comprise 300 model periods, equivalent to 75 years time, over 50 Monte Carlo runs.

Results will be laid out in tables that contain in the first column the baseline value for each variable, then the ratio of the given variable in the policy scenario and the p-value associated with them. We will adopt a 5% significance as a standard to define a considerable difference in variables, but we shall still mention whenever a variable is significant at 10%. Next to the ratio values, the number of asterisks represent the p-values of a Mann-Whitney U-test[1] with the null hypothesis of no difference to baseline.

The first section of each table shows results of the simulations using the unemployment rate slumps as trigger while the second relates to the GDP growth slump trigger. In each of the tables, columns will be name as 'sets' according to the parameter settings described in the previous chapter, the same way as presented in Table 2 in the previous chapter.

4.2.1 Baseline scenario

Before getting to the results for each policy, we shall briefly present the baseline scenario. This scenario is similar to some of the competitive scenarios presented in Dosi et

[1] The Mann–Whitney U test is a nonparametric statistical test that shows a difference in medians from two populations with the same distribution. It has a null hypothesis that the distributions are identical.

al. (2018, 2018b) and it was chosen according to its GDP and unemployment behavior.

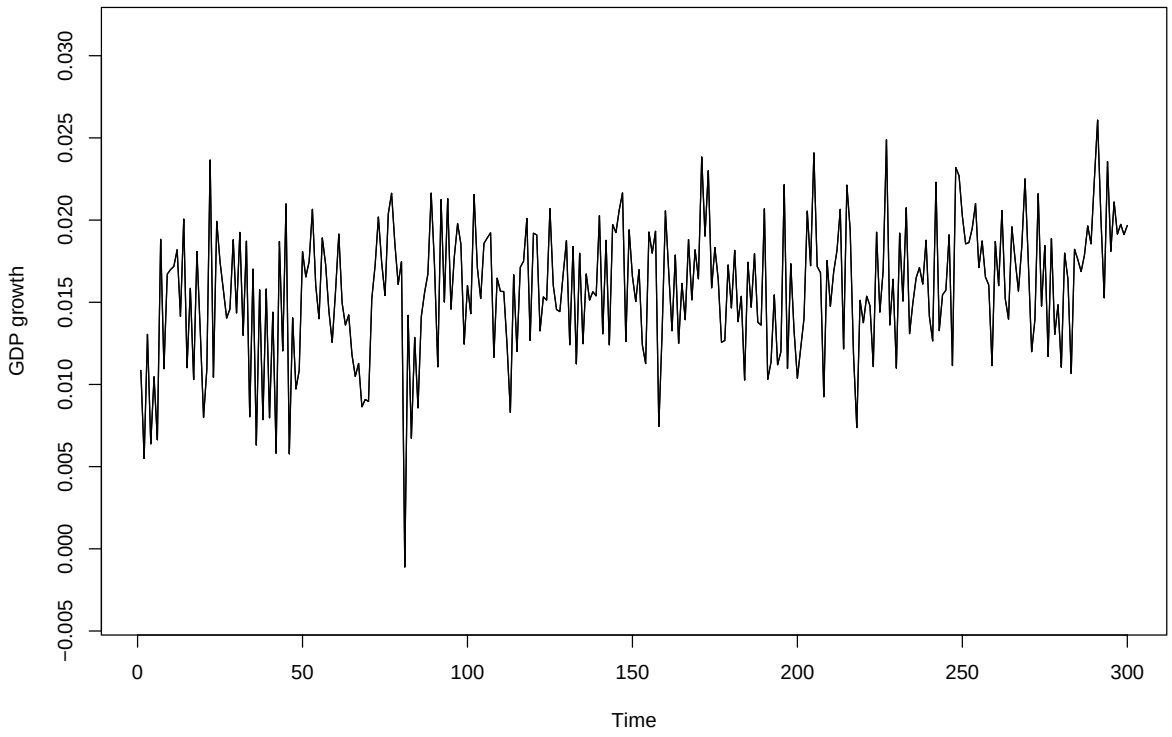
A proper canvas for our analysis is an economy without too much volatility, as stabilization policy is not designed to deal with very steep cycles, but also without too much stability, as a very stable economy would not need these policies and there would be no room for differences to be spotted.

The baseline scenario features a median GDP growth of 1.60 percent, reaching a maximum value of 2.25 percent and a minimum value of 1.14 percent. More important than the GDP growth itself is its standard deviation, which has a median of 5.92 percentage points, but reach up to 20.6 pp and 8.55 pp. Figure 2 shows median GDP growth.

The median unemployment rate is 13.4 percent, which ranges from 3.42 percent to 32.9 and yields a 13.89 pp standard deviation. This high standard deviation is due to the fact that among the 300 periods, there are phases of highs and lows, as can be seen in Figure 3.

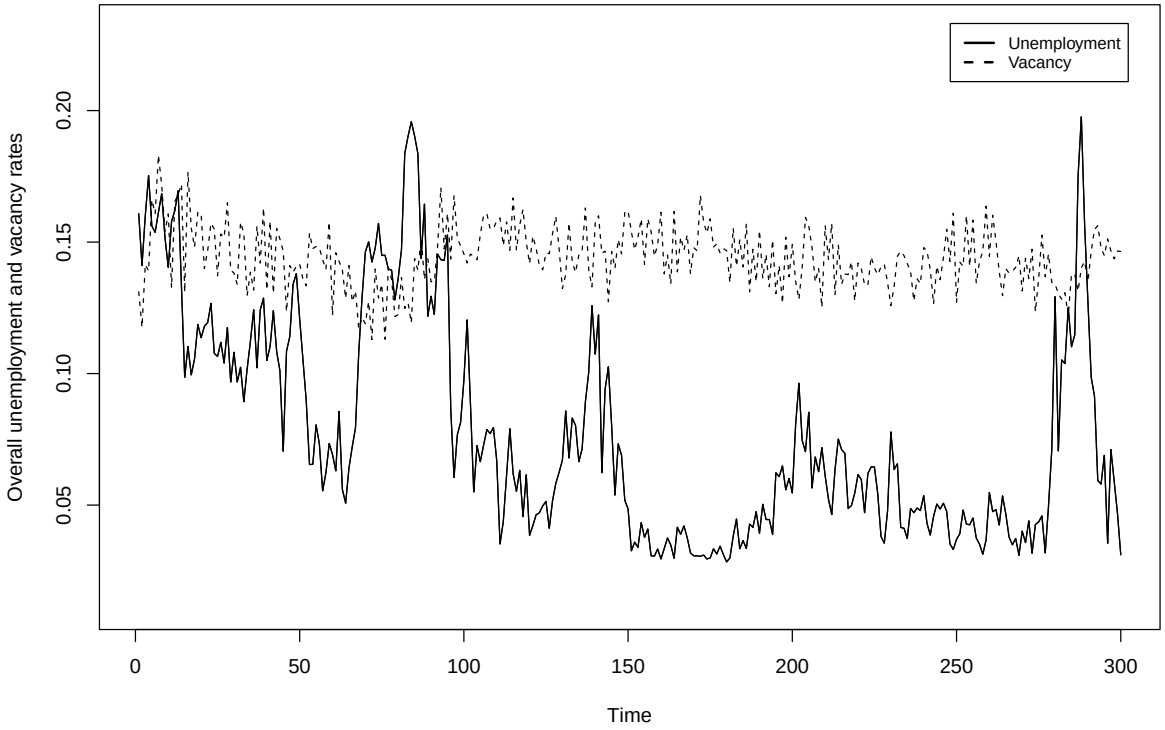
Labor participation (the sum of people employed and looking for a job) varies considerably and is mostly between 80 to 95 percent, as in Figure 4. Other relevant statistics of the baseline scenario are presented along with the experiments results. Also, in Appendix B more details of the baseline scenario are laid out.

Figure 2 – GDP growth in the baseline scenario.



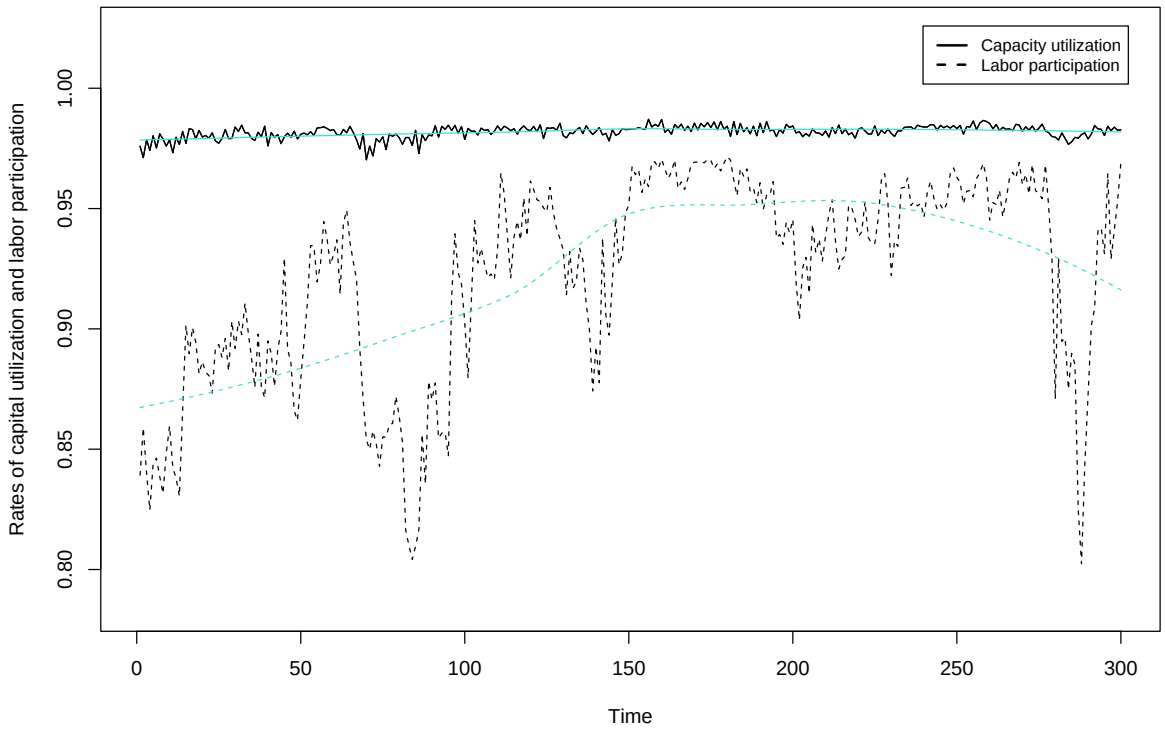
Note: Median of 50 Monte Carlo runs.

Figure 3 – Unemployment and vacancy rates in the baseline scenario.



Note: Median of 50 Monte Carlo runs.

Figure 4 – Capacity utilization and labor participation in the baseline scenario.



Note: Blue: Loess trend. Median of 50 Monte Carlo runs.

4.2.2 Direct stimulus payments program

Results for the direct stimulus payments program are reported in Table 3. As mentioned in the end of the previous chapter, Set 1 represents the scenario where the policy is restricted to a rainy-day fund, while Set 2 has no budget restriction.

Table 3 – Selected variables for the Direct stimulus payments program scenarios.

	Scenarios		
Unemployment slumps trigger	Baseline	Set 1	Set 2
GDP growth rate	0.016	0.969	0.991
Volatility of GDP growth	0.059	1.051	0.932
Likelihood of GDP crises	0.125	1.039	0.829
Recovery from GDP crises	19.60	1.071	0.978
Losses from GDP crises	4.416	0.985	0.683**
Unemployment	0.153	0.993	1.033
Volatility of Unemployment	0.144	1.065	1.019
Capacity utilization	0.968	0.999	1.000
Inflation	0.105%	1.227	1.186
Gini index	0.237	1.013	1.003
Government primary deficit	0.928%	1.210	1.383
Government debt	1.302	1.132	0.988
GDP slumps trigger			
GDP growth rate	0.016	0.974	0.993
Volatility of GDP growth	0.059	0.970	0.937
Likelihood of GDP crises	0.126	0.987	0.868
Recovery from GDP crises	19.60	1.029	0.892*
Losses from GDP crises	4.416	0.814	0.736**
Unemployment rate	0.153	1.096	0.948
Volatility of Unemployment	0.144	1.057	0.919
Capacity utilization	0.968	0.999	1.001
Inflation	0.105%	1.622	1.303
Gini index	0.237	1.029	0.986
Government primary deficit	0.928%	1.469	1.007
Government debt	1.302	1.063	0.862

Note: Comparison of ratios of each scenario to baseline across 50 Monte Carlo runs. *Significant at the 10% level. **Significant at the 5% level. ***Significant at the 1% level.

This policy design revealed to be ineffective in the model. The policy did not generate stabilization as desired in either trigger schemes. Recovery and losses from GDP crises were the only variables related to macroeconomic stabilization that were affected.

Although the policy did not perform as to fulfill its objectives, the results indicate that restraining the payments to the rainy-day fund makes the policy have no effect on the economy whatsoever. Using unemployment slumps as trigger, the policy was able to

reduce losses from GDP crises by around 31 percent to baseline. When the trigger rule was used, losses dropped by roughly 24 percent and the time taken to recover also fell by 11 percent (only significant at 10%).

4.2.3 Dynamic unemployment benefit

Table 4 – Selected variables for the Dynamic unemployment benefit program scenarios.

	Scenarios			
Unemployment slump trigger	Baseline	Set 1	Set 2	Set 3
GDP growth rate	0.016	1.010	1.006	1.006
Volatility of GDP growth	0.059	0.890**	0.909	0.822**
Likelihood of GDP crises	0.126	0.855*	0.895	0.763***
Recovery from GDP crises	19.60	0.734***	0.706***	0.686***
Losses from GDP crises	4.416	0.420***	0.459***	0.340***
Unemployment	0.153	0.735***	0.718***	0.660***
Volatility of Unemployment	0.144	0.721***	0.711***	0.585***
Capacity utilization	0.968	1.005***	1.004***	1.006***
Inflation	0.105%	1.887*	1.894*	2.907***
Gini index	0.237	0.890***	0.865**	0.834***
Government primary deficit	0.928%	0.861	0.721	0.779
Government debt	1.302	0.898	0.783	0.792
GDP slumps trigger				
GDP growth rate	0.016	0.982	1.002	0.984
Volatility of GDP growth	0.059	0.935	0.819**	0.924
Likelihood of GDP crises	0.126	0.816*	0.776**	0.908
Recovery from GDP crises	19.60	1.000	0.849	0.872**
Losses from GDP crises	4.416	0.718**	0.572***	0.497***
Unemployment	0.153	0.841*	0.778***	0.816**
Volatility of Unemployment	0.144	0.875**	0.724***	0.800***
Capacity utilization	0.968	1.001	1.004*	1.002*
Inflation	0.105%	1.703	1.619*	2.183**
Gini index	0.237	0.934*	0.893***	0.922**
Government primary deficit	0.928%	0.664	0.629	0.987
Government debt	1.302	0.822	0.671	0.898

Note: Comparison of ratios of each scenario to baseline across 50 Monte Carlo runs. *Significant at the 10% level. **Significant at the 5% level. ***Significant at the 1% level.

Results for the dynamic unemployment benefit program are reported in Table 4. Sets 1, 2 and 3, represent the scenarios where the replacement rate is increased by one-third, half and two-thirds, respectively.

This policy design was perhaps the most effective in the model. All of the policy settings simulated were capable of decreasing unemployment and its volatility. Also, most

of them showed signs of GDP stabilization.

In the first section of Table 4, where results for the unemployment-based trigger rule are shown, an interesting observation is that Set 2, with an intermediate value, did not reduce volatility of GDP growth, while Set 1 and 3 did. Set 3, where unemployment benefit is raised by two thirds relative to baseline, revealed the best results in terms of stabilization. However, it also generated inflation the most, by 190 percent.

4.2.4 Government purchases program

Results for the government purchases program are reported in Table 5. Sets 1 and 2 represent the policy with a baseline budget of 0.5 and 1.0 percent of GDP, respectively. They point to the fact that this policy design can be effective.

Particularly, it worked in the model when it featured a demand injection similar to the size of the direct stimulus payment program. For both types of triggers, the government purchases program was capable of generating stabilization when it was set to have a budget of 1 percent of GDP with smaller volatility of GDP and likelihood of crisis.[2] Job market also revealed positive results in those settings.

However, there was a small but significant decrease in GDP growth rate when the GDP slumps rule was adopted. This was the only setting throughout all of the tested scenarios where GDP growth was affected. This is detrimental to this policy design, since stabilization came at a cost of slower growth.

Table 5 – Selected variables for Government purchases program scenarios.

	Scenarios		
Unemployment slumps trigger	Baseline	Set 1	Set 2
GDP growth rate	0.016	0.978	0.987
Volatility of GDP growth	0.059	0.908	0.834**
Likelihood of GDP crises	0.126	0.868	0.803**
Recovery from GDP crises	19.60	0.993	0.976
Losses from GDP crises	4.416	0.634**	0.726**
Unemployment	0.153	0.902*	0.743***
Volatility of Unemployment	0.144	0.944	0.874**
Capacity utilization	0.968	1.002*	1.006***
Inflation	0.105%	2.174**	1.937**
Gini index	0.237	0.968	0.912***
Government primary deficit	0.928%	1.325	1.503*
Government debt	1.302	1.091	1.418**

[2] We also tested a scenario where the baseline budget of 0.01 percent of GDP, an amount compatible with the proposal of Haughwout (2019), but it did not result in any difference to baseline.

	Scenarios		
GDP slumps trigger	Baseline	Set 1	Set 2
GDP growth rate	0.016	1.003	0.962**
Volatility of GDP growth	0.059	0.895	0.868***
Likelihood of GDP crises	0.126	0.868	0.803***
Recovery from GDP crises	19.60	0.878	0.469***
Losses from GDP crises	4.416	0.985	0.682**
Unemployment	0.153	0.985	0.682***
Volatility of Unemployment	0.144	1.037	0.779***
Capacity utilization	0.968	1.002*	1.006***
Inflation	0.105%	1.798*	2.675***
Gini index	0.237	0.990	0.874***
Government primary deficit	0.928%	1.654	1.491
Government debt	1.302	1.320*	1.238

Note: Comparison of ratios of each scenario to baseline across 50 Monte Carlo runs. *Significant at the 10% level. **Significant at the 5% level. ***Significant at the 1% level.

4.2.5 Discretionary fiscal policy

Results for the discretionary policy simulations are reported in Table 6. Set 1 is the bad government setting, while Set 2 is the good government setting. In general, they revealed weak effectiveness to stabilize GDP but strong impacts on the job market.

All simulated settings resulted in fewer losses and time taken to recover from GDP, but no difference in volatility of GDP growth was found. The job market showed strong signs of stabilization: the unemployment rate was considerably smaller, dropping by 22 to 39 percent, and volatility also sharply decreased, ranging from 25 to 40 percent smaller than baseline.

An interesting result is that inflation turned out to be significantly higher only in one out of the four simulations. This could suggest that discretionary policy, especially when well made, does not affect inflation substantially.

However, it is necessary to be cautious when making comparisons between governments with good and bad policy design capabilities. The fact that results did not vary considerably between the Set 1 and 2 could also suggest that the specification adopted does not properly capture the difference of capabilities in designing discretionary policy, as economic intuition tells us that a government which is consistently bad at designing policy should, over the long-run, have destabilizing or at least null effects. Therefore, the two hypotheses are possible and this might be an interesting topic for future research.[3]

[3] That is, discussing what makes a government good or bad at designing discretionary fiscal policy, and also whether this set of government skills really matters.

Table 6 – Selected variables for Discretionary fiscal policy scenarios.

	Scenarios		
Unemployment slumps trigger	Baseline	Set 1	Set 2
GDP growth rate	0.016	0.991	1.017
Volatility of GDP growth	0.059	0.924	0.913
Likelihood of GDP crises	0.126	0.816	0.842
Recovery from GDP crises	19.60	0.662***	0.729***
Losses from GDP crises	4.416	0.347***	0.363***
Unemployment	0.153	0.608***	0.690***
Volatility of Unemployment	0.147	0.596***	0.629***
Capacity utilization	0.968	1.007***	1.007***
Inflation	0.105%	2.276***	1.704
Gini index	0.237	0.856***	0.885***
Government primary deficit	0.928%	0.605	0.667
Government debt	1.302	0.741	0.871
GDP slumps trigger			
GDP growth rate	0.016	0.992	1.009
Volatility of GDP growth	0.059	0.988	0.988
Likelihood of GDP crises	0.126	0.855	0.908
Recovery from GDP crises	19.60	0.628***	0.843*
Losses from GDP crises	4.416	0.379***	0.480***
Unemployment	0.153	0.698***	0.783***
Volatility of Unemployment	0.144	0.683***	0.753***
Capacity utilization	0.968	1.005***	1.004***
Inflation	0.105%	1.734	1.858
Gini index	0.237	0.880***	0.923***
Government primary deficit	0.928%	0.946	1.104
Government debt	1.302	0.907	0.911

Note: Comparison of ratios of each scenario to baseline across 50 Monte Carlo runs. *Significant at the 10% level. **Significant at the 5% level. ***Significant at the 1% level.

Another interesting result is that public deficit and debt did not increase. In fact, government income turned out to be higher, generally a small increase, of around 1 percent relative to baseline, yet statistically significant. This is reported in Tables 16 and 17 below.

4.3 Discussion

A high number of variables revealed interesting and consistent behavior across simulations of different policies. We now aim to make sense of them in light of the economic theory and the model operation.

For instance, almost all policies resulted in higher capacity utilization, workers

tenure skills, and inflation. They also led to fewer bad debt and savings in general. This hints some of the ways the policies are affecting GDP growth and the labor market. In this section, we will analyze these variables.

4.3.1 The two model engines

The model features a "Keynesian engine", which is embodied in fiscal policies, and consumption and investment decisions (Dosi et al. 2010). Beyond being the main engine of the model, it is natural to expect stabilization policy to work through a Keynesian route.

It also features a "Schumpeterian engine", embodied by the search and generation of innovations that raise productivity (Dosi et al. 2010). Its effect on demand stabilization might not so clear to see because it is not so obvious, as it does not deal with short-run aggregate demand fluctuations.

They are the best starting points to discuss the findings. First, we will look at the mechanisms within the Keynesian engine, then those within the Schumpeterian engine.

4.3.1.1 The Keynesian engine

Regarding the Keynesian engine, it makes sense to look at savings and consumption. First, we find a drop in savings and in its volatility in almost all scenarios. Figure 5 illustrates this in one of the policy scenarios: current saving (left panel) and accumulated savings (right panel) in the baseline scenario are generally higher and tend to have sharp increases, as the black line on the right is generally above the others and is more shaky. Current saving also seem to rise more and more often in baseline scenario than when the policy is active (left panel). This already relates my findings to precautionary saving and the paradox of thrift. Table 7 presents the results of savings and its volatility with more detail.

A second finding is that the volatility of consumption closely followed the volatility of GDP. Desired consumption in the model is a function of (among other factors) past consumption levels (as reported in equation 3.6 in the previous chapter), which creates a reference level and together with the "ratchet effect" prevents a very steep decrease in consumption from a period to another.

Theory tells us that as these policies kick-in, drops of worker's income are likely to be smaller than they would be if the policy did not exist, and less frequently the lower bound imposed by the "ratchet effect" is hit. This cushioning effect in income declines makes decreases in consumption less sharp on average and help sustain a higher reference consumption level.

However, this does not seem to be the complete story. In some of the scenarios, this is indeed what seems to be happening, but not in all of them (Table 8), which is interesting. Specifically in the case of the dynamic unemployment benefit, the stabilization effect

did not seem to come from a stabilization of income, while in the government purchases program it did. Also, discretionary policy was the best at stabilizing worker's income, yet it did not yield good results in terms of volatility of GDP growth.

Table 7 – Comparison of median of savings and volatility of savings.

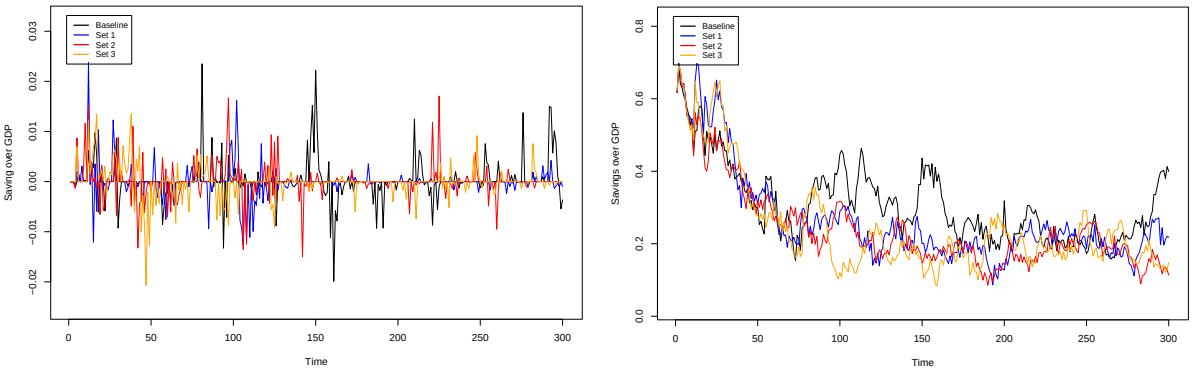
	Scenarios		
Unemployment slumps trigger	Set 1	Set 2	Set 3
Direct stimulus payment program			
Savings	0.9375	0.793^{**}	
Volatility of savings	1.005	0.985	
Dynamic unemployment benefit			
Savings	0.641^{***}	0.549^{***}	0.508^{***}
Volatility of savings	0.853^{***}	0.858^{**}	0.852^{**}
Government purchases program			
Savings	0.685^{**}	0.630^{**}	
Volatility of savings	0.951	0.909^{**}	
Discretionary policy			
Savings	0.512^{***}	0.466^{***}	
Volatility of savings	0.796^{***}	0.767^{***}	
GDP slumps trigger	Set 1	Set 2	Set 3
Direct stimulus payment program			
Savings	0.906	0.869	
Volatility of savings	1.003	1.006	
Dynamic unemployment benefit			
Savings	0.700^{***}	0.614^{***}	0.620^{***}
Volatility of savings	0.946^{*}	0.870^{**}	0.886^{**}
Government purchases program			
Savings	0.786	0.623^{***}	
Volatility of savings	1.003	0.902^{**}	
Discretionary policy			
Savings	0.596^{***}	0.578^{***}	
Volatility of savings	0.839^{***}	0.865^{***}	

Note: Comparison of ratios of each scenario to baseline across 50 Monte Carlo runs. *Significant at the 10% level. **Significant at the 5% level. ***Significant at the 1% level.

Therefore, even though in most cases the stabilization effect comes down to stabilizing consumption, which represents around 85 percent of GDP in the model, it is not always explained by the disposable income channel.

Also, consumption over GDP was found to decrease slightly or to remain unchanged. A smaller consumption level represents lower demand. However, no statistically significant

Figure 5 – Worker savings in the dynamic unemployment benefit program using GDP trigger rule.



Note: Median of 50 Monte Carlo runs.

difference in GDP growth was observed. So it can be deduce that these demand injections were more or less countercyclical – that is, demand is more evenly distributed across the cycle.[4] In fact, in almost all scenarios were savings decreased, losses and time to recover from GDP crises were reduced, even if volatility of GDP did not change, again suggesting that these extra demand stream were mostly acyclical or countercyclical.

Therefore, these policies can be interpreted as mechanisms that in a way or another hinder the effect described by Keynes' paradox of thrift. As aggregate demand is mostly composed of workers consumption, preventing sharp drops in consumption is expected to translate to smaller drops in aggregate output. Indeed, this is what precautionary saving literature points out – perhaps this literature has a little more forward-looking aspect, such as a insurance effect/channel, which is not present in the model, but the existence of a reference level of consumption based on the past is already capable of generating some of the effects presented by this literature.

Stabilization also seems to happen through the redistribution channel. A common result observed was a decrease in the Gini index of all incomes, generally from 10 to 15 percent in comparison to the baseline scenario. As examples, we show two of the most successful scenarios: the dynamic unemployment benefit and the government purchases program with unemployment slumps trigger rule.

Figures 6 and 7 show the trajectory of the Gini in these scenarios. It can be seen that in the baseline scenario the Gini index is persistently higher and also more subject to sharp drops and increases, especially in the case of the Gini index of all incomes, and that

[4] Another way to understand this is the following. If consumption over GDP were to increase, the influence of consumption (a somewhat procyclical variable) on volatility of GDP would also increase. In the opposite case, as found in the simulations, the influence of consumption on volatility of GDP decreased, so that it needs to be less procyclical in order to contribute to GDP stabilization. This suggests that the demand injections from the policies are countercyclical and make consumption less procyclical.

Table 8 – Comparison of median of volatility of consumption and volatility of worker's income over GDP.

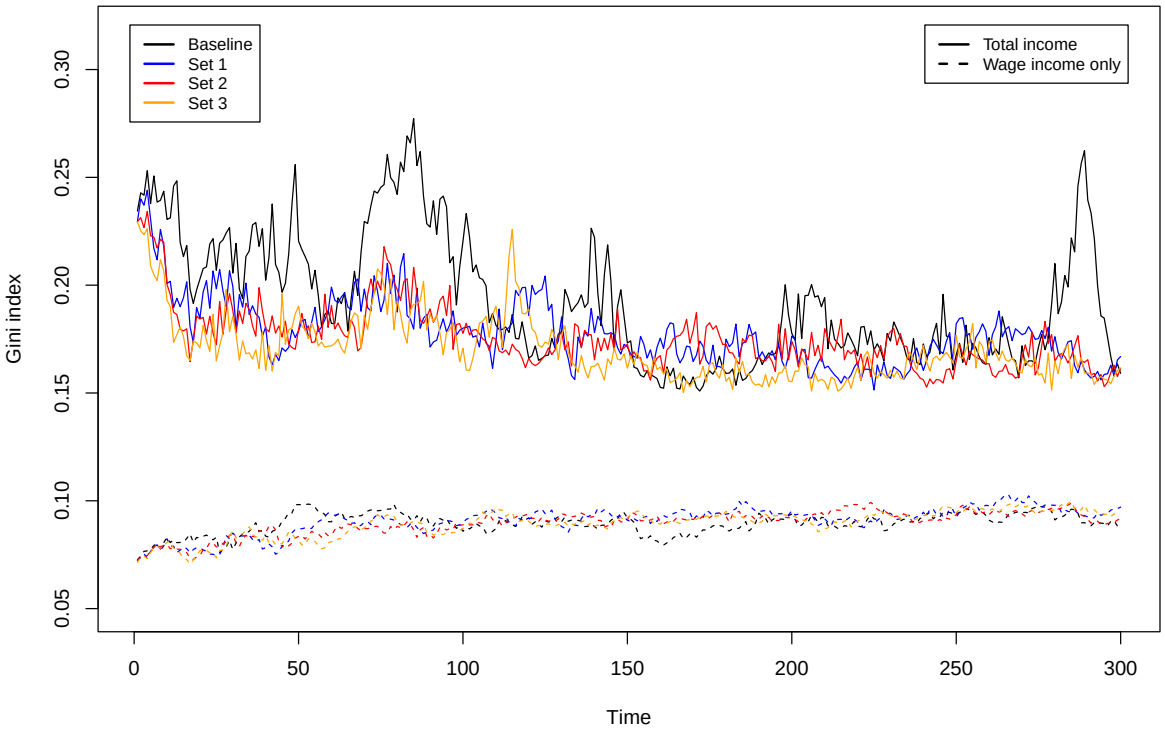
	Scenarios		
Unemployment slumps trigger	Set 1	Set 2	Set 3
Direct stimulus payment program			
Volatility of consumption	1.033	0.930**	
Volatility of worker's income over GDP	1.097	0.998	
Dynamic unemployment benefit			
Volatility of consumption	0.914**	0.896**	0.845***
Volatility of worker's income over GDP	0.950*	1.034	0.970
Government purchases program			
Volatility of consumption	0.913*	0.893***	
Volatility of worker's income over GDP	0.938***	0.882***	
Discretionary policy			
Volatility of consumption	0.877***	0.887***	
Volatility of worker's income over GDP	0.743***	0.773***	
GDP slumps trigger	Set 1	Set 2	Set 3
Direct stimulus payment program			
Volatility of consumption	0.982	0.946	
Volatility of worker's income over GDP	1.009	0.969	
Dynamic unemployment benefit			
Volatility of consumption	0.953	0.889*	0.947
Volatility of worker's income over GDP	1.028	0.922***	0.973***
Government purchases program			
Volatility of consumption	0.938*	0.869***	
Volatility of worker's income over GDP	0.961**	0.873***	
Discretionary policy			
Volatility of consumption	0.936*	0.938	
Volatility of worker's income over GDP	0.841***	0.841***	

Note: Comparison of ratios of each scenario to baseline across 50 Monte Carlo runs. *Significant at the 10% level. **Significant at the 5% level. ***Significant at the 1% level.

propensity to consume. Even in scenarios where GDP volatility did not decrease (Set 2 of Figure 6 and Set 1 of Figure 7), the Gini index is still considerably smaller and more stable. This is likely a consequence of smaller unemployment and more stability in the labor market. Table 9 lays out the Gini results in detail.

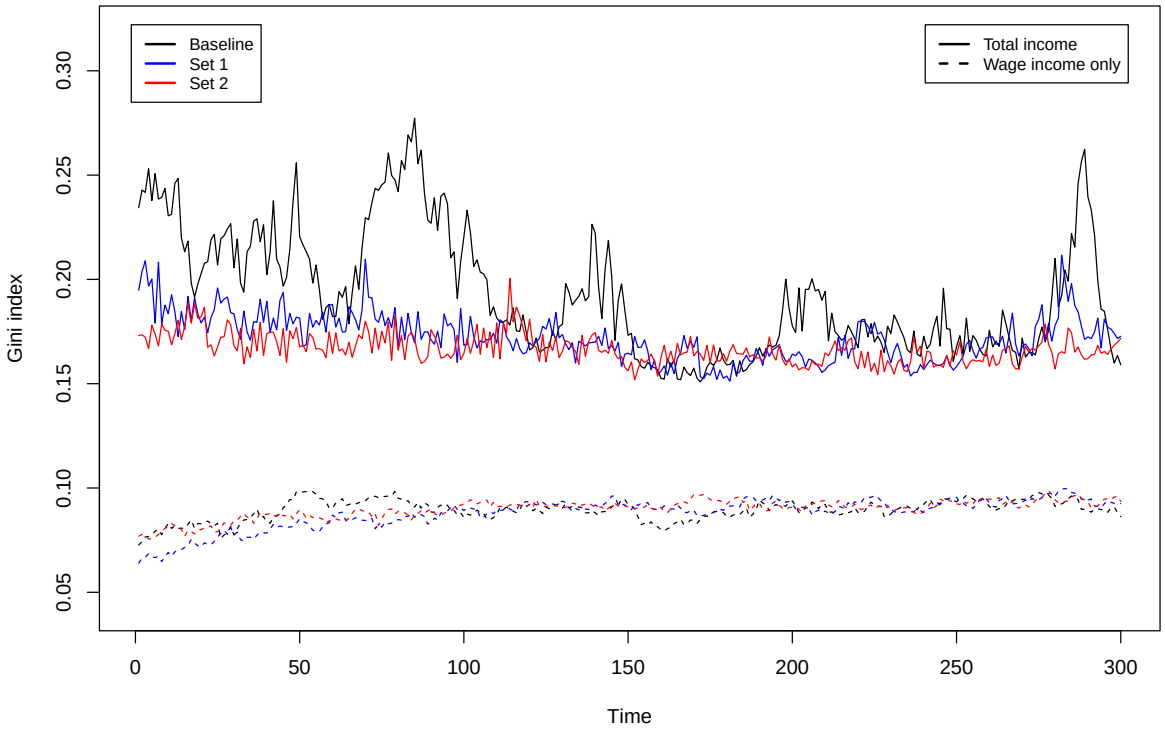
As more income is distributed towards lower percentiles, where individuals have higher marginal propensity to consume, aggregate consumption rises and becomes more stable. Boxplots of propensity to consume in these scenarios suggest that indeed more income were distributed towards lower percentiles (Figure 8).

Figure 6 – Gini index in the dynamic unemployment benefit program using unemployment trigger rule.



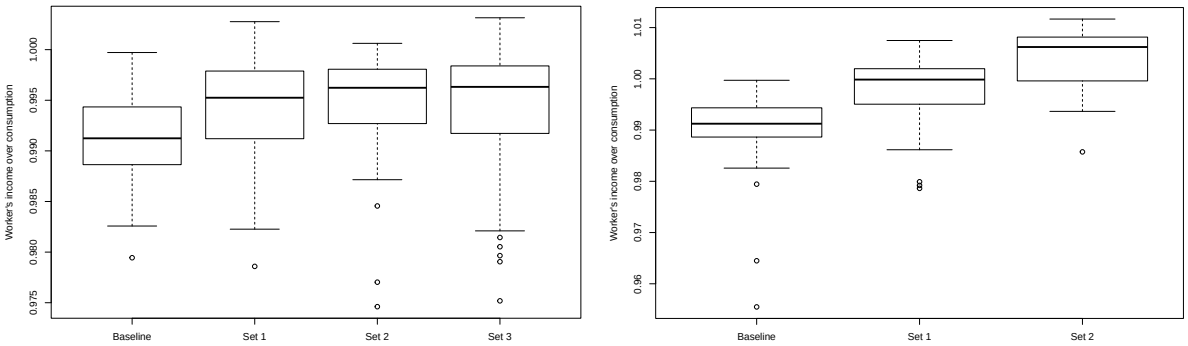
Note: Median of 50 Monte Carlo runs.

Figure 7 – Gini index in the government purchases program using unemployment slumps trigger rule.



Note: Median of 50 Monte Carlo runs.

Figure 8 – Boxplots of propensity to consume in selected scenarios.



Note: Dynamic unemployment benefit program on the left and government purchases program on the right, both with unemployment slumps trigger rule. Median of 50 Monte Carlo runs.

Table 9 – Comparison of median Gini index of all incomes.

	Scenarios		
Unemployment slumps trigger	Set 1	Set 2	Set 3
Direct stimulus payment program	1.013	1.003	
Dynamic unemployment benefit	0.890^{***}	0.865^{***}	0.834^{***}
Government purchases program	0.968	0.912^{***}	
Discretionary policy	0.856^{***}	0.885^{***}	
GDP slumps trigger	Set 1	Set 2	Set 3
Direct stimulus payment program	1.029	0.986	
Dynamic unemployment benefit	0.891^{***}	0.849^{***}	0.922^{**}
Government purchases program	0.990	0.874^{***}	
Discretionary policy	0.880^{***}	0.923^{***}	

Note: Comparison of ratios of each scenario to baseline across 50 Monte Carlo runs. *Significant at the 10% level. **Significant at the 5% level. ***Significant at the 1% level.

During an economic downturn, when firms need to fire workers, they do so by choosing workers with higher skills-to-wage payback ratio. As less skilled workers on average receive smaller wages, they might be the most affected by layoffs. When a policy like the dynamic unemployment benefit is implemented, more income is directed to the unemployed – who are likely to have greater marginal propensity to consume – generating more aggregate consumption and demand – or at least minimizing their decrease.

When a worker is fired, they first keep their requested wage unchanged and then reduce it for every period that they are unable to find a job. This is a source of inequality in the model. Policies focused on firms grant them some level of demand for their products, reducing potential necessities to fire workers. Thus, these policies also result in a more equal distribution of income.

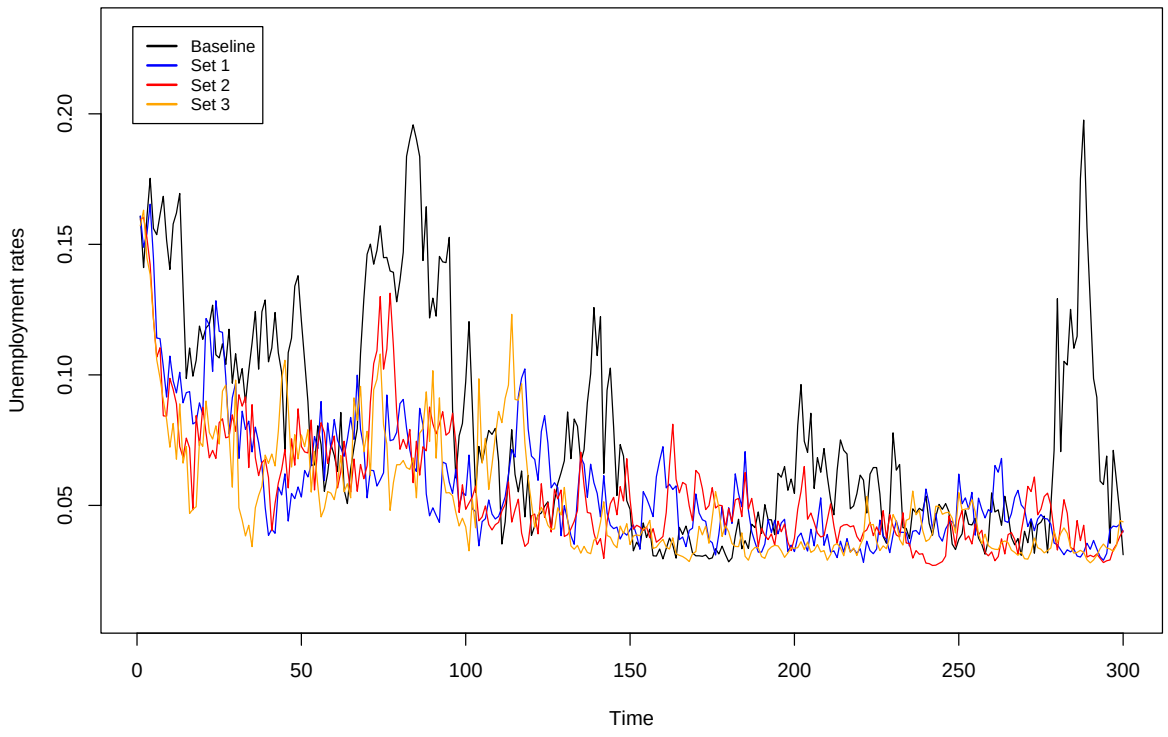
Indeed, for every single simulation where unemployment was reduced, so was the Gini index. This suggests that the redistribution channel takes place not only directly through government transfers, but also through the labor market.

Stabilization in the labor market is revealed by worker tenure and workers tenure skills. The former reflects the time spent on average in a single job position, while the latter relates to the skills accumulated while being employed. Most policies resulted in higher tenure, and, specially, more skills (Tables 10 and 11), suggesting a more stable labor market as workers are fired or quit jobs less often.

Figures 9, 10 and 11 illustrate the labor market stabilization. The first two of them show the median unemployment rate across the 300 periods in two of the most successful scenarios. Again, similarly to the behavior observed in the case of the Gini index, in the baseline scenario unemployment is persistently higher and more turbulent than when policies are active. Specifically in the case of Set 2 of the government purchases program with GDP slumps trigger (Figure 10), the unemployment rate was very strongly stabilized.

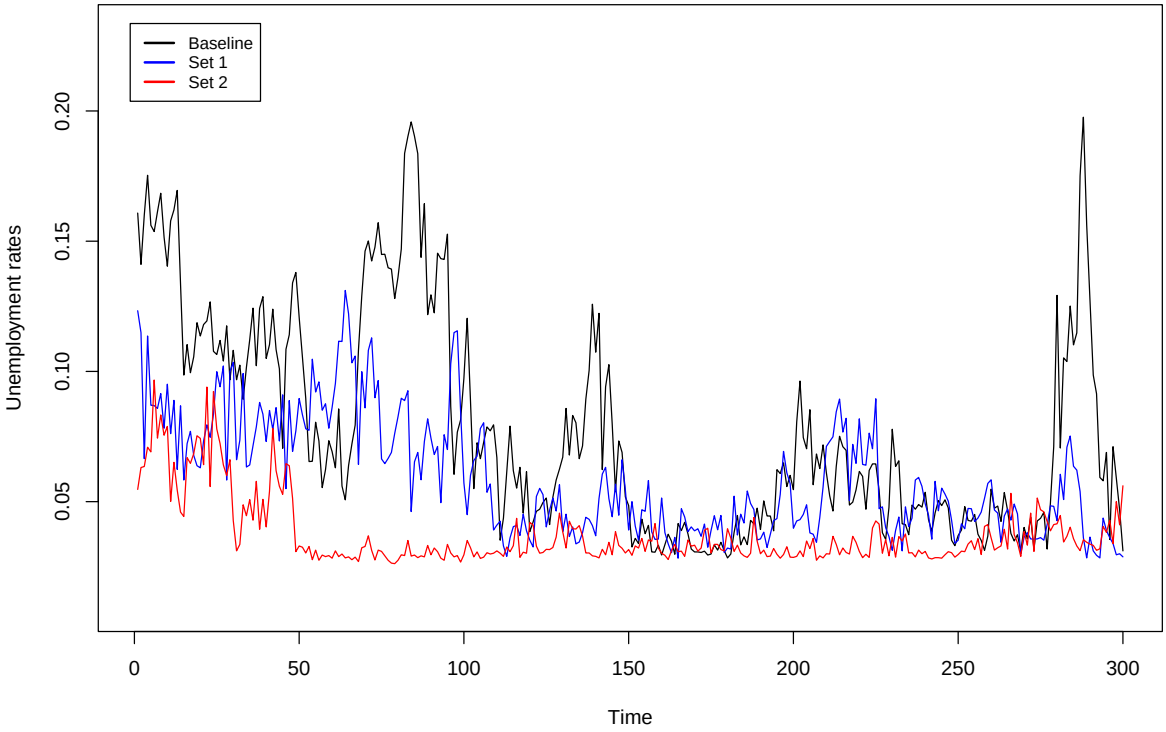
Set 1 of Figure 11 shows a scenario where the median volatility of unemployment did not drop in a statistically significant way. Yet, on a graphical analysis, it can be seen that during a time span, the unemployment rate was considerably less turbulent, namely from around period 100 to period 270. The difference in medians was not significant likely due to the behavior of unemployment during the beginning and finishing stretches.

Figure 9 – Unemployment rate in the dynamic unemployment program using unemployment slumps trigger rule.



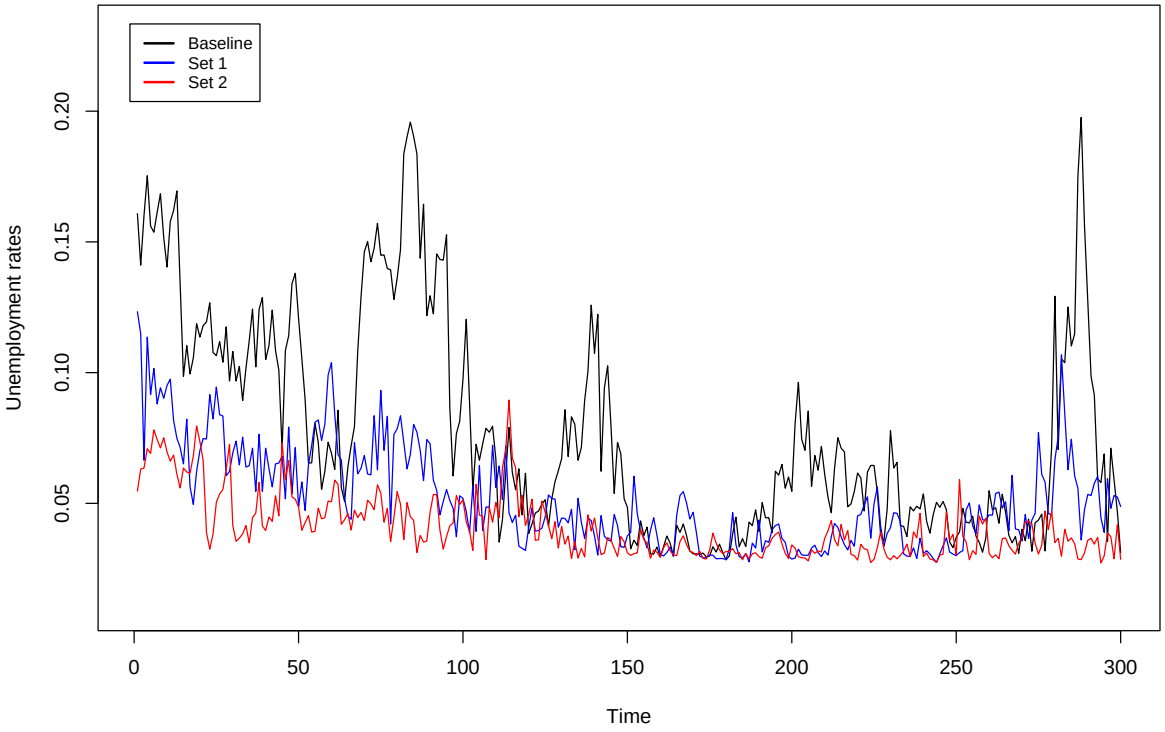
Note: Median of 50 Monte Carlo runs.

Figure 10 – Unemployment rate in the government purchases program using GDP slumps trigger rule.



Note: Median of 50 Monte Carlo runs.

Figure 11 – Unemployment rate in the government purchases program using unemployment slumps trigger rule.



Note: Median of 50 Monte Carlo runs.

Table 10 – Comparison of median worker tenure.

	Scenarios		
Unemployment slumps trigger	Set 1	Set 2	Set 3
Direct stimulus payment program	0.991	0.987	
Dynamic unemployment benefit	1.033	1.060	1.060^{***}
Government purchases program	1.022	1.027	
Discretionary policy	1.083^{***}	1.072^{***}	
GDP slumps trigger			
Direct stimulus payment program	0.978	1.011	
Dynamic unemployment benefit	1.011	1.059^{*}	1.041^{**}
Government purchases program	0.958	1.038^{**}	
Discretionary policy	1.039^{*}	1.039	

Note: Comparison of ratios of each scenario to baseline across 50 Monte Carlo runs. *Significant at the 10% level. **Significant at the 5% level. ***Significant at the 1% level.

Also relevant to the policies focused on firms are the investment decisions. This is the link between the Keynesian and Schumpeterian engines.

4.3.1.2 The Schumpeterian engine

Stabilization policy can also work through the Schumpeterian engine, although this might not be so obvious at first. Periods of slow or negative growth in aggregate demand lead to less sales and financial hardship for firms. This, in turn, means less resources dedicated to research & development (in the form of innovation and imitation). A slower technical progress and diffusion translates into a slow down in investment in machines - buying new, more productive ones, or replacing old ones.

This is were the link between the Keynesian and Schumpeterian engines is. Avoiding strong and long lasting demand shortfalls prevents the economy from getting into this vicious cycle.

As mentioned before, an increase in workers tenure skills was observed in many scenarios (Table 11). Although this is a variable that contributes to firms productivity, this increase did not seem enough to make a difference in productivity growth.

No policies resulted in more innovation or imitation. As innovation happens in the capital-goods firms and the policies affect more directly consumption-good firms, one could expect that a very big increase in demand would be necessary to spill-over into innovation. At first, one could think this could be the case of the government purchases program where government consumption increased by up to 25 times, as will be shown below. But even in this case, this did not happen.

Table 11 – Comparison of median worker tenure skills.

	Scenarios		
Unemployment slumps trigger	Set 1	Set 2	Set 3
Direct stimulus payment program	0.992	1.007	
Dynamic unemployment benefit	1.031***	1.032***	1.044***
Government purchases program	1.026**	1.040***	
Discretionary policy	1.054***	1.041***	
GDP slumps trigger			
Direct stimulus payment program	0.997	1.013	
Dynamic unemployment benefit	1.016*	1.033**	1.023**
Government purchases program	1.012*	1.044***	
Discretionary policy	1.036***	1.030***	

Note: Comparison of ratios of each scenario to baseline across 50 Monte Carlo runs. *Significant at the 10% level. **Significant at the 5% level. ***Significant at the 1% level.

Surprisingly, some of the policies actually negatively affected these activities. Innovation usually shrunk by 1 to 2 percent (Table 12). Specifically in the case of the government purchases program, a higher market share concentration in the capital-goods sector was a common finding, suggesting this policy had detrimental effects on competition by benefiting big, well established firms. In the real world, this should deserve attention by the policymaker.

Table 12 – Comparison of median innovation.

	Scenarios		
Unemployment slumps trigger	Set 1	Set 2	Set 3
Direct stimulus payment program	0.996	0.984*	
Dynamic unemployment benefit	0.967	0.981*	0.962***
Government purchases program	0.988*	0.984*	
Discretionary policy	0.991	1.000	
GDP slumps trigger			
Direct stimulus payment program	0.989	0.980	
Dynamic unemployment benefit	0.988	0.984	0.987
Government purchases program	0.975**	0.982	
Discretionary policy	0.998	0.987	

Note: Comparison of ratios of each scenario to baseline across 50 Monte Carlo runs. *Significant at the 10% level. **Significant at the 5% level. ***Significant at the 1% level.

Moreover, another consistent result was decrease in bad debt. This suggests less firms failure taking place and some kind of stabilization in the business sector (Table 13).

Table 13 – Comparison of median bad debt.

	Scenarios		
Unemployment slumps trigger	Set 1	Set 2	Set 3
Direct stimulus payment program	1.000	1.001	
Dynamic unemployment benefit	0.893**	0.878***	0.863***
Government purchases program	0.912*	0.858**	
Discretionary policy	0.899**	0.914*	
GDP slumps trigger			
Direct stimulus payment program	1.016	1.040	
Dynamic unemployment benefit	0.939*	0.877***	0.915***
Government purchases program	0.917	0.813	
Discretionary policy	0.923**	0.936*	

Note: Comparison of ratios of each scenario to baseline across 50 Monte Carlo runs. *Significant at the 10% level. **Significant at the 5% level. ***Significant at the 1% level.

It seems, therefore, like mixed forces acted on the Schumpeterian engine, resulting in a slightly negative effect. This did not compromise the stabilization effects of the policies, likely because, as Dosi et al., (2010) points out, it is the Keynesian engine that is powerful to generate demand and regulate growth and unemployment levels.

4.3.2 Comparing policies' performances

Looking at the results obtained, two interesting questions arise. Why did the dynamic unemployment benefit work and the direct stimulus payment did not? Why discretionary policy only worked to stabilize the labor market, while the government purchases program managed to stabilize GDP growth as well?

We aim to investigate the findings in order to try to investigate the reasons for these results. We will try to answer these questions in this order.

4.3.2.1 Dynamic unemployment benefit work vs. direct stimulus payment

To compare these policies, it makes sense to look at government transfers to try to understand if any pattern that could explain the difference in effectiveness has appeared. In Table 14, we present government transfers over GDP comparative to baseline.

An interesting finding is that the dynamic unemployment benefit reduced the median of governments transfers over GDP. However, none of the policies resulted in a statistically significant change to the baseline scenario, so it is not a relevant fact to explain their differences.

This decrease in government transfers over GDP could be explained by the fact

Table 14 – Comparison of median government transfers over GDP.

	Scenarios		
Unemployment slumps trigger	Set 1	Set 2	Set 3
Direct stimulus payment program	1.058	1.103	
Dynamic unemployment benefit	0.936	0.914	0.952
GDP slumps trigger			
Direct stimulus payment program	1.153	0.998	
Dynamic unemployment benefit	0.904	0.884	0.992

Note: Comparison of ratios of each scenario to baseline across 50 Monte Carlo runs. *Significant at the 10% level. **Significant at the 5% level. ***Significant at the 1% level.

that the dynamic unemployment benefit scenarios also resulted in higher GDP growth comparative to the direct stimulus scenarios, as in Table 3. But, again, these differences in GDP growth are not statistically significant.

Aggregate demand boosts were similar on both policies. So, somehow one of them was more efficient than the other. We believe the explanation lies in the precision of demand injection of each policy design. As the direct stimulus payment program works with a fixed amount, it sometimes might result in too small or too big of a stimulus, while the dynamic unemployment benefit leads to more proportional responses. The redistribution channel also might have played a role, as raising unemployment benefit payments benefits people with higher propensity to consume the most.

Therefore, the answer to the first question asked in the beginning of this section is probably related to the fact that the dynamic unemployment benefit is better at targeting people with higher propensity to consume out of the transfer. The fact that Gini index was not reduced in the direct stimulus payment program also suggests this. Another reason why the dynamic unemployment benefit worked while direct stimulus payment program did not is that, due its contingent design, it reacts more proportionally to the downturn, well cushioning small fluctuations and avoiding possible destabilizing overshoots.

4.3.2.2 Government purchases program vs. discretionary policy

Now, it makes sense to look at government consumption to try to understand the different outcomes of these two policies. As reported in Table 15, the policies led to different levels of government consumption.

All policies led to significantly higher government consumption levels, but only Set 2 of the government purchases program (the one with 1 percent GDP as baseline budget) managed to stabilize GDP growth, as reported in the previous section. This suggests that the answer lies in the difference in size of the purchases in each policy/scenario.

Table 15 – Comparison of median government consumption over GDP.

	Scenarios	
Unemployment slumps trigger	Set 1	Set 2
Government purchases program	12.72***	24.73***
Discretionary policy	18.07***	17.27***
GDP slumps trigger		
Government purchases program	13.55***	26.74***
Discretionary policy	17.06***	14.47***

Note: Comparison of ratios of each scenario to baseline across 50 Monte Carlo runs. *Significant at the 10% level. **Significant at the 5% level. ***Significant at the 1% level.

Indeed, in the government purchases program scenarios, the lower quartile of government consumption over GDP across simulations was higher than the upper quartile of the discretionary policy scenarios.

4.3.3 Fiscal stance

Perhaps surprisingly, no relevant fiscal drawbacks were found. In general, the policies did not increase government primary deficit or debt, even though median GDP growth did not increase. These drawbacks were present only in the government purchases program. Set 2 in particular was a setting that led to GDP stabilization but also resulted in detrimental fiscal effects.

Table 16 – Comparison of median government primary deficit.

	Scenarios		
Unemployment slumps trigger	Set 1	Set 2	Set 3
Direct stimulus payment program	1.210	1.383	
Dynamic unemployment benefit	0.861	0.721	0.779
Government purchases program	1.325	1.503*	
Discretionary policy	0.605	0.666	
GDP slumps trigger			
Direct stimulus payment program	1.469	1.007	
Dynamic unemployment benefit	0.664	0.629	0.987
Government purchases program	1.654	1.491	
Discretionary policy	0.946	1.104	

Note: Comparison of ratios of each scenario to baseline across 50 Monte Carlo runs. *Significant at the 10% level. **Significant at the 5% level. ***Significant at the 1% level.

Table 17 – Comparison of median government debt.

	Scenarios		
Unemployment slumps trigger	Set 1	Set 2	Set 3
Direct stimulus payment program	1.132	0.988	
Dynamic unemployment benefit	0.898	0.783	0.792
Government purchases program	1.091	1.418**	
Discretionary policy	0.741	0.871	
GDP slumps trigger			
Direct stimulus payment program	1.063	0.862	
Dynamic unemployment benefit	0.822	0.671	0.898
Government purchases program	1.320*	1.238	
Discretionary policy	0.907	0.911	

Note: Comparison of ratios of each scenario to baseline across 50 Monte Carlo runs. *Significant at the 10% level. **Significant at the 5% level. ***Significant at the 1% level.

4.3.4 Drawbacks

The main drawback found was inflation. No policy was capable of generating GDP stabilization without a surge in inflation. The most two effective policies reached up to 168 percent and 191 percent increase in inflation from the baseline scenario.

The only scenarios that did not result in higher inflation were the ones that did not achieve any kind of stabilization, while some generated inflation without generating any stabilization. It is important, however, to mention that baseline inflation is extremely low, so that a two-fold increase is still a small difference in percentage points.

4.3.5 Comparing triggers

As a general result, the choice of trigger design did not seem to be very relevant to the policies' performance, as changing the trigger did not change considerably the stabilization results in general. One could expect the unemployment rate slumps to lead to higher labor market stabilization and the GDP growth slumps to lead to higher GDP stabilization as the policies would be deployed according to GDP growth dynamics, but this was not found.

The change of trigger design yielded interesting results particularly in the case of the dynamic unemployment benefit. As reported in Table 3, Set 2 of unemployment slumps trigger, with an intermediate value, did not reduce volatility of GDP growth, while Set 1 and 3 did. On the other hand, when the trigger was based on GDP growth slumps, only Set 2 generated a significant reduction in volatility of GDP. These results are unexpected and hard to make sense of.

The fact that only the intermediate value setting led to less volatility could be explained using economic intuition: too little of a stimulus might not make any difference, while an excessively large stimulus can also hinder the stabilization effect. Indeed, as shown above, savings, volatility of savings and volatility of consumption showed better results in terms of stabilization for Set 2 of GDP slumps trigger.

Yet, this explanation could be challenged by the results observed when the trigger followed the unemployment rate. In this case, we could attribute these results to poor statistical power of the U-test. Even though we have adopted a number of Monte Carlo runs similar to most publications using K+S models (Dosi et al., 2017; 2018; 2018b; 2019; 2019b; Amendola & Pereira, 2025) and a larger number of periods, it is possible that this is not enough to perfectly evaluate the effects of this policy.

4.4 Summary of results

Table 18 presents the key findings of the simulations. Only variables relating to economic stabilization are shown. Signs point whether variables statistically significantly increased, decreased or did not change.

4.5 Links to empirical studies

In this section, we aim to briefly discuss the two most effective policies: the dynamic unemployment benefit and the government purchases program.

It is interesting to relate the dynamic unemployment benefit to the Federal Pandemic Unemployment Compensation (FPUC) implemented in the U.S. as part of the CARES Act during the Covid-19 pandemic. This program provided an additional financial benefit of $600 to unemployed workers receiving unemployment benefit. This is, thus, somewhat close to the dynamic unemployment benefit implemented in the model.

Studies show the FPUC resulted in small disincentives on job search although it was a large increase in replacement rates (Petrosky-Nadeau & Valletta, 2024; Marinescu et al., 2021). The economic rationale for this is that while more generous unemployment benefit might increase labor market tightness, they are implemented in periods of unusually low tightness.

As Marinescu et al. (2021) argue, the FPUC decreased the cost of unemployment for those who lost a job without a considerable increase in recruitment difficulties for employers. During the pandemic, firms were receiving a very high number of applications comparative to vacancy, so that a decrease in applications due to the raised replacement rate had small detrimental impacts on the number of workers hired.

Table 18 – Summary of results.

Variables	Unemployment trigger			GDP growth trigger		
Direct stimulus payments	Set 1	Set 2	Set 3	Set 1	Set 2	Set 3
Volatility of GDP growth	-	-		-	-	
Likelihood of GDP crises	-	-		-	-	
Recovery from GDP crises	-	-		-		↓ *
Losses from GDP crises	-	↓ **		-	↓ **	
Unemployment	-	-		-	-	
Volatility of Unemployment	-	-		-	-	
Dynamic unemployment benefit	Set 1	Set 2	Set 3	Set 1	Set 2	Set 3
Volatility of GDP growth	↓ **	-	↓ **	-	↓ **	-
Likelihood of GDP crises	↓ *	-	↓ ***	↓ *	↓ **	
Recovery from GDP crises	↓ ***	↓ ***	↓ ***	-	-	↓ **
Losses from GDP crises	↓ ***	↓ ***	↓ ***	↓ **	↓ ***	↓ ***
Unemployment	↓ ***	↓ ***	↓ ***	↓ *	↓ ***	↓ **
Volatility of Unemployment	↓ ***	↓ ***	↓ ***	↓ **	↓ ***	↓ ***
Government purchases program	Set 1	Set 2	Set 3	Set 1	Set 2	Set 3
Volatility of GDP growth	-	↓ **		-	↓ ***	
Likelihood of GDP crises	-	↓ **		-	↓ ***	
Recovery from GDP crises	-	-		-	↓ ***	
Losses from GDP crises	↓ **	↓ **		-	↓ **	
Unemployment	↓ *	↓ ***		-	↓ ***	
Volatility of Unemployment	-	↓ ***		-	↓ ***	
Discretionary policy	Set 1	Set 2	Set 3	Set 1	Set 2	Set 3
Volatility of GDP growth	-	-		-	-	
Likelihood of GDP crises	-	-		-	-	
Recovery from GDP crises	↓ ***	↓ ***		↓ ***	↓ *	
Losses from GDP crises	↓ ***	↓ ***		↓ ***	↓ ***	
Unemployment	↓ ***	↓ ***		↓ ***	↓ ***	
Volatility of Unemployment	↓ ***	↓ ***		↓ ***	↓ ***	

Note: Dashes represent no change and blank cells mean policy does not feature a third set. Comparison of ratios of each scenario to baseline across 50 Monte Carlo runs. *Significant at the 10% level. **Significant at the 5% level. ***Significant at the 1% level.

Therefore, increasing unemployment insurance when tightness in inefficiently low improves welfare (Landais et al. 2018). Moreover, this supplement in unemployment benefit greatly boosts consumption, which also helps to minimize the potential side-effects on the labor market.

Indeed, Ganong et al. (2021) find that the FPUC played an important role on the aggregate spending dynamics, but not on employment dynamics. A similar conclusion is reached by Dube (2021), who also claim that the costs of providing higher benefit levels

during deep downturns might be small. Both suggest that a raise in unemployment benefit rate during economic downturns could be made permanent. This is precisely what our simulation results point to.

However, this policy is in no way a panacea to stabilization policy. The desired behavior of a dynamic unemployment benefit bumps into a possible obstacle. This policy design might be ineffective or even destabilizing in developing countries, as unemployment benefit claims frequently present a pro-cyclical behavior (Gerard et al., 2024).

Regarding the government purchases program, our results are in line with the CBO's estimated impact of the fiscal policy after 2009. Their report displays the purchase of goods and services by the federal government to have had the higher output multiplier across all policies of the American Recovery and Reinvestment Act of 2009 (CBO, 2012).

The results also relate to the findings of the meta-analysis conducted by Heimberger (2023). First, he finds that fiscal policy is, on average, countercyclical in advanced countries, although government spending is less countercyclical than the overall fiscal deficit. Considering that the program raised the government consumption considerably to baseline (by around 25 times), and that purchases are made during downturns, it very likely increased procyclicality of spending. Another finding by Heimberger (2023) is that zooming in on discretionary fiscal action consistently makes the multiplier estimates lean more towards procyclicality. This is in line with the results from the discretionary policy settings, where no GDP stabilization was reached, though it resulted in a more stable labor market.

4.6 Final remarks

In this chapter, we presented and discussed the results for the simulations of each policy proposal studied in this thesis. We found that the dynamic unemployment benefit and the government purchases program were capable of achieving stabilization of GDP growth and unemployment rate. The effectiveness of these designs did not depend on the type of trigger. On the other hand, discretionary policy was only capable of stabilizing the labor market, while the direct stimulus program failed to produce any stabilizing effect.

We analyzed the results in light of the two engines of the model. The Keynesian engine is where almost all stabilization originated. We attributed the effectiveness of policies to a drop in precautionary saving, preventing an effect similar to Keynes' paradox of thrift, and to the redistribution of income promoted by these policies, which are part of the Keynesian engine of the model. The Schumpeterian engine was characterized by mixed forces that resulted in a slight negative effect.

We also compared policies' performances, attributing the success of the unem-

ployment benefit and government purchases program over the direct stimulus program and discretionary policy to a better precision of the bulk of demand boosts. At last, we presented the drawbacks – mainly more inflation – and links to recent empirical studies regarding the effective policies.

5 CONCLUSIONS

Interest on fiscal policy has risen along the last two decades, especially after the global financial crisis and the Covid-19 pandemic. But this movement was characterized by pragmatic action by politicians followed by academic interest, with both being short-lived and somewhat reverted after some time. While there was no relevant change in the core mainstream disbelief of discretionary fiscal policy that has dominated since the surge of rational expectation hypothesis in the late 1970s, some suspicion over the effectiveness of monetary policy alone to stabilize macroeconomic activity has also arisen. In this context, the idea of implementing semiautomatic stabilizers and enhancing automatic stabilizers emerged.

In this thesis, we tried to overview the discussion of fiscal policy as a stabilization tool. We traced back the history of the debate of how fiscal policy should take form and how the mainstream economic thought got to where it is right now. As we have showed, fiscal policy was born with the Keynesian revolution and for some time was a primary government tool, but later relegated to the backseat in favor of monetary policy. This view was slowly and briefly changed by the events of the beginning of the twenty-first century.

We also aimed to sum up the latest debates on fiscal policy. Although it is still mostly distrusted, the current mainstream economic thought is not as consensual about this topic as it has been in three or four decades ago. Enhancing existing stabilizers and creating semiautomatic stabilizers – policies that take place after a predetermined variable reaches a threshold, activating a trigger – were some of the alternatives proposed by some economists close to the mainstream. This was due to the fact that they would allow a more active fiscal policy without leaving the rule-based realm.

Our experiment was done using an agent-based model. The option for this kind of model was due to its properties and capacities. ABMs are microfounded, bottom-up models with heterogeneity in a persistent and relevant manner for the aggregate. They reverse several neoclassical assumptions and portray the economy as a complex adaptive system. Specifically, the choice of the K+S labor model was due to its detailed labor market and capacity to reproduce hysteresis and many economic stylized facts.

Having this background, we analyzed some rule-based fiscal policy schemes based on some actual policy proposals. The designs chosen to be assessed were a program that sends fiscal stimulus directly to all workers; a program that increases the unemployment benefit rate during downturns; a public consumption program; and a discretionary policy scheme.

Also, we explored the two main suggestions for trigger variables: GDP growth and

unemployment rate. As we have seen, there was no relevant difference from one type of trigger to the other. Supposedly, deploying the policies in the presence of unemployment slumps would be preferable because it would capture only fluctuations around potential GDP.

This thesis contributes to the current debate of implementing new stabilizers and/or reforming existing ones. The model's results showed that making unemployment benefit dynamic by raising replacement rates in periods of downturns should yield positive results, and that when it comes to policies aimed at consumers, this policy design might be preferable to a program of direct transfers to all individuals. We also found that a fixed size government purchases program might be more effective than pure discretionary action.

All policies that led to some level of stabilization were characterized by smaller workers savings and Gini index. This suggests that stabilization happens mainly through preventing excessive saving and through the redistribution channel. The findings also somewhat relate to empirical studies, specially in the case of the recent unemployment insurance supplementation that was established in the U.S. during the Covid-19 pandemic.

As we end, the safest conclusion to be taken is that fiscal policy is powerful and should not be neglected as a stabilization tool. Beyond this, our assessment of policies is in no way exhaustive. The main limitation of this analysis is likely the number of Monte Carlo runs, which could be larger to enhance the statistical power of tests. The possibility that 50 Monte Carlo runs not being enough to properly analyze outcomes/impacts of the policies on an ensemble of variables was not anticipated, since most publications using this family of models use this number of replications. For future research, this should be increased. Perhaps a better suited baseline scenario or model (with inflation and GDP growth rates closer to the real world) to test these policies can be found. Also, as mentioned above, studying what makes a government good or bad at conducting fiscal policy and whether this matters at all should be an interesting topic of study. Moreover, it is possible that a direct stimulus payment program and a well done discretionary policy can also work to stabilize economies, and more research needs to be done on this topic since some developing countries suffer from procyclical unemployment benefit schemes. However, supplementing a properly working unemployment benefit scheme during downturns might be a simpler and easier alternative.

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Appendices

A PARAMETER VALUES

	Scenarios		
Variables	Set 1	Set 2	Set 3
Direct stimulus payment			
φ^{disb}	0.01	0.1	-
φ^{trf}	0.001	0.1	-
Dynamic unemployment benefit			
φ^{bonus}	0.1	0.15	0.2
Government purchases program			
φ^{disb}	0.005	0.01	-
Discretionary policy			
φ^{fp}	0 (0.25 sd)	0 (0.05 sd)	-
δ_r	0.3	0.1	-
δ_w	0.75	0.95	-

Table A1 – Values for the introduced parameters

B BASELINE SCENARIO RESULTS

Variables	Median	SD	Min	Max
GDP growth	0.0160	0.0020	0.0115	0.0225
Volatility of GDP growth	0.0592	0.0154	0.0207	0.0855
Likelihood of GDP crises	0.1267	0.0476	0.0233	0.2500
Recovery from GDP crises	17.000	8.8860	5.6670	46.670
Losses from GDP crises	3.8440	3.1430	0.1573	14.930
Capacity utilization	0.9694	0.0090	0.9327	0.9839
Inflation	0.0726%	0.0013	-0.0647%	0.0050%
Government income	0.0172	0.0004	0.0162	0.0180
Government consumption	0.0004	0.0011	0.0000	0.0039
Government transfers	0.0226	0.0111	0.0056	0.0537
Government primary deficit	0.0062	0.0103	-0.0085	0.0361
Government debt	1.0720	0.9534	0.0969	4.7260
Volatility of Consumption	0.0566	0.0107	0.0290	0.0720
Volatility of Income	0.0434	0.0090	0.0312	0.0671
Bad debt	0.0173	0.0041	0.0112	0.0306
Savings	0.0101	0.0069	0.0027	0.0445
Volatility of Savings	0.0637	0.0125	0.0340	0.0986
Unemployment	0.1336	0.0672	0.0342	0.3287
Volatility of Unemployment	0.1389	0.0484	0.0320	0.3201
Gini index (all income)	0.2236	0.0464	0.1485	0.3489
Worker tenure	6.4580	0.8693	4.1020	8.1780
Workers tenure skills	1.6100	0.0821	1.4180	1.7490
Innovation	0.0910	0.0058	0.0810	0.1072

Table A2 – Monte Carlo descriptive statistics of the baseline scenario